The Treatment of Hexavalent Chromium (Cr(VI)) in the City of Glendale, California Ground Water Supply:

Phase III
Demonstration-Scale
Reduction with Ferrous Sulfate, Coagulation, Filtration (RCF)
Treatment Technology Evaluation

QUALITY ASSURANCE PROJECT PLAN

Draft Submitted to the USEPA Region 9 on

June 16, 2008

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Distribution List of Principal Project Participants

Each organization included in this project is to receive and retain a copy of this QAPP.

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1 Project Description and Objectives

The City of Glendale's groundwater supply in the San Fernando Valley has been contaminated with a wide variety of chemicals, including hexavalent chromium [Cr(VI)], trichloroethylene (TCE), perchloroethylene (PCE), 1,2,3-trichloropropane (TCP), and others, mainly as a result of the improper disposal of industrial waste products. Extraction and treatment of volatile organic compounds (VOCs) is underway in the San Fernando Valley using air stripping and granular activated carbon (GAC), and the treated water is served to customers. Although Cr(VI) was also found in the groundwater supplies, levels were below the total Cr maximum contaminant level (MCL) of 50 μg/L in California. No Cr(VI) treatment was included with the VOC facilities at the time they were constructed.

Until June 2007, the health effects of Cr(VI) in drinking water were uncertain; Cr(VI) was a proven carcinogen by inhalation but little evidence existed to demonstrate the impact of Cr(VI) ingestion. However, a recent study conducted by the National Toxicology Program (NTP) showed that Cr(VI) is a carcinogen by ingestion in animal studies (NTP 2007). Even prior to this study, the Legislature of California mandated that the California Department of Public Health (DPH) establish a Cr(VI) MCL. First, the Office of Environmental Health Hazard Assessment (OEHHA) must set a public health goal (PHG), which will likely be based on the new NTP findings. In Glendale, public concern about Cr(VI) in the groundwater supply led the city to embark on a multi-phase study to identify and install Cr(VI) treatment in anticipation of a Cr(VI) MCL lower than the current total Cr MCL in California.

In the year 2000, the City of Glendale, along with the Cities of Los Angeles, Burbank, and San Fernando, initiated a testing program to develop a full-scale Cr(VI) treatment system capable of removing Cr(VI) to low parts-per-billion levels. The **Phase I Bench-scale study** was conducted to improve the understanding of fundamental chromium chemistry and to screen promising technologies for their ability to treat and remove Cr(VI) to very low levels. The Phase I study is complete and the final report was published by AwwaRF (Brandhuber et al. 2004).

The **Phase II Pilot-scale study** was initiated in the summer of 2003 to further test the promising Cr(VI) removal technologies at pilot scale (i.e., several gallons-per-minute flows) using Glendale groundwater. A final report on the Phase II pilot-scale study was completed in 2005 (MEC 2005). Selected results were also published in peer-reviewed scientific journals (Qin et al. 2005, McGuire et al. 2006).

The **Phase III Demonstration-scale study** will finalize the treatment evaluation, residuals assessment, and cost estimate development by implementing one or more Cr(VI) removal technologies. The initial part of the Phase III effort was designated as the Phase III Bridge Project, which included additional studies to finalize testing of weak-base anion exchange resins for Cr(VI) treatment, refinement of treatment technology cost estimates based on Phase III Bridge Project results, and assembly of an expert panel to recommend one or more treatment processes for demonstration-scale testing. The Phase III Bridge Project was completed in early 2007 and the project report was published by AWWA (McGuire et al. 2007).

The Phase III Demonstration-scale study will start with testing WBA resin for Cr(VI) removal from a 425 gallons per minute (gpm) groundwater well. The WBA resin evaluation is funded in part by the US Environmental Protection Agency (USEPA) State and Tribal Assistance Grant (STAG) and California Proposition 50. The Experimental Plan and Quality Assurance Project Plan (QAPP) for WBA resin evaluation are under review by different stakeholders including USEPA Region 9, California DPH, City of Glendale, and Glendale Respondent's Group (GRG). Constructions of the WBA demonstration-scale systems are expected to begin in the fall of 2008.

Reduction with ferrous sulfate, coagulation, and filtration (RCF) was recommended for demonstration-scale testing by the expert panel convened as part of the Phase III Bridge Project. The recommendation was based on process effectiveness, a thorough understanding of the RCF technology, and ease of permitting. Consequently, the City of Glendale intends to design and build a demonstration-scale RCF treatment facility to treat part or all of the water from two high-chromium wells from the North Operable Unit (i.e., GN-2 and GN-3), depending on additional funding availability.

The purpose of this project is to demonstrate the effectiveness of the RCF process in removing Cr(VI) to low part-per-billion levels. The system will be operated for one year under the Proposition 50 grant and other available grants. Treated water will be put to beneficial use by serving Glendale's consumers. Treatment cost information developed in the Phase II Pilot-scale and Phase III Bridge studies will be updated as a result of this effort. This information is intended to be of use to other utilities requiring Cr(VI) treatment and to the state of California in setting a Cr(VI) MCL.

1.1 Treatment System Description

1.1.1 Design Concept Evolution

In the RCF process, Cr(VI) is first reduced to Cr(III) with the addition of excess ferrous iron (Fe^{2+}), which is oxidized to ferric iron (Fe^{3+}) by the electron transfer during the reduction of Cr(VI) and by dissolved oxygen present in the water. Ferrous iron doses found to be acceptable in Phase II testing ranged from 1.5 to 2.5 mg/L for reducing 100 μg/L of Cr(VI) to less than 5 μg/L. Cr(III) either precipitates, forms a co-precipitate with the ferric iron, or adsorbs onto the ferric floc. The ferric iron/Cr(III) particles form larger floc during the aeration and coagulation (with the use of a polymer) stages. Particles are then removed by filtration.

RCF is a mature treatment process for removing of high concentrations of Cr(VI) from industrial wastewaters. RCF minus the reduction step (i.e., just coagulation/filtration) is an accepted technology for arsenic removal in drinking water treatment. Unfortunately, only limited studies have been conducted to examine the possibility of achieving low chromium treatment goals using the RCF process for drinking water. Recent studies investigating the reduction of Cr(VI) with ferrous sulfate in bench-scale experiments yielded mixed results (Brandhuber et al. 2004, Lee and Hering 2003). The process was effective for the removal of Cr from drinking water in one study (Lee and Hering 2003) but not in the other (Brandhuber et al. 2004). Both studies demonstrated that ferrous sulfate effectively reduces Cr(VI) but that subsequent Cr(III) removal by filtration is not effective under all conditions. In Phase II testing, a pilot-scale RCF unit (approx. 2-gpm capacity) successfully removed total chromium to below detectable levels for 23 to 46 hours (Qin et al. 2005).

Based on the Phase II pilot results, a demonstration-scale RCF system was conceptually designed with a treatment capacity of 500 gpm (i.e., one of the likely configurations to treat one well). According to a recent cost estimate by Malcolm Pirnie, the total capital cost for the 500-gpm RCF system was $3.05 million and the annual operations and maintenance (O&M) cost was estimated at $164,000. Due to limited funding availability, the treatment capacity of the demonstration-scale system may have to be reduced to 100 gpm. Further optimization of the RCF system was also necessary to reduce the overall capital cost. As part of the optimization effort, an additional RCF pilot system with 2-gpm capacity was tested during February and March of 2008 to identify the most effective and least costly design.

The additional pilot testing results revealed that an RCF process with 45 minutes of reduction time followed by filtration was successful in consistently reducing Cr(VI) and removing total Cr to concentrations below 1 µg/L (i.e., the method reporting level for total Cr) without the need for an aeration step. In addition, the pilot testing demonstrated that the RCF system could be operated for extended hours (more than 24 hours) with little pressure drop across the filters, further reducing the frequency of backwashing and the quantity of wash water produced. Figure 1-1 shows a simplified schematic of the pilot-scale treatment process. Refer to the document entitled *Report on Additional RCF Pilot Testing to Optimize Design* for more details.

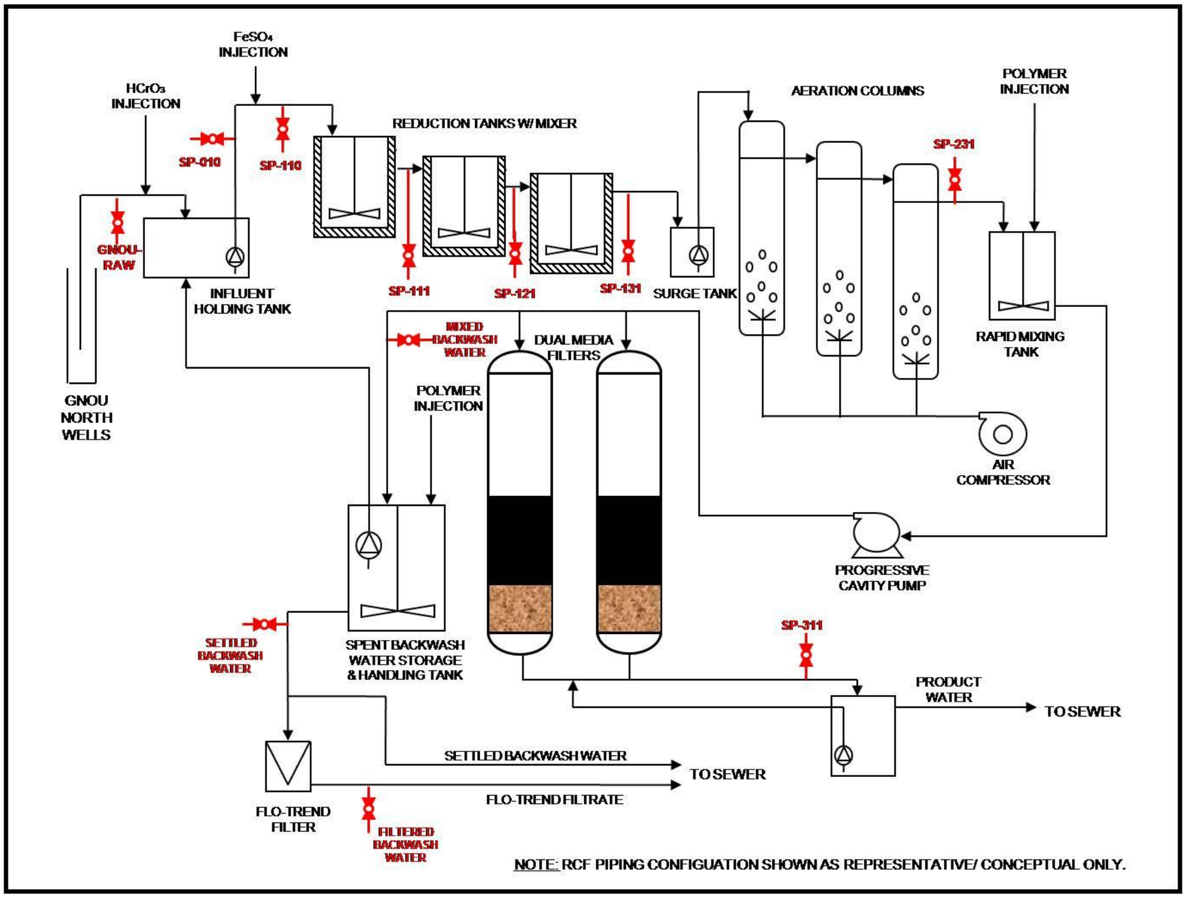

Figure 1-1 Simplified schematic of the additional RCF pilot system

1.1.2 Proposed Demonstration-Scale RCF System (100 GPM)

Figure 1-2 provides the process flow schematic of a 100-gpm demonstration-scale RCF system, which incorporated the design concepts of the 500-gpm system and modifications based on additional pilot study findings.

Raw water from GN-2 and/or GN-3 will be flow to the RCF demonstration site at a rate of 100 gpm. Ferrous sulfate will be injected into the water at a dose of 1.25 mg/L as Fe. The Fe dosage is based on the influent Cr(VI) concentration of 50 μg/L, and the 25:1 ratio of Fe to Cr(VI) shown to be effective in both Phase II and the additional RCF pilot study[1].

After going through a static mixer, the Fe-spiked influent water will flow to three identical reduction tanks piped in series. Each reduction tank will be equipped with a mechanical mixer and have a volume of 1,500 gallons. The three reduction tanks in series provide a total detention time of 45 minutes for the 100 gpm water flow. The purpose of using three tanks in series is to

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[1] Fe dosage will be adjusted during the demonstration-scale study to account for the actual influent water Cr(VI) concentration.

increase mixing efficiency by minimizing short circuiting and back flow problems. The three reduction tanks will also be designed with the ability to bypass one or two tanks so that any maintenance or malfunction issues with the tank and/or mechanical mixer will not cause a shut-down of the whole RCF system.

One of the most important findings from the additional pilot study was that no pH adjustment or additional aeration (beyond that provided by the dissolved oxygen in the water) was necessary. Therefore, Malcolm Pirnie recommended the exclusion of those two components in the demonstration-scale RCF system design for cost saving purposes. However, physical space and hydraulic capacity for pH adjustment and aeration will be included in the design process in case the two components are needed at a later time.

After going through the reduction tanks, the water will flow to a 500-gallon rapid mixing tank, into which polymer is injected for enhanced Fe and Cr floc formation. The mixing tank will provide an additional 5 minutes for floc formation. Different anionic polymers, Magnafloc Ciba E38, E40, and Nalco 9901, were tested during the additional RCF pilot study. Under optimized condition, 0.1 mg/L of Magnafloc Ciba E38 polymer was determined to be an effective dose for floc formation in the RCF process.

After mixing tank, water containing Fe and Cr floc will be pumped by progressive cavity pump to two pressurized dual media filters in down-flow mode. One lesson learned from the additional pilot study is that the use of progressive cavity pump is necessary for enhanced filtration performance by minimizing the break-up of Fe and Cr floc that has already been formed. In fact, any pumping of process water in which floc formation has occurred should employ a progressive cavity pump. The dual media filters will consist of approximately 24 inches of anthracite and 12 inches of sand, with a supportive underdrain. The design hydraulic loading rate for both filters is about 3 gallons per minute per square foot (gpm/sf). Conceptually, two 4.5-foot diameter vertical pressure vessels will be needed for the 100 gpm system.

The majority of filtered water will blend with water from other GOU wells and undergo further VOC treatment at the Glendale Water Treatment Plant. A small portion of filtered water will be diverted to a product water storage tank for backwash purpose or product water from the GWTP will be used for backwash.

During backwash, stored product water will be pumped through the filters in an up-flow mode at a loading rate of 21 gpm/sf or higher for 5 to 10 minutes. Concurrent air scouring is also desirable during backwash. Spent backwash water will overflow to a separate storage tank, where polymer is injected and mixed so that the solids in the backwash water will settle efficiently. During the additional RCF pilot study, backwash water was effectively settled using 1.0 mg/L Magnafloc Ciba E38 anionic polymer. It should be noted that the same polymer was also effective for promoting floc formation in the rapid mixing tank. Therefore, it is possible to design a common polymer storage system for use in both the rapid mixing tank and spent backwash water storage tank at the demonstration-scale facility. Supernatant from the backwash storage tank contained approximately 30 μg/L total Cr and 1 mg/L Fe as determined during the addition pilot study. The supernatant water quality was considered acceptable to be recycled to the head of the RCF system at a rate of 4 – 5 % of the influent flow (i.e., 4 – 5 gpm).

Settled backwash solids will be sent to a passive filtration system using a technology akin to the Flo-Trend system. The filtrate is expected to have a water quality similar to the backwash supernatant and can be recycled to the spent backwash water storage tank while dewatered solids captured on the filter will be shipped for disposal at a hazardous waste landfill[2].

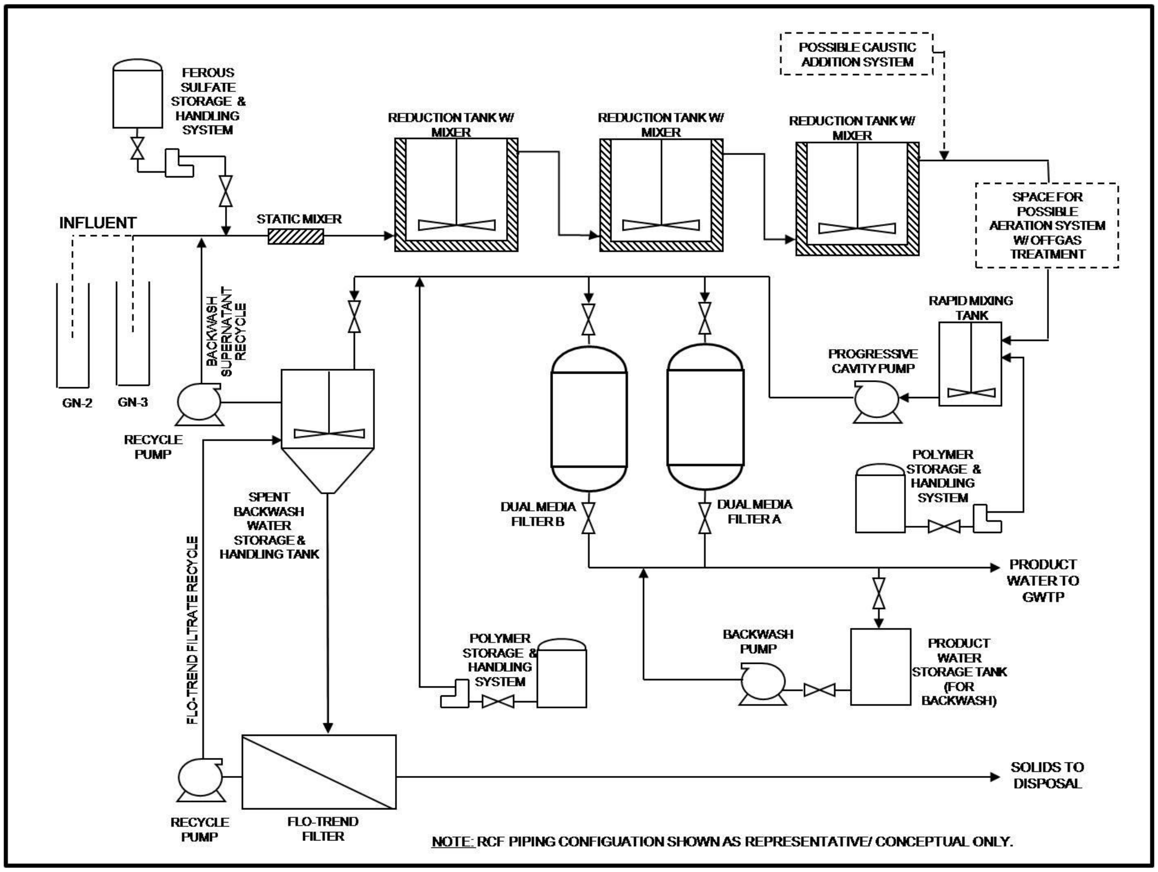

Figure 1-2: Flow schematic of the proposed demonstration-scale RCF treatment plant (100 gpm)

1.1.3 Location of the RCF System

The demonstration-scale RCF system is proposed to be located adjacent to the Glendale Water Treatment Plant (GWTP) to treat water from GN-2 and/or GN-3. The wells GN-2 and GN-3 each have a capacity of 567 gpm. Cr(VI) concentration in these two wells ranges from 40 to 60 µg/L and is expected reach as high as 170 µg/L according to a CH2MHILL report. High Cr(VI) levels in the well water make them good candidates for the demonstration study.

Well GN-2 is located on the site of the Dream Works Animation Studios and Well GN-3 is located on the new Disney Animation Studios site now under development. For both locations, no property is available at the well sites for the demonstration-scale RCF system.

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[2] Phase II RCF pilot testing showed that the settled backwash solids failed the California WET test and were characterized as hazardous waste in California.

A dedicated pipeline will be constructed from the well site(s) to the proposed demonstration facility next to the GWTP. The site of this potential RCF demonstration facility is owned by the City of Glendale and is part of the City's Corporate Yard for the water and power field personnel. The City has "fee" title to this property that has been designated as the location for a demonstration facility. Figure 2-4 shows the location of proposed demonstration-scale RCF system.

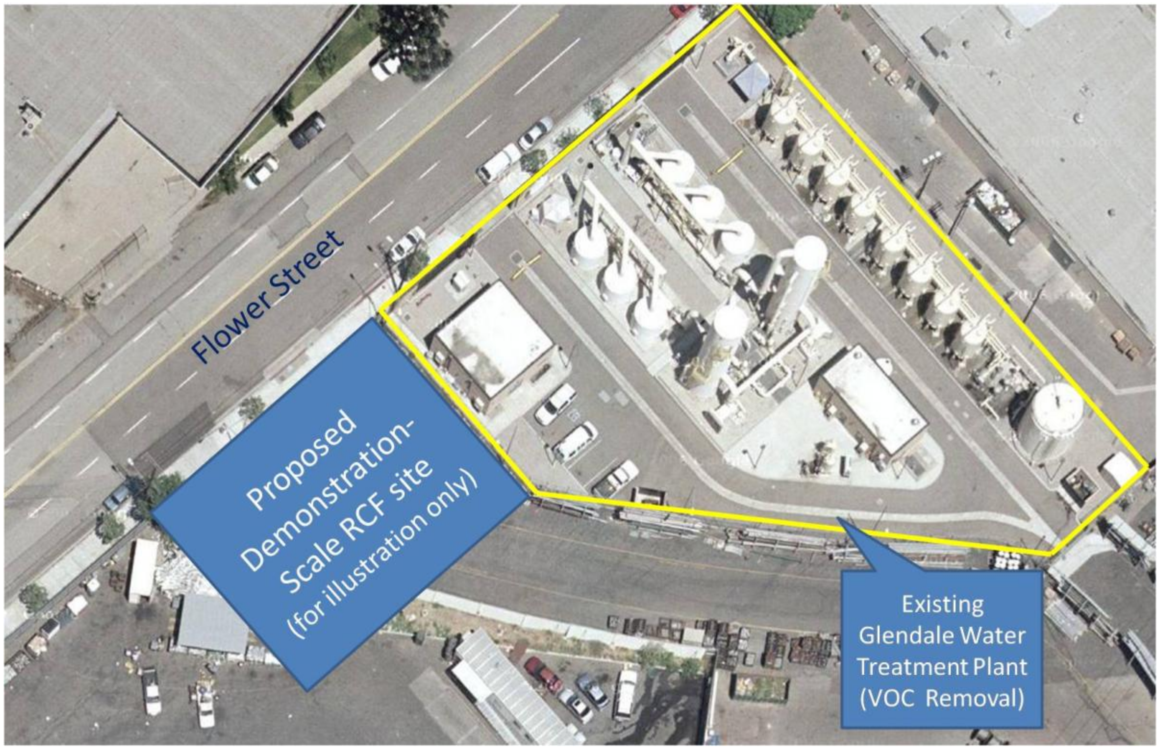


Figure 1-3: Map showing the location of proposed RCF system (100 gpm)

1.2 Study Objectives

The primary goal of the study is to demonstrate that a 100-gpm RCF system can reduce Cr(VI) concentration in the GN-2 and/or GN-3 wells, and Cr(VI) and total Cr concentrations from the RCF system effluent remain below 1 μg/L over extended periods of time. It should be noted that total Cr and/or Cr(VI) concentration in the RCF effluent might exceed 1 μg/L due to possible system upsets. However, as a Cr(VI) –specific MCL does not currently exist and the 100-gpm RCF effluent will be blended with approximately 4,900 gpm GOU well water for subsequent VOC removal, total Cr concentrations in the GWTP effluent are not expected to exceed the 50 μg/L California MCL.

In addition, the objectives of the Phase III Demonstration-scale RCF study include:

- Minimizing operational costs of the RCF system through continued treatment process optimization
- Optimizing residuals handling and disposal strategies
- Drafting a comprehensive operations and maintenance (O&M) manual for the system
- Updating unit cost information developed in the Phase II Pilot-scale study with actual treatment cost, and
- Publicly disseminating project plans and findings to a wide audience, including water agencies also concerned with Cr(VI) in water supplies, California DPH, the USEPA, and consumers

For residuals disposal, critical values that may trigger hazardous waste restrictions in this treatment system include:

- Total chromium (5 mg/L by California Waste Extraction Test, or CWET, and 5 mg/L by the Toxicity Leaching Characteristic Procedure, TCLP)

2 Project Organization

2.1 Key Points of Contact

Refer to the above Distribution List of Principal Project Participants for the key points of contact at each organization.

2.2 QA Managers

The QAPP dictates procedures that will be used by two primary organizations: Malcolm Pirnie and the ELAP-certified laboratories (Montgomery Watson Harza (MWH) Laboratories and Test America). With respect to data quality assurance, Malcolm Pirnie is charged with the tasks of sample collection, handling, field analysis of selected parameters, data management, data reduction, and data validation. Malcolm Pirnie's QA Manager will be Dr. Michael MacPhee. He is independent of Project Management and his only role in the project is as QA Manager. The QA Manager at MWH Labs will be Ms. Linda Geddes, Quality Assurance Officer. The QA Manager at Test America will be Marti Ward.

2.3 Responsibilities of Project Participants

Each project participant responsible for critical components in this project is listed in Table 2-1. Team members' affiliations and overall project involvement roles are also listed. Project involvement roles specified here include: Planning, Coordination, Sample Collection, Sample Custody, Measurements (Analytical, Physical, and Process), Data Reduction, Data Validation, and Report Preparation. The project team organization is illustrated in Figure 2-1.

The majority of the project team was significantly involved in Phase II testing, which was covered by the QAPP entitled *The Treatment of Hexavalent Chromium (Cr(VI)) in the City of Glendale Ground Water Supply: Phase II Demonstration of Pilot Scale Treatment Technologies* (dated July 31, 2003). Dr. Bruce Macler has been the EPA Project Manager of the Phase II and Phase III efforts and is up-to-date on the historical study progress. Peter Kavounas and Don Froelich have also been key participants in the previous projects representing the City of Glendale. Dr. Michael J. McGuire, currently the Project Manager, was the Principal-in-Charge of the last study. Dr. Michael J. MacPhee will serve in the same role as in Phase II, as Technical Advisor and Quality Assurance Manager. Dr. Nicole Blute will plan, coordinate, oversee the field operations, and prepare reports. In the Phase II effort, Dr. Blute conducted the pilot-scale operations along with Dr. Danny Qin, who will conduct the field testing in the demonstration study. Dr. Qin is highly experienced in field sampling and analysis, having worked on the Phase II Pilot Study and Phase III Bridge Study and Additional RCF Testing, among other compliance testing and pilot testing efforts for other clients. The three university technical advisors, Dr. Mel Suffet, Dr. Laurie McNeill, and Dr. Gary Amy, have all been part of the Phase I and Phase II efforts. The two laboratories selected for this effort have been used in the prior work or in other projects with the City of Glendale.

Table 2-1. Project participant roles

Team Member	Title and Organization	Overall Project Involvement	Specific Involvement
Bruce Macler, Ph.D.	USEPA, Project Manager	Project Manager	Project Management
Peter Kavounas, PE	City of Glendale	Glendale Principal Investigator	Planning Coordination
Don Froelich, PE	City of Glendale	Glendale Project Management	Planning Coordination
Leighton Fong, PE	City of Glendale	Glendale Project Management	Coordination
Michael McGuire, Ph.D., PE	Vice President, Malcolm Pirnie	Malcolm Pirnie Project Manager	Experimental Design Report Preparation
Michael MacPhee, Ph.D.	Vice President, Malcolm Pirnie	Malcolm Pirnie Technical Advisor	Quality Assurance Manager
Nicole Blute, Ph.D.	Project Engineer, Malcolm Pirnie	Malcolm Pirnie Deputy Project Manager	Planning Coordination Data Reduction and Validation Report Preparation
Danny Qin, D.Env.	Project Engineer, Malcolm Pirnie	Study Field Testing	Study Operations Sample Collection Sample Custody Field Measurements Data Management
Yolanda Martin	Project Manager, MWH Labs	Analytical Support	Coordination of Analytical Laboratory Measurements
Linda Geddes	QA Officer, MWH Labs	Laboratory Quality Assurance	Laboratory Quality Assurance
Kay Clay	Project Manager, Test America Labs	Analytical Support	Coordination of Analytical Laboratory Measurements
Marti Ward	QA Officer, Test America Labs	Laboratory Quality Assurance	Laboratory Quality Assurance
Gary Amy, Ph.D.	Professor, UNESCO	Technical Advisor	Experimental Design
Laurie McNeill, Ph.D.	Associate Professor, USU	Technical Advisor	Experimental Design
Mel Suffet, Ph.D.	Professor, UCLA	Technical Advisor	Experimental Design
To Be Determined	To Be Determined	To Be Determined	Construction

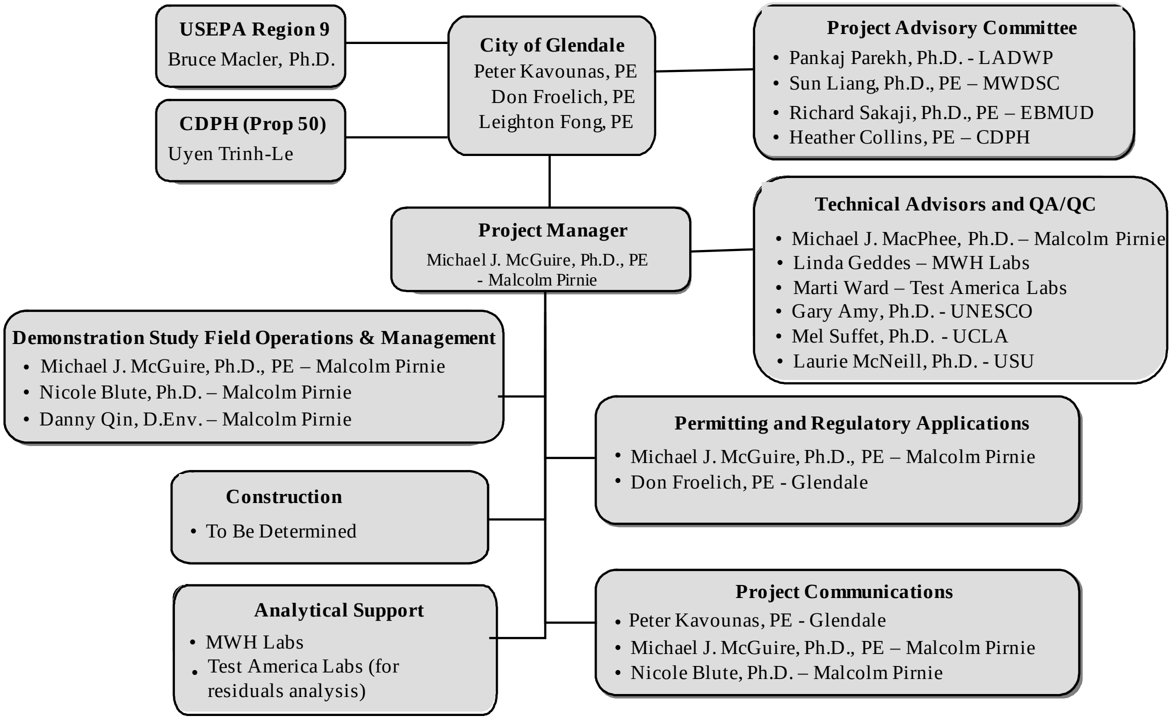


Figure 2-1. Demonstration Study Team Organization and Lines of Communication

2.4 Laboratory Certification Requirements

Each of the laboratories that will be used is certified by the California Department of Public Health under the State's Environmental Laboratory Accreditation Program (ELAP; certifications in Appendix A). Each laboratory's QA and Project Managers will be responsible for ensuring that the laboratory staff are appropriately trained and qualified to conduct the analyses.

3 Experimental Approach

3.1 General Approach and Test Conditions

Evaluation of RCF treatment technology for Cr(VI) removal at demonstration scale will focus on measurement of key water quality and process related parameters (including residuals). Of critical importance, the project team will closely monitor Cr(VI) concentration, total Cr concentration, and turbidity from selected sampling ports installed on the RCF system. In addition, other process-related parameters and water quality constituents described below will be measured to assess operational effectiveness and the impact of the RCF technology on water quality.

Due to the complexity of the RCF system and the inherent difference between water quality and process-related parameters, the sections below describes the sampling strategies for each type of parameters separately. Please note this document focuses on quality assurance and quality control of the demonstration-scale RCF study. Other experimental details of the RCF demonstration-scale study can be found in the document entitled *Experimental Design for Hexavalent Chromium Removal using Reduction with Ferrous Sulfate, Coagulation, and Filtration (RCF) Process: A Demonstration-Scale Study* attached as Appendix B.

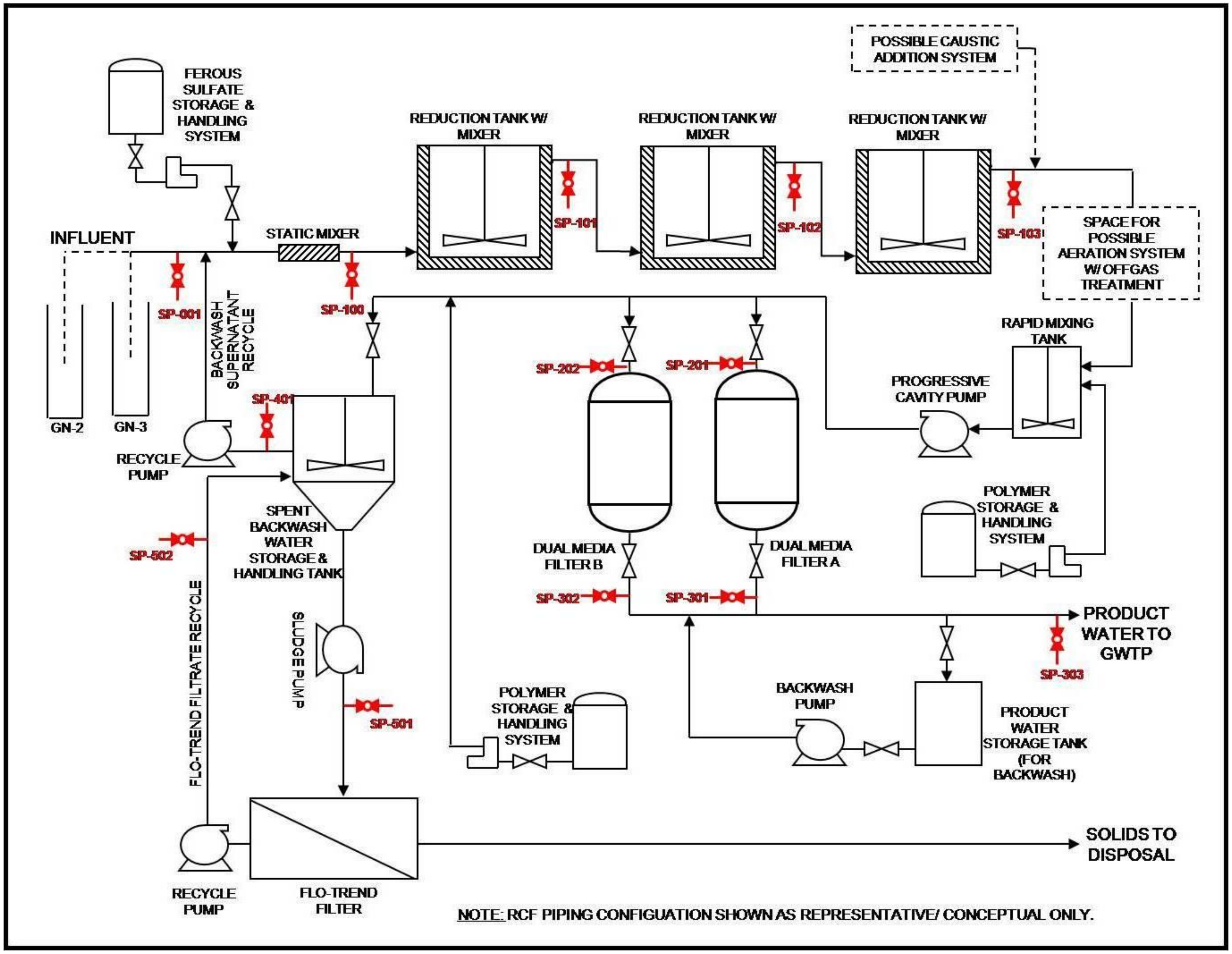
3.2 Sampling Strategies for Water Quality Parameters

3.2.1 Sampling Locations

Sampling ports will be installed as part of the RCF system and water quality samples will be collected from these ports during the demonstration-scale study. Figure 3-1 shows a schematic of the RCF system with sampling ports highlighted in red. A brief description for each sampling port is listed in Table 3-1.

Table 3-1. Water Quality Sampling Location Identification

Sampling Port Identification	Description
SP-001	GN-2 and/or GN-3 Well/Plant Influent
SP-100	Influent after Ferrous Sulfate Addition
SP-101	Reduction Tank #1 Effluent
SP-102	Reduction Tank #2 Effluent
SP-103	Reduction Tank #3 Effluent
SP-201	Dual Media Filter A Influent
SP-202	Dual Media Filter B Influent
SP-301	Dual Media Filter A Effluent
SP-302	Dual Media Filter B Effluent
SP-303	Combined Filter Effluent
SP-401	Backwash Supernatant
SP-501	Settled Backwash Solids
SP-502	Flo-Trend Filtrate



NOTE: RCF PIPING CONFIGUATION SHOWN AS REPRESENTATIVE/ CONCEPTUAL ONLY.

Figure 3-1 Demonstration-scale RCF schematic with sampling ports highlighted in red

3.2.2 Sampling Parameters

Critical water quality parameters of the demonstration-scale RCF study include Cr(VI), total Cr, total Fe, turbidity, dissolved oxygen (DO), and pH. Cr(VI) and total Cr concentrations in process influent and effluent samples are measured to determine whether the treatment goal of less than 1 µg/L Cr(VI) and total Cr is achieved and to determine Cr removal efficiencies. Total Fe, turbidity, and DO from selected sampling ports are important because they are good indicators of the RCF system performance and can be easily measured using onsite instruments. The additional RCF pilot study demonstrated that total Cr concentration in the filter effluent greater than 5 µg/L was coupled with high filter effluent turbidity (i.e., greater than 1 NTU) and high total Fe concentration (i.e., greater than 0.19 mg/L). A high DO concentration in the influent (above ~5 mg/L) would ensure that enough dissolved oxygen is available to oxidize excess ferrous sulfate in the treatment process. pH from selected sampling ports is another important parameter which needs to be monitored routinely.

Other chemical and physical parameters, including ferrous iron (Fe^{2+}), pH, temperature, and total suspended solids (TSS) will be routinely measured to monitor any drastic water quality changes within the RCF process and investigate the possible causes for water quality changes. Table 3-2 summarizes the proposed water quality parameters to be monitored in the demonstration-scale RCF study. Water quality parameters from each sampling port are identified as critical (C), non-critical (N/C), or not necessary (-).

Table 3-2. Water quality parameters to be monitored in the RCF demonstration-scale Study [parameters identified as Critical (C), non-Critical (N/C), and not necessary (-)]

Sampling Port	Cr(VI)	Total Cr	Total Fe	Fe^{2+}	Turbidity	pH	Temp	DO	TSS
SP-001	C	C	N/C	N/C	N/C	C	N/C	C	
SP-100	-	-	C	C	-	-	-	-	-
SP-101	-	-	N/C	N/C	-	C	N/C	-	-
SP-102	-	-	N/C	N/C	-	C	N/C	-	-
SP-103	C	-	C	C	-	C	N/C	C	-
SP-201	-	-	-	-	-	C	N/C	C	-
SP-202	-	-	-	-	-	C	N/C	C	-
SP-301	C	C	C	C	C	N/C	N/C	N/C	-
SP-302	C	C	C	C	C	N/C	N/C	N/C	-
SP-303	C	C	C	C	C	C	C	C	-
SP-401	C	C	C	C	C	N/C	N/C	-	-
SP-501	-	-	-	-	-	-	-	-	N/C
SP-502	C	C	N/C	N/C	C	N/C	N/C	-	-

3.2.3 Sampling Frequency

The planned sampling frequency for water quality parameters, shown in Table 3-3, is based on treatment process design and the expected duration of testing (approximately one year for the demonstration-scale study). Water quality samples will be collected at a sufficient frequency to provide enough information to achieve the project's stated objectives.

Generally, measuring of the critical water quality parameters at each sampling port will occur on a weekly basis, except for parameters that will be monitored continuously. The weekly sampling frequency will generate 52 sets of Cr(VI) and total Cr data from various locations of the RCF system over one-year period, which will enable us to have a comprehensive evaluation of the system performance. Dual media effluent turbidity is a good indicator of total Cr removal performance and will be monitored continuously during the one-year study. Other non-critical parameters will be monitored on a monthly basis, unless noted otherwise in Table 3-3. It should be noted that the sampling frequency listed in Table 3-3 will be adopted once the RCF system has reached a steady-state condition. During system start-up and other operation optimization periods, the sampling frequency may vary.

Table 3-3. Sampling frequency

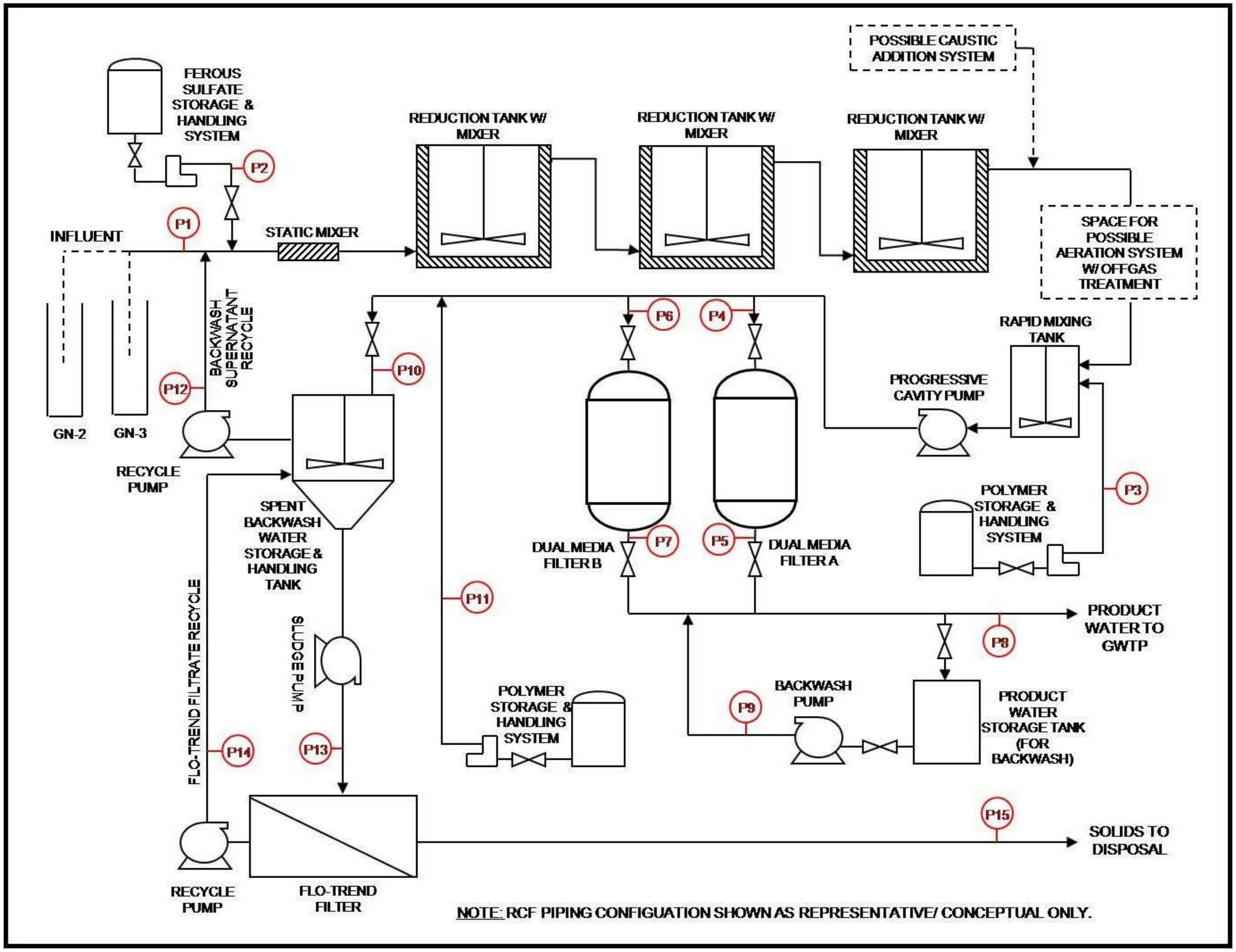
Sampling Port	Laboratory Analysis			Field Analysis					
	Cr(VI)	Total Cr	TSS	Cr(VI)	Total Fe	Fe^{2+}	Turbidity	pH/ Temp[3]	DO
SP-001	1/W[1]	1/W		1/W	1/M[2]	1/M	1/M	Continuous	Continuous
SP-100	-	-	-	-	1/W	1/W	-	-	-
SP-101	-	-	-	-	1/M	1/M	-	1/W	-
SP-102	-	-	-	-	1/M	1/M	-	1/W	-
SP-103	1/W	-	-	-	1/W	1/W	-	1/W	1/W
SP-201	-	-	-	-	-	-	-	1/W	1/W
SP-202	-	-	-	-	-	-	-	1/W	1/W
SP-301	1/W	1/W	-	1/W	1/W	1/W	Continuous	1/M	1/M
SP-302	1/W	1/W	-	1/W	1/W	1/W	Continuous	1/M	1/M
SP-303	1/W	1/W	-	1/W	1/W	1/W	Continuous	1/W	1/W
SP-401	1/W	1/W	-	1/W	1/W	1/W	1/W	1/M	-
SP-501	-	-	1/M	-	-	-	-	-	-
SP-502	1/W	1/W	-	1/W	1/M	1/M	1/W	1/M	-

[1] 1/W = Once per week
[2] 1/M = Once per month
[3] pH and temperature will be monitored at the same frequency because the pH meter selected for the RCF study has temperature compensation function to ensure more accurate measurement.

3.3 Monitoring Strategies for Process-Related Parameters

3.3.1 Monitoring Locations

Figure 3-2 shows a schematic of the RCF system with monitoring locations for process-related parameters highlighted in red.



NOTE: RCF PIPING CONFIGUATION SHOWN AS REPRESENTATIVE/ CONCEPTUAL ONLY.

Figure 3-2. RCF schematic with monitoring locations for process-related parameters highlighted

3.3.2 Monitoring Parameters

Process parameters for the demonstration study include water flow rate, chemical feed rate, pressure buildup through the filter columns, and more. Treatment residuals are also categorized as process-related parameters in the study. Table 3-4 identifies the process parameters that will be monitored at each location.

Table 3-4. Monitoring locations and frequencies for process-related parameters

Monitoring Location	Process-related parameters	Frequency
P1	Influent water flow rate and total volume	Once Daily
P2	Ferrous sulfate injection rate and liquid level	Once Daily
P3	Polymer injection rate and liquid level	Once Daily
P4	Dual Media Filter A influent flow rate and inlet pressure	Once Daily
P5	Dual Media Filter A outlet pressure	Once Daily
P6	Dual Media Filter B influent flow rate and inlet pressure	Once Daily
P7	Dual Media Filter B outlet pressure	Once Daily
P8	Combined filter effluent flow rate and total volume	Once Daily
P9	Backwash water flow rate and total volume	Once every backwash cycle
P10	Spent backwash water total volume	Once every backwash cycle
P11	Polymer injection rate and liquid level	Once every backwash cycle
P12	Backwash supernatant recycle flow rate and total volume	Once every backwash cycle
P13	Settled backwash solids total volume	Once every backwash cycle
P14	Flo-Trend filtrate recycle total volume	Once every backwash cycle
P15	Dewatered sludge total quantity, moisture content, and TCLP and WET test on dewatered sludge	Once every off-site disposal

3.3.3 Monitoring Frequency

The planned monitoring frequency for process-related parameters is also shown in Table 3-4. It should be noted that the demonstration-scale RCF system will be designed to operate automatically with minimal operators' supervision. As a result, some of the process-related parameters will be monitored and recorded continuously and the data will be transmitted to the GWTP via the Supervisory Control and Data Acquisition (SCADA) system. However, system operators are still required to follow the monitoring plan as specified in Table 3-4 to ensure the completeness of the operational data.

3.4 Identification of Measurements

Table 3-2 identify water quality parameters and specify whether they are critical (C) or non-critical (N/C) analytes. Process-related parameters are considered equally important in this study and will be monitored as specified in Table 3-4.

3.5 Evaluation of Project Objectives

Treatment technology success will primarily be judged by the effectiveness of the process to remove Cr(VI) and total Cr from the water supply. Effluent Cr(VI) and total Cr will be measured and plotted as a function of time to determine whether the demonstration-scale RCF system will continuously produce water containing less than 1 µg/L Cr(VI) and total Cr.

Another way to evaluate chromium removal efficiency is to calculate the difference between influent and effluent chromium concentrations during the demonstration-scale study. Efficiency of removal will be calculated as follows:

$$\text{Removal (\%)} = (1- [\text{Cr}_{\text{effluent}}]/[\text{Cr}_{\text{influent}}])*100\%.$$

It should be noted that total Cr and/or Cr(VI) concentration in the RCF effluent might exceed 1 µg/L due to possible system upsets. However, as a Cr(VI) –specific MCL does not currently exist and the 100-gpm RCF effluent will be blended with approximately 4,900 gpm GOU well water for subsequent VOC removal, total Cr concentrations in the GWTP effluent are expected to be less than the 50 µg/L California MCL. Therefore, occasional spikes in total Cr and/or Cr(VI) concentrations from RCF effluent do not reflect a project failure.

Operations and maintenance (O&M) issues will be evaluated through monitoring the process-related parameters as listed in Table 3-4. The process-related information will also be important in the development of the RCF treatment cost.

The Phase II Pilot study indicated that the dewatered solids would be classified as hazardous in the state of California due to the California Waste Extraction test (WET -- CCR Title 22 §66261.24) but not in states governed only by the federal Toxicity Characteristic Leaching Procedure (TCLP – EPA Method 1311 as mandated by 40 CFR 261). Subsamples of dewatered solids from the demonstration test will be analyzed to verify the hazardous nature of the residuals and, subsequently, the disposal options.

A broader purpose of the demonstration testing is to develop a technology that can be applied in other water utilities needing Cr(VI) treatment. Glendale’s demonstration study will therefore foster a better understanding of the RCF treatment technology for Cr(VI) removal from groundwater.

4 Sampling Procedures

4.1 Methods to Establish Steady-State Conditions

For the demonstration-scale RCF system, sampling conditions that reflect steady-state operations will be based on consistency of flows, stable chemical feed conditions, influent water quality and optimized operation of every unit process. Malcolm Pirnie proposes to dedicate the first week to system start-up. During the start-up period, operating conditions including influent water flow rate, chemical dosages and filter operations will be adjusted and optimized to obtain a consistent Cr(VI) removal performance (i.e., establishing steady-state conditions). Once the RCF system produces water with less than 1 µg/L Cr(VI) and total Cr for three consecutive days, the steady-state conditions are considered to have been established and routine sampling will start. Refer to Appendix B for more information on start-up procedures.

4.2 Known Site-Specific Factors Affecting Sampling and Monitoring Procedures

The proposed demonstration testing site will have dedicated space, power, and water from the GN-2 and/or GN-3 well. The effluent will be pumped into the transmission line leading to the Glendale Water Treatment Plant for VOC treatment. The RCF system will be designed with sampling ports to enable appropriate sampling for technology performance assessment as detailed in Section 3.

Limited hours of site accessibility (approximately 8 hours per day) will affect the possible time on site. However, the system will be tied into the existing SCADA system and equipped with alarms at critical locations. Operators are available around the clock in case the system experiences problems.

4.3 Site Preparation Prior to Sampling

The demonstration-scale facility will be located adjacent to the existing Glendale Water Treatment Plant (see Figure 1-3). Site preparations that will be conducted before the demonstration-scale study commences include the following tasks:

- construction of a demonstration-scale RCF system with a flow capacity of 100 gpm,
- preparation of necessary electrical power supplies,
- integration of the treatment system with the existing SCADA system,
- piping of the raw GN-2 and/or GN-3 well water to the treatment system,
- piping of the RCF treated water to the transmission pipeline serving the GWTP, and
- obtaining necessary permits for the project (e.g., CEQA, NEPA and sewer discharge permits).

4.4 Sampling/Monitoring Methods

Water quality parameters and residuals characteristics will be measured in this demonstration-scale study either in the field or in a laboratory. The analytical methods and locations of analyses are shown in Table 4-1.

Laboratory analytical measurements will be sent to the labs listed below:

- MWH Laboratories, Inc. – for Cr(VI), total Cr, and TSS
- Test America (formerly Severn Trent) – for moisture content, TCLP, and CWET

Quality assurance sampling includes field-collected duplicate samples and field blanks (refer to Section 6.1 for full details). Generally, field-collected duplicate samples will be collected for at least 10% of all samples. These duplicates will not be identified as QA samples when sent to the laboratory.

Blanks that will be analyzed include: metal-free water added to a sample bottle in the field and shipped to the laboratory for analysis (testing field sample handling, transport, and storage), preservative reagents added to metal-free water, and deionized water used for diluting field samples for measurement. Blanks submitted to the laboratory for analysis will not be identified as QA samples.

Samples will not be composited to amplify sample volume or average samples over time. Sufficient sample volume will be available for the required analyses.

4.5 Split Sampling for QA/QC Sampling

Split samples (i.e., samples split into two or more subsamples) will be used to verify analytical precision. Additional details in Section 6.1 describe precision testing with split samples. In addition to split samples, field-collected duplicate samples will be collected at the frequency shown in Table 6-1 to test analytical accuracy.

Table 4-1. Analytical methods and locations

Sampling Parameters	Analytical Method	Analysis Location
Cr(VI) – Lab	EPA 218.6 (IC)	MWH Labs
Total Cr	EPA 200.8 (ICP-MS)	MWH Labs
TSS	EPA 160.2 (Gravimetric)	MWH Labs
Cr(VI) – Field	Hach 8023 (Diphenlcarbohydrazide)	Field
Total Iron	Hach Method 8008 (Ferro Ver)	Field
Ferrous Iron	Hach Method 8146 (1, 10-Phenanthroline)	Field
pH	SM 4500H+ B (Electrometric)	Field
pH (Continuous)	SM 4500H+ B (Electrometric)	Online
Temperature	SM 2550 (Thermometric)	Field
Turbidity	SM 2130 B (Nephelometric)	Field
Turbidity – Continuous	SM 2130 B (Nephelometric)	Online
DO	Hach 8166 (HRDO)	Field
DO – Continuous	Hach Method 10360 (Luminescence measurement)[1]	Online
Residuals – TCLP	EPA 1311 – Extraction EPA 6010B – Total Cr	Test America Labs
Residuals – CWET	CWET Test (Title 22) – Extraction EPA 6010 B – Total Cr EPA 7196A – Cr(VI)	Test America Labs
Residuals – Moisture Content	EPA Contract Laboratory Program (CLP) Statement of Work (SOW) ILM 05.3	Test America Labs

[1] EPA approved method

4.6 Calibration of Sampling/Monitoring Equipment

Field equipment calibration will be performed in accordance with manufacturer specifications for each instrument. Certified standard solutions will be used to test the functionality and accuracy of each instrument within the range of measurements and at a frequency specified by the manufacturer, or at least once per month.

Process instruments, such as flow meters and pumps, will be calibrated before the demonstration-scale treatment unit is brought online, at one intermediate time during operations (minimally), and at the conclusion of the test. Calibration results and date and time of calibration will be recorded in the Field Sample Log Book.

Trained operators will determine whether the calibrations are acceptable based on the allowed drift specified by the manufacturer. If an instrument is not functioning properly (e.g. calibration attempts are unsuccessful or the standard curve is unacceptable), the operator will obtain a calibrated back-up instrument for interim use and will send the malfunctioning instrument for repair.

4.7 Avoidance of Cross-Contamination

Sample contamination will be avoided by practicing clean sampling techniques. Water samples will be collected from dedicated sampling ports by directly filling pre-cleaned sample bottles Sample collections staff will avoid contact with the interior surfaces of the bottles. Hosing from the sampling ports will initially be cleaned to remove any contaminants. Prior to sample collection, the sampling port and hose will be flushed for at least 1 minute to clean out the lines.

California DPH recommends *not* filtering drinking water samples to avoid potential sorption of Cr(VI) on the filter membranes and cross-contamination (CA DHS, 2001). Cr(VI) samples will therefore remain unfiltered in the field.

4.8 Selection of Representative Samples

Samples collected in this demonstration-scale study will be representative of the whole study based on consistent sampling from established sampling locations and at specified sampling frequencies (refer to Tables 3-3 and 3-4).

4.9 Sample Amounts Required for Analysis

Table 4-2 lists the sample amounts required for analysis according to each method (including QA aliquots except duplicates), preservatives, and maximum holding times. The same amounts will be required for each analysis at each sampling location. Field-collected duplicate sample quantities discussed in Section 4.4 will be in addition to the bottles below.

To determine if dewatered sludge will be classified as a hazardous waste, TCLP and WET tests will be performed. The Federal TCLP test requires a minimum of two 100-gram samples: one sample to determine percent solids, and one sample on which the extractions will be performed.

California WET mandates a 50 gram sample for analysis. Moisture content analysis requires a minimum of 10-gram sample.

Table 4-2. Sample handling requirements

Sampling Parameters	Sample Size Required, including QC Aliquots	Container Material	Preservative	Maximum Holding Time
Cr(VI) – Lab	125 mL	P[1]	None	24 hours[2]
Total Cr	125 mL	P	HNO_3 to pH <2	6 months
TSS	500 mL	P	4 ℃	7 days
Cr(VI) – Field	50 mL	P	None	Analyze Immediately
Total Iron	50 mL	P	None	Analyze Immediately
Ferrous Iron	50 mL	P	None	Analyze Immediately
pH	500 mL[3]	P	None	Analyze Immediately
pH (Continuous)	Not Applicable (NA)	NA	None	Real-time Analysis
Temperature	500 mL[3]	P	None	Analyze Immediately
Turbidity	500 mL[3]	P	None	Analyze Immediately
Turbidity (Continuous)	NA	NA	None	Real-time Analysis
DO	500 mL[3]	P	None	Analyze Immediately
DO (Continuous)	NA	NA	None	Real-time Analysis
Residuals – TCLP	200 g	P	4 ℃	None specified
Residuals – CWET	50 g	P	4 ℃	None specified
Residuals – Moisture Content	10 g	P	4 ℃	None specified

[1] P = Plastic.

[2] Although samples preserved with ammonium sulfate/ ammonium hydroxide buffer (pH 9 to 9.5) can be held for 28 days, analyses will be conducted within 24 hours.

[3] Combined 500 mL bottle for pH, temperature, turbidity, and DO.

4.10 Sample Containers

All samples will be collected using containers pre-cleaned and approved by the USEPA for the analytes of interest. Samples for the critical Cr(VI) and total Cr analyses will be collected in pre-cleaned plastic bottles provided by the laboratory or, for field testing, those shown to be clean of contamination in the Phase II testing. Bottle types for other analyses of interest may be plastic or glass (EPA 1997), although plastic will be used to eliminate breakage during shipping (refer to Table 4-2). Empty containers will be stored in the original packaging until use. Once collected, samples will be shipped to the laboratories for analysis according to the protocol for sample custody.

4.11 Sample Identification

Samples will be identified using a standardized code that imparts sampling information to each party. Each sample location will be assigned a numerical ID (see Table 3-1). Next, the sample will be numbered consecutively. The date and time will then be recorded using the convention of military time. The analyte(s) to be measured in that sample will be recorded on the label, as will the preservative used. Finally, the field sample collector’s initials will be added.

An example identification label is as follows:

Sample Location ___________________
Sample ID ___________________
Date and Time ___________________
Analyte(s) ___________________
Preservative, if any ___________________
Field Sampler Initials ___________________

4.12 Sample Preservation Methods

Table 4-2 lists the preservation requirements for each of the methods that will be used in the demonstration study. Details of sample preservation include whether the sample needs to be chilled at 4°C, if an acid or base is required (and if so, what dosage), the type of container required for sample collection and storage, and the maximum holding time.

As the critical analytes, more details for Cr(VI) and total Cr are provided here. Samples for total Cr will be preserved with 2% nitric acid (HNO_3). It is intended that Cr(VI) samples will be analyzed within 24 hours of sample collection, thereby avoiding the need for preservative. If this is not possible, samples will be preserved with ammonium sulfate/ ammonium hydroxide buffer, and analyzed within 28 days.

4.13 Sample Holding Time Requirements

Maximum holding times for each of the analytes are shown in Table 4-2.

4.14 Sample Shipment

Samples will be shipped by courier from the site of collection to the appropriate contract laboratory using a reputable shipping company. Shipping containers will consist of coolers with ice packs to chill samples and bubble wrap to protect the bottles during transit.

4.15 Sample Chain-of-Custody

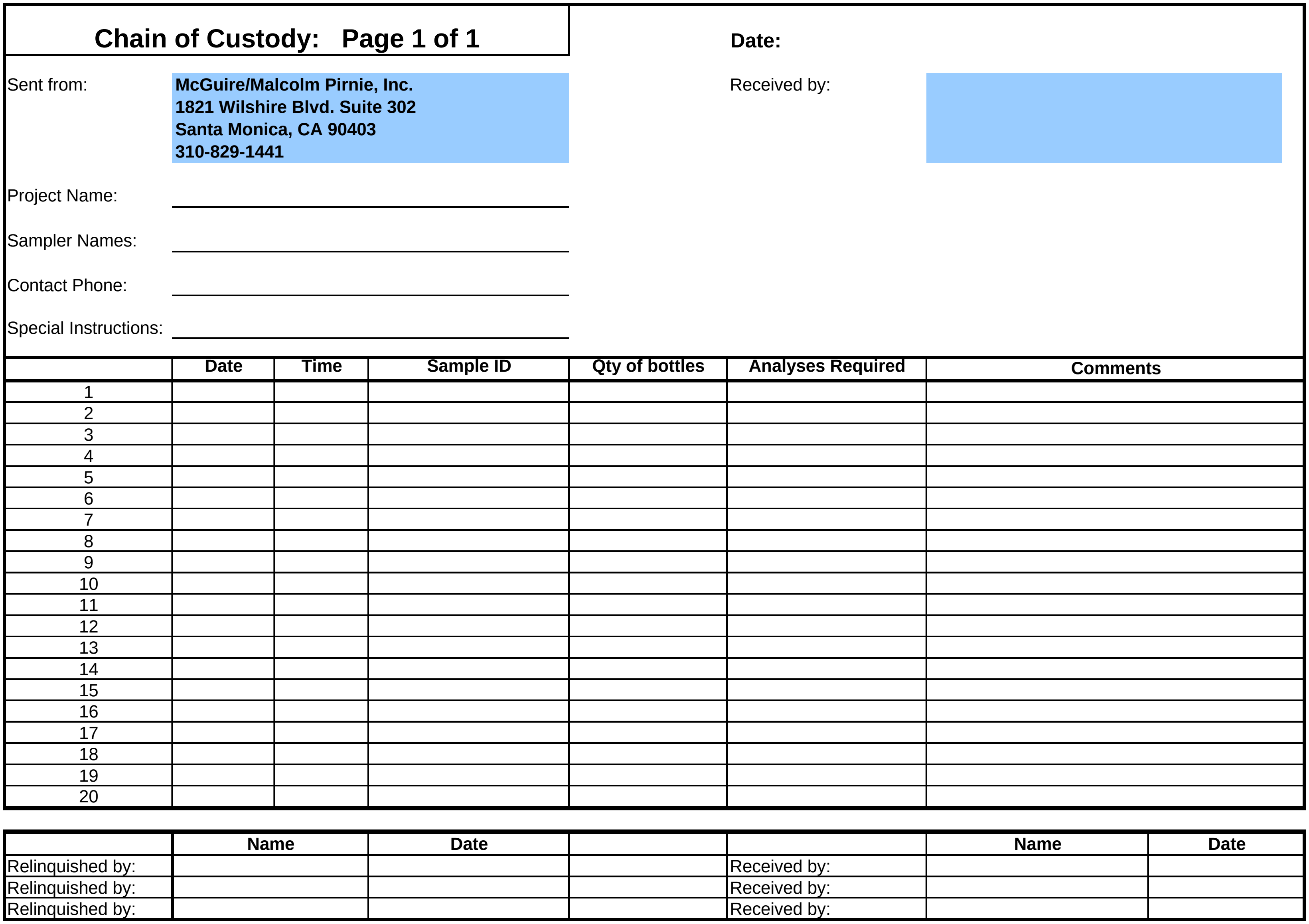
Samples will be considered “in custody” when they are in someone’s physical possession or view, locked up, or stored in a secure area accessible only by authorized personnel. A minimal number of persons participating in sample handling and custody is desirable.

Samples collected for analyses will be recorded in a sampling field log using waterproof, permanent ink. The log will contain the following information: Sample ID (as described in Section 4.11), results of field measurements, and descriptions of incidents that may have affected operations.

After samples have been collected for laboratory measurements, the field staff person will complete the Sample Chain-of-Custody form in ink, affix and sign Custody Seals, and surrender the samples to the ELAP-certified lab courier or the authorized shipper for shipment. Figure 4-1 shows an example of the Sample Chain-of-Custody form. Upon arrival at the contract laboratory, laboratory personnel will immediately log the samples in on the Chain-of-Custody form, inspect for damage and sample integrity, and store the samples as appropriate until analysis. Problems encountered during sample shipping will be reported to the analytical manager.

4.16 Sample Archives

Samples will be stored at 4°C after analysis until personnel at the laboratory and Malcolm Pirnie review sample data and associated quality control analyses. In general, samples are kept by MWH or Test America Labs for two years. Unless directed otherwise, samples will then be disposed of in accordance with appropriate environmental health and safety regulations for hazardous chemical waste.



Chain of Custody: Page 1 of 1

Date:

Sent from:
McGuire/Malcolm Pirnie, Inc.
1821 Wilshire Blvd. Suite 302
Santa Monica, CA 90403
310-829-1441

Received by:

Project Name: ____________________

Sampler Names: ____________________

Contact Phone: ____________________

Special Instructions: ____________________

	Date	Time	Sample ID	Qty of bottles	Analyses Required	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

	Name	Date			Name	Date
Relinquished by:				Received by:		
Relinquished by:				Received by:		
Relinquished by:				Received by:		

Figure 4-1. An example of the Sample Chain-of-Custody form

5 Testing and Measurement Protocols

5.1 Measurement Methods

The analytical methods for the water quality parameters and treatment residuals will conform to EPA guidelines and recommended test methods, including those in *Standard Methods for the Examination of Water and Wastewater* (APHA 1999). Standard Operating Procedures (SOPs, attached as Appendix C to this document) will be used for all measurements according to the methods shown in Table 4-2.

At MWH Laboratories, total chromium analyses will be performed using the ICP-MS method (EPA Method 200.8). Ion chromatography (EPA Method 218.6) will be used to analyze Cr(VI). Treatment residuals from the RCF process will be shipped to Test America Labs for moisture content, TCLP, and CWET analyses prior to disposal. Other water quality parameters will be measured in the field by trained operators (as discussed in Section 4.6).

5.2 Verification of Unproven Methods

No unproven laboratory methods will be used in this project.

5.3 Calibration Procedures

For Cr(VI) analysis, the ion chromatograph at MWH Labs will be calibrated each analysis day using a 6-point calibration curve ranging from 0.1 to 50.0 μg/L. Acceptance criteria include a correlation coefficient for the linear calibration curve of greater than 0.999. The method detection limit (MDL) at the laboratory is reported to be 0.015 μg/L. However, the method reporting limit (MRL) is 0.1 μg/L. Samples falling within the range of the MDL and MRL will be flagged as “J values”. An external laboratory control sample (LCS) at 2 μg/L will be analyzed for every batch of 20 samples or less. The acceptance percent recovery range for the LCS sample is within 90-110%. A 20 ppb instrument performance check (IPC) sample will be run after the initial calibration and subsequently after every 10 samples, with an acceptable percent recovery range of 95 to 105%. A laboratory reagent blank (LRB) will also be measured after every 10 samples and should be below the MRL of 0.1 μg/Leach time.

Total Cr samples will be analyzed by ICP-MS, which includes daily calibration using a 3-point calibration curve (plus a blank) ranging from 1 to 250 μg/L. Acceptance criteria include a correlation coefficient for the linear calibration curve of greater than 0.999. The laboratory-reported MDL for total Cr is 0.192 μg/L, and the MRL is 1 μg/L. An initial calibration verification standard (ICV) will be analyzed immediately after the calibration curve with an acceptance percent recovery range of 95 to 105%. A continuing calibration verification standard (CCV) will be run subsequently after every 10 samples, with an acceptable percent recovery range of 90 to 110%. A continuing calibration blank (CCB) will also be measured after every 10 samples and should be below one-half of the MRL of 1.0 μg/Leach time.

If the laboratory calibration check criteria are not met, the analysis run will be stopped and the instrument recalibrated. Additional details are available in the Appendix C SOPs.

Leachate metal concentrations using the TCLP and CWET methods will be measured using ICP-AES. Details of the standards used to calibrate the ICP-AES for the various metals are shown in Appendix C. In general, at least 3 standards and a blank are used to calibrate the instrument daily, with acceptance criteria of greater than 0.995 for the correlation coefficient. Following the calibration, an ICV sample will be run, with acceptance criteria of 95-105%. An initial calibration blank (ICB) will subsequently be run and should fall within +/- of the MRL from zero. CCV and CCB samples will then be run every 10 samples with acceptance levels of 90-110% and +/- the MRL from zero, respectively.

Other analyses run at the ELAP-certified laboratories will conform to the calibration procedures described in the SOPs (Appendix C). Standard calibration curves run on the field instrument will be sufficient to ensure that the instrument is operational and large deviations in concentrations are real phenomena.

6 QA/QC Checks

6.1 Quantitative Acceptance Criteria for Data

QA/QC sampling, which includes field-collected duplicate samples and blanks, as well as laboratory, split samples (i.e., replicate analyses) and matrix spikes will be used to verify consistency in sample collection and handling and analytical accuracy.

6.1.1 Field QA/QC Samples

Field-collected duplicate samples will be obtained for at least 10% of all samples collected and will be co-located samples taken one right after the other. Duplicates will not be identified as QA/QC samples when sent to the laboratory. Field-collected duplicates will serve to ensure acquisition of representative samples, consistency of sampling, and precision of the analytical methods. Acceptance criteria for the field-collected duplicate samples will be within the analytical acceptance criteria for the specific analytical method (Appendix C).

Field blank samples will be prepared by filling metal-free distilled water in the sample bottles provided by the lab (with added preservatives, if necessary); these samples will be sent for analysis to test any possible contamination during sample handling, transport, and storage. At least one field blank sample per method will be prepared for each shipment. The routine frequency for the field blanks will be approximately one in ten samples to be shipped (i.e., 10% field blanks). Field blanks submitted to the laboratory for analysis will not be identified as QA/QC samples. The proposed QA/QC sampling and analysis frequency is listed in Table 6-1. Acceptance criteria for the field blanks will be +/- the MRL from zero.

For field-measured water quality parameters (e.g., total iron and ferrous iron), accuracy and precision acceptance criteria will be based on manufacturer specifications, which will be tested using standards prepared in the water matrices. In general, acceptance criteria for these analytes will be less than 20% for field-collected duplicate samples. For the field methods, precision will be analyzed every 20 samples from repeat analyses on known-concentration accuracy check standards, with an acceptance criteria of 80 to 120%.

6.1.2 Laboratory QA/QC Samples

Calibration curve development and CCV samples were discussed in Section 5.3. Additional QA/QC samples to test for accuracy and precision are described below.

Accuracy (a combination of random and systematic error) in Cr(VI) and total Cr analyses will be evaluated by determining percent recoveries in samples spiked in the laboratory. A matrix spike (MS) will be performed on 10% of samples (or at least one sample per run), chosen at random. MS recoveries should be between 90 and 110% of the expected value for Cr(VI) and between 70 to 130% for total Cr. National Institute of Standards and Technology (NIST) traceable Cr(VI) solutions and ICS total Cr standard solutions will be used for matrix spikes. Accuracy will also be tested throughout the runs and after every 10 samples by analyzing a mid-range IPC sample and a laboratory reagent blank (LRB). The acceptance criteria for the IPC sample is between 95 and 105%. The LRB should be below ½ the MRL. If concentrations are outside of these ranges, corrective actions will be performed as detailed in the SOPs for Method 218.6 or 200.6 (Appendix C).

Precision (random error) will be investigated by performing repeat analyses on the same analytical instruments. For every batch of twenty samples, a LCS and a MS will be run. The acceptable ranges for these sample results are between 90 and 110% for Method 218.6 and 70 to 130% for Method 200.8. Laboratory replicates and matrix spike duplicates (MSD) will be analyzed for every batch of twenty samples with an acceptance criterion of < 20% relative percent difference (RPD).

As the critical parameters in evaluating the success of the project, total Cr and Cr(VI) concentration data quality will also be subjected to paired sample analyses (i.e., Cr(VI) and total Cr samples collected at the same time). Paired samples will be used to assess the chromium speciation and verify that the two concentrations are similar, as observed in the Phase III Bridge Project. Discrepancies between the total Cr and Cr(VI) values will be investigated more closely to ensure that no bias exists for the total Cr analyses (as was observed in the Phase III Additional RCF Testing project).

Table 6-1. Quality assurance sampling and measurement frequency

Sampling Parameters[1]	**Sampling QA/QC Frequency**		
	Field-Collected Duplicates	**Laboratory Matrix Spikes**	**Field Blanks**
Cr(VI) – Lab	10% of samples	5% of samples	1/week
Total Cr	10% of samples	5% of samples	1/week
TSS	10% of samples	None	None
Cr(VI) – Field	10% of samples	None	1/week
Total Iron	10% of samples	None	1/week
Ferrous Iron	10% of samples	None	1/week
pH	10% of samples	None	None
Temperature	10% of samples	None	None
Turbidity	10% of samples	None	None
DO	10% of samples	None	None
Residuals – TCLP	10% of samples	5% of samples	None
Residuals – CWET	10% of samples	5% of samples	None
Residuals – Moisture Content	10% of samples	None	None

1. Not including online parameters

6.2 Additional Project-Specific Quality Assurance Objectives

In addition to the primary objective of evaluating the effectiveness of Cr(VI) removal from water using the RCF process, this demonstration-scale study will test the operations and maintenance (O&M) requirements for this technology. Table 3-4 highlights the critical process-related measurements that will be obtained during testing. To ensure data quality, operational parameters, including flow rates and pressures, will be measured and assessed within the acceptance criteria set forth by manufacturer specifications for the instrumentation.

6.3 Procedures to Assess QA Objectives

Quality assurance objectives will be assessed as detailed throughout this QAPP. Field measurements will be tested for accuracy by frequent calibration of equipment, for precision by obtaining replicate analyses of parameters, and for any contamination that may occur during sample handling and transfer by analyzing blanks.

Laboratory analyses, including critical chromium measurements, will be subjected to numerous procedures to assess quality assurance objectives. Sample accuracy will be tested by comparing sample concentrations to matrix spike concentrations and laboratory control samples. Relative percent differences on replicate samples will be used to determine instrumental precision. The examination of QA parameters including accuracy, precision, and sample contamination will enable us to have confidence in data and trends observed throughout the demonstration-scale study.

7 Data Reporting, Data Reduction, & Data Validation

7.1 Data Reporting Requirements

Table 7-1 details the reporting requirements for each of the analyses to be performed. Data reporting requirements for residuals analyses are also listed in Table 7-1.

7.2 Field and Laboratory Data Deliverables

Field data to be collected includes Cr(VI), total iron, ferrous iron, pH, temperature, turbidity, and DO. Measurements will be recorded in the Field Sampling Log Book and entered into Microsoft Excel.

Laboratory data for Cr(VI), total Cr, TSS, and residuals characteristics (including TCLP, CWET, and moisture content) will be reported to Malcolm Pirnie by the contract laboratories. The data will be stored in the project data management system as well as at the contract laboratory. Routine analytical QC data will also be stored electronically.

Malcolm Pirnie will gather all data and prepare summary tables and graphics to characterize the findings from the demonstration-scale study. Quality assurance procedures (refer to Section 7.4) will be used to validate and confirm the data.

7.3 Data Reduction Procedures

In the laboratory and in the field, analytical measurements will be converted to concentrations by running appropriate calibration curves on the same instrument and interpolating the sample values.

Sample and QC concentrations received from the labs will be entered manually into a Microsoft Excel spreadsheet, from which efficiencies of Cr(VI) removal will be calculated. A minimum of 10% of data entered will be checked by the Malcolm Pirnie Quality Assurance Manager or Deputy Project Manager to ensure that transcription errors have not occurred.

Table 7-1. Measurement data reporting

Sample Analysis	Analytical Method	Units	Method Detection Level (MDL)	Method Reporting Level (MRL)*
Cr(VI) – Lab	EPA 218.6 (IC)	µg/L	0.015	0.1
Total Cr	EPA 200.8 (ICP-MS)	µg/L	0.192	1.0
TSS	EPA 160.2 (Gravimetric)	mg/L	4	4
Cr(VI) – Field	Hach Method 8023 (Diphenylcarbohydrazide)	mg/L	0.01	0.01
Total Iron	Hach Method 8008 (FerroVer)	mg/L	0.02	0.02
Ferrous Iron	Hach Method 8146 (1,10-Phenanthroline)	mg/L	0.02	0.02
pH	SM 4500H+ B (Electrometric)	pH units	N/A	N/A
pH (Continuous)[1]	SM 4500H+ B (Electrometric)	pH units	N/A	N/A
Temperature	SM 2550 (Thermometric)	°C	N/A	N/A
Turbidity[2]	SM 2130 B (Nephelometric)	NTU	0.02	0.02
Turbidity (Continuous)[3]	SM 2130 B (Nephelometric)	NTU	0.02	0.02
DO	Hach Method 8166 (HRDO)	mg/L	0.3	0.3
DO (Continuous)[4]	Hach Method 10360 (Luminescence measurement)[5]	mg/L	0.1	0.1
Residuals – TCLP	EPA 1311 (TCLP) EPA 6010B (ICP): Total Cr	µg/L	2.466	10
Residuals – STLC	CA WET Test (Title 22: §66261.126) EPA 7196A: Cr(VI) EPA 6010B (ICP): Total Cr	µg/L µg/L	2.985 2.466	10 10
Residuals – TTLC	CA WET Test (Title 22: §66261.126) Cr(VI) compounds Cr and/or Cr(III) compounds	mg/kg (wet wt) mg/kg (wet wt)	2.985 2.466	10 10
Residuals – Moisture Content	EPA CLP SOW ILM 05.3	%	0.01	0.01

1. Based on Hach LGI DPC1R2A pH sensor
2. Based on Hach 2100P Turbidimeter
3. Based on Hach 1720E Low Range Turbidimeter
4. Based on Hach LDO Dissolved Oxygen probe
5. EPA approved method

7.4 Data Validation Procedures

Depending on the analytical measurement, the types of QA/QC samples may include the following:

- Laboratory matrix spike samples that are used to assess the accuracy of laboratory procedures in at least 5% of the samples;
- Laboratory blank samples that are used to determine the MDL of the analytical procedure and to detect potential laboratory contamination;
- Laboratory control samples that are subjected to multiple analyses to determine laboratory precision in at least 5% of the samples;
- Field-collected duplicate samples to assess how representative samples are and the degree to which the samples reflect actual field conditions; and
- Field-collected blank samples to detect potential problems in the sample collection, handling, and preservation methods.

Operational data will be routinely collected onsite using standardized log sheets. Log sheets will contain information about operational conditions and will be transferred into Microsoft Excel each week.

At the contract laboratory, a person other than the analyst will compare ten percent of all spreadsheet data to original hard-copy printouts. The analyst will ensure that all QC criteria are met, and the analysis manager will review all QC data monthly. The contract labs also conduct an annual performance evaluation for all methods.

Field data entered manually will be validated internally by qualified Malcolm Pirnie personnel. Calculations performed in a spreadsheet will be carefully examined to ensure the accuracy of the formulas, data input, and results. After data have been validated and reduced, the QA Manager will review the files to ensure that the data are not suspicious. Any quality control data that do not meet the acceptance criteria, either in the field or in the laboratory, will be flagged and either reported with an explanatory note or excluded from the data reduction.

7.5 Data Storage Requirements

Project data will be generated and duplicated in several locations. Operational data and water quality data generated on site will be recorded on standardized sheets in the Field Sampling Log Book. Water quality samples collected will be labeled to ensure correct identification of sample results returned from off-site laboratories. Information collected on water quality samples will include: sample identification number, name of person who collected the sample, date, time, sample volume, and sample preservation method.

Electronic and hard copies of data will be sent to Malcolm Pirnie by the contract labs. Project data in the Field Sampling Log Book and off-site laboratory reports will be entered into and will reside in the main project data files. The project data files will serve many purposes, including validation of data entry, central storage of all project data, and routine reduction and reporting of operational and water quality data. In addition, the contract labs will keep the electronic data for at least 5 years.

The main project data files will be hosted on the data server at the Malcolm Pirnie-Santa Monica office. This data server is backed up on daily, weekly, and monthly schedules, with weekly off-site backups. The server is protected with hardware firewall, and the data files are protected from viruses with reputable anti-virus software.

7.6 Project Documentation

The product documents from this project include an O&M manual for the RCF system and a final report. In addition, monthly reports will be produced for this project to provide updates, including discussion of any QA/QC issues and necessary resolutions.

8 Assessments

8.1 Audit Schedule

Internal audits are not scheduled for this project. However, the Quality Assurance managers at Malcolm Pirnie and the contract laboratories will review all QC data monthly to ensure that QC objectives are being met.

8.2 Corrective Action Procedures

The need for corrective action may be identified by assessing standard QC procedures. The essential steps in the corrective action system are detailed below.

<u>Identification and definition of the problem</u>
Corrective action will be required if analytical data are determined to be out-of-control. An analytical batch will be considered to be out-of-control when replicate samples, matrix spiked samples, calibration blanks, the standard curve, calibration check samples, or external reference samples fail to meet the QC criteria.

<u>Investigation and determination of the cause of the problem</u>
When an analysis is determined to be out-of-control, steps will be taken to determine the cause. First, it must be determined whether a calculation error has occurred. Then the instrument used in the analysis will be checked against performance specifications. The indicators of being out-of-control will be a clue to the problem. For example, wrong readings of laboratory control samples may indicate the instrument is not properly set-up or standards are bad; if replicates are not within precision limits, contamination may be a problem; if spike recovery is outside acceptable limits, matrix interferences may have occurred; or if blanks are too high, contamination has probably occurred.

<u>Determination of a corrective action to eliminate the problem</u>

- Calibration check samples

  If results of the daily calibration sample check are out-of-control, as indicated by flagged values, causes may include instrument malfunction or improper set-up, bad standards, or operator error. The first step will be to check instrument performance. The instrument will be restarted. If this does not bring the system back into control, then standards will be re-made and analyzed. If the problem is operator error, the analyst will be re-trained and put through a rigorous QC check before he/she can continue with the sample analyses.

- Accuracy

  When a result is out-of-control as indicated by flagged values for spiked samples, the following steps will be taken to determine the cause. First, calculations will be checked. Then the instrument will be checked for proper set-up. The sample(s) will be reanalyzed. If these steps do not bring the analysis under control, then the spiked sample will be prepared again and analyzed. It may be necessary at this time to prepare fresh standards. If all of the above procedures do not bring the analysis into control, analysis will be performed by standard addition. All samples analyzed in the batch containing the out-of-control sample will be re-analyzed by the procedure used to bring the analysis back into control.

- Precision

  When a result for replicate analysis is out-of-control as indicated by flagged values, steps will be taken to determine the cause. First calculations will be checked. Then instrument performance will be evaluated. The sample(s) will be reanalyzed. If these procedures do not bring the samples back into control, then all samples in the analytical batch will be prepared again and analyzed.

- Blank contamination

  If the laboratory control blank shows contamination (i.e. concentrations greater than ½ the MRL during analysis, materials and reagents used to make that blank will be replaced before additional samples are prepared. Also, glassware and sample preparation will be re-evaluated to ensure that contamination is not occurring during these processes. Standards prepared with contaminated reagents will be discarded, and samples will be reprocessed.

- External reference sample analysis

  The inability of the laboratory to accurately analyze an external reference sample is indicative of analytical problems related to sample preparation procedures, instrument operation, or calibration. If the calibration check sample within the same analytical batch analysis is also out-of-control, a problem with the instrument or operator performance is indicated. Corrective action will be taken as described earlier. If the calibration check sample is within the control limits, the problem may be with the sample preparation procedure. At this point the calibration standards will be prepared again and analyzed. If this fails to bring the measurement back into control, the procedure will be reevaluated to determine if there are points within the procedure likely to be the source of contamination or the cause of a loss of the analyte. All samples analyzed in the batch with the out-of-control sample will be re-analyzed by the procedure used to bring the check samples back into control.

8.3 Implementation of Corrective Action

Analysts at the contract laboratories will have the authority to implement corrective action (described in Section 8.2 Investigation and Determination of the Cause of the Problem) during an analysis run if quality control samples are determined to be out-of-control. The Quality Assurance managers and Project Managers at Malcolm Pirnie and the contract laboratories will review QC logs monthly and will consult with the analyst if further corrective action is identified as necessary. Following any corrective action, the primary investigators will ensure that the analysis is truly back in control, as indicated by consistently meeting quality control criteria.

9 References

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Appendix A: ELAP Certifications

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

MARK B HORTON, MD, MSPH
Director

ARNOLD SCHWARZENEGGER
Governor

January 23, 2008

ANDREW D. EATON, Ph.D.
MWH LABORATORIES, a division of MWH Americas, Inc.
750 ROYAL OAKS DRIVE, SUITE 100
MONROVIA, CA 91016-3629

Dear ANDREW D. EATON, Ph.D.:

Certificate No 01114CA

Enclosed is an updated copy of your certificate.

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

Sincerely,

George C.

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

Enclosure

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

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 91016-3629

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: **01/31/2009**
Effective Date: **01/31/2008**

George C. Kul

Richmond, California
subject to forfeiture or revocation

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

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 91016-3629

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

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
102.050	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
102.140	001	SM2540C	Total Dissolved Solids

102.145	001	EPA 160.1	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
102.564	001	Quickchem 10-204-00-1-X	Cyanide

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
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
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

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
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
105.190	007	SM6251B	Trichloroacetic Acid
105.190	008	SM6251B	Haloacetic Acids (HAA5)
105.191	001	SM6251B (20th)	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, Total
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
108.231	001	EPA 353.2	Nitrate calc.
108.232	001	EPA 353.2	Nitrate-nitrite, Total
108.260	001	EPA 365.1	Phosphate, Ortho

108.261	001	EPA 365.1	Phosphorus, Total
108.291	001	EPA 376.2	Sulfide
108.323	001	EPA 410.4	Chemical Oxygen Demand
108.360	001	EPA 420.1	Phenols, Total
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
109.010	017	EPA 200.7	Nickel
109.010	021	EPA 200.7	Silver
109.010	024	EPA 200.7	Tin
109.010	025	EPA 200.7	Titanium
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
109.808	001	SM3500-Cr B (21st)	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
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
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

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

MARK B HORTON, MD, MSPH
Director

ARNOLD SCHWARZENEGGER
Governor

February 6, 2008

ANDREW D. EATON, Ph.D.
MWH LABORATORIES, a division of MWH Americas, Inc.
750 ROYAL OAKS DRIVE, SUITE 100
MONROVIA, CA 91016-3629

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

This is to advise you that the laboratory named above has been 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.

The Fields of Testing for which this laboratory has been certified are indicated on the enclosed "Fields of Testing." The certificate shall remain in effect until **January 31, 2009** unless it is revoked. This certificate is subject to an annual fee as prescribed by HSC 100860(a).

The application for renewal of this certificate must be received before the expiration date of this certificate to remain in force according to the HSC 100845(a).

Any changes in laboratory location or structural alterations, which may affect adversely the quality of analysis in the Fields of Testing for which this laboratory has been granted a certificate, require prior notification. Notification is also required for changes in ownership or laboratory director within 30 days after the change (HSC, Section 100845(b) and (d)).

Your continued cooperation with the above requirements is essential for maintaining the high quality of the data produced by environmental laboratories certified by the State of California.

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

Sincerely,

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

Enclosure

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

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

ENVIRONMENTAL LABORATORY CERTIFICATION

Is hereby granted to

MWH LABORATORIES, a division of MWH Americas, Inc.

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

Scope of certification is limited to the "Accredited Fields of Testing" which accompanies this Certificate.

Continued certification status depends on successful completion of site visit, 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: **01/31/2009**
Effective Date: **01/01/2007**

George C. Ku

Richmond, California
subject to forfeiture or revocation

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

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.

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

FLORIDA DEPARTMENT OF HEALTH

State of Florida
Department of Health, Bureau of Laboratories

This is to certify that

E87689
TESTAMERICA ST. LOUIS
13715 RIDER TRAIL NORTH
EARTH CITY, MO 63045

has complied with Florida Administrative Code 64E-1,
for the examination of Environmental samples in the following categories

DRINKING WATER - GROUP II UNREGULATED CONTAMINANTS, DRINKING WATER - OTHER REGULATED CONTAMINANTS, DRINKING WATER - RADIOCHEMISTRY, NON-POTABLE WATER - EXTRACTABLE ORGANICS, NON-POTABLE WATER - GENERAL CHEMISTRY, NON-POTABLE WATER - METALS, NON-POTABLE WATER - PESTICIDES-HERBICIDES-PCB'S, NON-POTABLE WATER - RADIOCHEMISTRY, NON-POTABLE WATER - VOLATILE ORGANICS, SOLID AND CHEMICAL MATERIALS - EXTRACTABLE ORGANICS, SOLID AND CHEMICAL MATERIALS - PESTICIDES-HERBICIDES-PCB'S, SOLID AND CHEMICAL MATERIALS - GENERAL CHEMISTRY, SOLID AND CHEMICAL MATERIALS - METALS, SOLID AND CHEMICAL MATERIALS - RADIOCHEMISTRY, SOLID AND CHEMICAL MATERIALS - VOLATILE ORGANICS

Continued certification is contingent upon successful on-going compliance with the NELAC Standards and FAC Rule 64E-1 regulations. Specific methods and analytes certified are cited on the Laboratory Scope of Accreditation for this laboratory and are on file at the Bureau of Laboratories, P. O. Box 210, Jacksonville, Florida 32231. Clients and customers are urged to verify with this agency the laboratory's certification status in Florida for particular methods and analytes.

EFFECTIVE March 05, 2008 THROUGH June 30, 2008

Max Salfinger, M.D.
Chief, Bureau of Laboratories
Florida Department of Health
DH Form 1697, 7/04
NON-TRANSFERABLE E87689-13-3/5/2008
Supersedes all previously issued certificates

Charlie Crist
Governor

Ana M. Viamonte Ros, M.D., M.P.H.
State Surgeon General

Laboratory Scope of Accreditation

Attachment to Certificate #: E87689-13, expiration date June 30, 2008. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87689 **EPA Lab Code: MO00054** **(314) 298-8566**

E87689
TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045

Matrix: Drinking Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1,2-Tetrachloroethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,1,1-Trichloroethane	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
1,1,2,2-Tetrachloroethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,1,2-Trichloroethane	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
1,1-Dichloroethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,1-Dichloroethylene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
1,1-Dichloropropene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,2,3-Trichlorobenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,2,3-Trichloropropane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,2,4-Trichlorobenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,2,4-Trimethylbenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,2-Dibromo-3-chloropropane (DBCP)	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,2-Dichlorobenzene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
1,2-Dichloroethane	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
1,2-Dichloropropane	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
1,3,5-Trimethylbenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,3-Dichlorobenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,3-Dichloropropane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
1,4-Dichlorobenzene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
2,2-Dichloropropane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
2-Chlorotoluene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
4-Chlorotoluene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
4-Isopropyltoluene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Benzene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Bromobenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Bromochloromethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Bromodichloromethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Bromoform	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Carbon tetrachloride	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Chlorobenzene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Chloroethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Chloroform	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
cis-1,2-Dichloroethylene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
cis-1,3-Dichloropropene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Dibromochloromethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003

Laboratory Scope of Accreditation

Attachment to Certificate #: E87689-13, expiration date June 30, 2008. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87689 **EPA Lab Code: MO00054** **(314) 298-8566**

E87689
TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045

Matrix: Drinking Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Dibromomethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Dichlorodifluoromethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Dichloromethane (DCM, Methylene chloride)	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Ethylbenzene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Gamma Emitters	EPA 901.1	Radiochemistry	NELAP	12/1/2006
Gross-alpha	EPA 900	Radiochemistry	NELAP	12/1/2006
Gross-beta	EPA 900	Radiochemistry	NELAP	12/1/2006
Hexachlorobutadiene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Isopropylbenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Methyl bromide (Bromomethane)	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Methyl chloride (Chloromethane)	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Methyl tert-butyl ether (MTBE)	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Naphthalene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
n-Butylbenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
n-Propylbenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Radium-226	EPA 903	Radiochemistry	NELAP	12/1/2006
Radium-228	EPA 904	Radiochemistry	NELAP	12/1/2006
sec-Butylbenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Strontium-89	DOE Sr-02	Radiochemistry	NELAP	12/1/2006
Strontium-90	DOE Sr-02	Radiochemistry	NELAP	12/1/2006
Styrene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
tert-Butylbenzene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Tetrachloroethylene (Perchloroethylene)	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Toluene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
trans-1,2-Dichloroethylene	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
trans-1,3-Dichloropropylene	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Trichloroethene (Trichloroethylene)	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Trichlorofluoromethane	EPA 524.2	Group II Unregulated Contaminants	NELAP	7/17/2003
Tritium	EPA 906	Radiochemistry	NELAP	12/1/2006
Uranium	ASTM D5174-91	Radiochemistry	NELAP	12/1/2006
Vinyl chloride	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003
Xylene (total)	EPA 524.2	Other Regulated Contaminants	NELAP	7/17/2003

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E87689
TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,1,1-Trichloroethane	EPA 624	Volatile Organics	NELAP	2/13/2002
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,1,2,2-Tetrachloroethane	EPA 624	Volatile Organics	NELAP	2/13/2002
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,1,2-Trichloroethane	EPA 624	Volatile Organics	NELAP	2/13/2002
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,1-Dichloroethane	EPA 624	Volatile Organics	NELAP	2/13/2002
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,1-Dichloroethylene	EPA 624	Volatile Organics	NELAP	2/13/2002
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,1-Dichloropropene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2,3-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2,3-Trichloropropane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2,4,5-Tetrachlorobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
1,2,4-Trichlorobenzene	EPA 625	Extractable Organics	NELAP	2/13/2002
1,2,4-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2,4-Trichlorobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
1,2,4-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	2/13/2002
1,2-Dichlorobenzene	EPA 625	Extractable Organics	NELAP	2/13/2002
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2005
1,2-Dichloroethane	EPA 624	Volatile Organics	NELAP	2/13/2002
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2-Dichloropropane	EPA 624	Volatile Organics	NELAP	2/13/2002
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,3,5-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8330	Extractable Organics	NELAP	7/1/2003
1,3-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	2/13/2002
1,3-Dichlorobenzene	EPA 625	Extractable Organics	NELAP	2/13/2002
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,3-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2005
1,3-Dichloropropane	EPA 8260	Volatile Organics	NELAP	7/1/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
1,3-Dinitrobenzene (1,3-DNB)	EPA 8330	Extractable Organics	NELAP	7/1/2003
1,4-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	2/13/2002
1,4-Dichlorobenzene	EPA 625	Extractable Organics	NELAP	2/13/2002
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,4-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2005
1,4-Dioxane (1,4-Diethyleneoxide)	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,4-Naphthoquinone	EPA 8270	Extractable Organics	NELAP	7/1/2003
1-Naphthylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	7/1/2003
2,3,4,6-Tetrachlorophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,4,5-T	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
2,4,5-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	10/26/2005
2,4,6-Trichlorophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
2,4,6-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,4,6-Trinitrotoluene (2,4,6-TNT)	EPA 8330	Extractable Organics	NELAP	7/1/2003
2,4-D	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
2,4-DB	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
2,4-Dichlorophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
2,4-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,4-Dimethylphenol	EPA 625	Extractable Organics	NELAP	2/13/2002
2,4-Dimethylphenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,4-Dinitrophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
2,4-Dinitrophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,4-Dinitrotoluene (2,4-DNT)	EPA 625	Extractable Organics	NELAP	2/13/2002
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,4-Dinitrotoluene (2,4-DNT)	EPA 8330	Extractable Organics	NELAP	7/1/2003
2,6-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,6-Dinitrotoluene (2,6-DNT)	EPA 625	Extractable Organics	NELAP	2/13/2002
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270	Extractable Organics	NELAP	7/1/2003
2,6-Dinitrotoluene (2,6-DNT)	EPA 8330	Extractable Organics	NELAP	7/1/2003
2-Amino-4,6-dinitrotoluene (2-am-dnt)	EPA 8330	Extractable Organics	NELAP	7/1/2003
2-Aminoanthraquinone	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260	Volatile Organics	NELAP	7/1/2003
2-Chloroethyl vinyl ether	EPA 624	Volatile Organics	NELAP	2/13/2002
2-Chloroethyl vinyl ether	EPA 8260	Volatile Organics	NELAP	7/1/2003
2-Chloronaphthalene	EPA 625	Extractable Organics	NELAP	2/13/2002

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Analyte	Method/Tech	Category	Certification Type	Effective Date
2-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Chlorophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
2-Chlorophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	7/1/2003
2-Hexanone	EPA 8260	Volatile Organics	NELAP	7/1/2003
2-Methyl-4,6-dinitrophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
2-Methylphenol (o-Cresol)	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Nitroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Nitrophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
2-Nitrophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	7/1/2003
2-Picoline (2-Methylpyridine)	EPA 8270	Extractable Organics	NELAP	7/1/2003
3,3'-Dichlorobenzidine	EPA 625	Extractable Organics	NELAP	2/13/2002
3,3'-Dichlorobenzidine	EPA 8270	Extractable Organics	NELAP	7/1/2003
3,3'-Dimethoxybenzidine	EPA 8270	Extractable Organics	NELAP	7/1/2003
3,3'-Dimethylbenzidine	EPA 8270	Extractable Organics	NELAP	7/1/2003
3/4-Methylphenols (m/p-Cresols)	EPA 8270	Extractable Organics	NELAP	7/24/2006
3-Methylcholanthrene	EPA 8270	Extractable Organics	NELAP	7/1/2003
3-Nitroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
3-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	7/1/2003
4,4'-DDD	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
4,4'-DDD	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
4,4'-DDE	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
4,4'-DDE	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
4,4'-DDT	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
4,4'-DDT	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
4-Amino-2,6-dinitrotoluene (4-am-dnt)	EPA 8330	Extractable Organics	NELAP	7/1/2003
4-Aminobiphenyl	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Bromophenyl phenyl ether	EPA 625	Extractable Organics	NELAP	2/13/2002
4-Chloro-3-methylphenol	EPA 625	Extractable Organics	NELAP	2/13/2002
4-Chloro-3-methylphenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Chloroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Chlorophenyl phenylether	EPA 625	Extractable Organics	NELAP	2/13/2002
4-Chlorophenyl phenylether	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	7/1/2003
4-Dimethyl aminoazobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
4-Methyl-2-pentanone (MIBK)	EPA 8260	Volatile Organics	NELAP	7/1/2003
4-Nitroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Nitrophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
4-Nitrophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	7/1/2003
7,12-Dimethylbenz(a) anthracene	EPA 8270	Extractable Organics	NELAP	7/1/2003
a-a-Dimethylphenethylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
Acenaphthene	EPA 625	Extractable Organics	NELAP	2/13/2002
Acenaphthene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Acenaphthene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Acenaphthylene	EPA 625	Extractable Organics	NELAP	2/13/2002
Acenaphthylene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Acenaphthylene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Acetone	EPA 8260	Volatile Organics	NELAP	7/1/2003
Acetonitrile	EPA 8260	Volatile Organics	NELAP	7/1/2003
Acetophenone	EPA 8270	Extractable Organics	NELAP	7/1/2003
Acrolein (Propenal)	EPA 624	Volatile Organics	NELAP	2/13/2002
Acrolein (Propenal)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Acrylonitrile	EPA 624	Volatile Organics	NELAP	2/13/2002
Acrylonitrile	EPA 8260	Volatile Organics	NELAP	7/1/2003
Aldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Alkalinity as CaCO3	EPA 310.1	General Chemistry	NELAP	2/13/2002
Alkalinity as CaCO3	SM 2320 B	General Chemistry	NELAP	5/4/2007
Allyl chloride (3-Chloropropene)	EPA 8260	Volatile Organics	NELAP	7/1/2003
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
alpha-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	3/2/2005
Aluminum	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Aluminum	EPA 200.8	Metals	NELAP	2/13/2002
Aluminum	EPA 6010	Metals	NELAP	7/1/2003
Aluminum	EPA 6020	Metals	NELAP	7/1/2003
Ammonia as N	EPA 350.1	General Chemistry	NELAP	2/13/2002
Aniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
Anthracene	EPA 625	Extractable Organics	NELAP	2/13/2002
Anthracene	EPA 8270	Extractable Organics	NELAP	7/1/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Anthracene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Antimony	EPA 200.7	Metals	NELAP	2/13/2002
Antimony	EPA 200.8	Metals	NELAP	2/13/2002
Antimony	EPA 6010	Metals	NELAP	7/1/2003
Antimony	EPA 6020	Metals	NELAP	7/1/2003
Aramite	EPA 8270	Extractable Organics	NELAP	7/1/2003
Aroclor-1016 (PCB-1016)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1016 (PCB-1016)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Aroclor-1221 (PCB-1221)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1221 (PCB-1221)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Aroclor-1232 (PCB-1232)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1232 (PCB-1232)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Aroclor-1242 (PCB-1242)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1242 (PCB-1242)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Aroclor-1248 (PCB-1248)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1248 (PCB-1248)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Aroclor-1254 (PCB-1254)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1254 (PCB-1254)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Aroclor-1260 (PCB-1260)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1260 (PCB-1260)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Arsenic	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Arsenic	EPA 200.8	Metals	NELAP	2/13/2002
Arsenic	EPA 6010	Metals	NELAP	7/1/2003
Arsenic	EPA 6020	Metals	NELAP	7/1/2003
Barium	EPA 200.7	Metals	NELAP	2/13/2002
Barium	EPA 200.8	Metals	NELAP	2/13/2002
Barium	EPA 6010	Metals	NELAP	7/1/2003
Barium	EPA 6020	Metals	NELAP	7/1/2003
Benzene	EPA 624	Volatile Organics	NELAP	2/13/2002
Benzene	EPA 8021	Volatile Organics	NELAP	7/1/2003
Benzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Benzidine	EPA 625	Extractable Organics	NELAP	2/13/2002
Benzidine	EPA 8270	Extractable Organics	NELAP	7/1/2003
Benzo(a)anthracene	EPA 625	Extractable Organics	NELAP	2/13/2002
Benzo(a)anthracene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Benzo(a)anthracene	EPA 8310	Extractable Organics	NELAP	7/1/2003

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Benzo(a)pyrene	EPA 625	Extractable Organics	NELAP	2/13/2002
Benzo(a)pyrene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Benzo(a)pyrene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Benzo(b)fluoranthene	EPA 625	Extractable Organics	NELAP	2/13/2002
Benzo(b)fluoranthene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Benzo(b)fluoranthene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Benzo(g,h,i)perylene	EPA 625	Extractable Organics	NELAP	2/13/2002
Benzo(g,h,i)perylene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Benzo(g,h,i)perylene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Benzo(k)fluoranthene	EPA 625	Extractable Organics	NELAP	2/13/2002
Benzo(k)fluoranthene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Benzo(k)fluoranthene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Benzoic acid	EPA 8270	Extractable Organics	NELAP	7/1/2003
Benzyl alcohol	EPA 8270	Extractable Organics	NELAP	7/1/2003
Beryllium	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Beryllium	EPA 200.8	Metals	NELAP	2/13/2002
Beryllium	EPA 6010	Metals	NELAP	7/1/2003
Beryllium	EPA 6020	Metals	NELAP	7/1/2003
beta-BHC (beta-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
beta-Naphthylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
Biochemical oxygen demand	EPA 405.1	General Chemistry	NELAP	2/13/2002
Biochemical oxygen demand	SM 5210 B	General Chemistry	NELAP	5/4/2007
bis(2-Chloroethoxy)methane	EPA 625	Extractable Organics	NELAP	2/13/2002
bis(2-Chloroethoxy)methane	EPA 8270	Extractable Organics	NELAP	7/1/2003
bis(2-Chloroethyl) ether	EPA 625	Extractable Organics	NELAP	2/13/2002
bis(2-Chloroethyl) ether	EPA 8270	Extractable Organics	NELAP	7/1/2003
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 625	Extractable Organics	NELAP	2/13/2002
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270	Extractable Organics	NELAP	7/1/2003
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 625	Extractable Organics	NELAP	2/13/2002
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270	Extractable Organics	NELAP	7/1/2003
Boron	EPA 200.7	Metals	NELAP	2/13/2002
Boron	EPA 6010	Metals	NELAP	7/1/2003
Boron	EPA 6020	Metals	NELAP	7/24/2006
Bromide	EPA 300.0	General Chemistry	NELAP	2/13/2002

Laboratory Scope of Accreditation

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State Laboratory ID: **E87689** **EPA Lab Code:** **MO00054** **(314) 298-8566**

**E87689
TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045**

Matrix: **Non-Potable Water**

Analyte	Method/Tech	Category	Certification Type	Effective Date
Bromide	EPA 9056	General Chemistry	NELAP	7/1/2003
Bromobenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Bromochloromethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Bromodichloromethane	EPA 624	Volatile Organics	NELAP	2/13/2002
Bromodichloromethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Bromoform	EPA 624	Volatile Organics	NELAP	2/13/2002
Bromoform	EPA 8260	Volatile Organics	NELAP	7/1/2003
Butyl benzyl phthalate	EPA 625	Extractable Organics	NELAP	2/13/2002
Butyl benzyl phthalate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Cadmium	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Cadmium	EPA 200.8	Metals	NELAP	2/13/2002
Cadmium	EPA 6010	Metals	NELAP	7/1/2003
Cadmium	EPA 6020	Metals	NELAP	7/1/2003
Calcium	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Calcium	EPA 6010	Metals	NELAP	7/1/2003
Calcium	EPA 6020	Metals	NELAP	11/7/2003
Carbazole	EPA 8270	Extractable Organics	NELAP	7/1/2003
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	7/1/2003
Carbon tetrachloride	EPA 624	Volatile Organics	NELAP	2/13/2002
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	7/1/2003
Chemical oxygen demand	EPA 410.4	General Chemistry	NELAP	2/13/2002
Chlordane (tech.)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Chlordane (tech.)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Chloride	EPA 300.0	General Chemistry	NELAP	2/13/2002
Chloride	EPA 9056	General Chemistry	NELAP	7/1/2003
Chlorobenzene	EPA 624	Volatile Organics	NELAP	2/13/2002
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Chloroethane	EPA 624	Volatile Organics	NELAP	2/13/2002
Chloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Chloroform	EPA 624	Volatile Organics	NELAP	2/13/2002
Chloroform	EPA 8260	Volatile Organics	NELAP	7/1/2003
Chloroprene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Chromium	EPA 200.7	Metals	NELAP	2/13/2002
Chromium	EPA 200.8	Metals	NELAP	2/13/2002
Chromium	EPA 6010	Metals	NELAP	7/1/2003
Chromium	EPA 6020	Metals	NELAP	7/1/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Chromium VI	EPA 7196	Metals	NELAP	7/1/2003
Chrysene	EPA 625	Extractable Organics	NELAP	2/13/2002
Chrysene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Chrysene	EPA 8310	Extractable Organics	NELAP	7/1/2003
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	7/1/2003
cis-1,3-Dichloropropene	EPA 624	Volatile Organics	NELAP	2/13/2002
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	7/1/2003
cis-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Cobalt	EPA 200.7	Metals	NELAP	2/13/2002
Cobalt	EPA 200.8	Metals	NELAP	2/13/2002
Cobalt	EPA 6010	Metals	NELAP	7/1/2003
Cobalt	EPA 6020	Metals	NELAP	7/1/2003
Conductivity	EPA 120.1	General Chemistry	NELAP	2/13/2002
Conductivity	EPA 9050	General Chemistry	NELAP	7/1/2003
Copper	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Copper	EPA 200.8	Metals	NELAP	2/13/2002
Copper	EPA 6010	Metals	NELAP	7/1/2003
Copper	EPA 6020	Metals	NELAP	7/1/2003
Corrosivity (pH)	EPA 9040	General Chemistry	NELAP	7/1/2003
Dalapon	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
delta-BHC	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
delta-BHC	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Diallate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Dibenz(a,h) anthracene	EPA 625	Extractable Organics	NELAP	2/13/2002
Dibenz(a,h) anthracene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Dibenz(a,h) anthracene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Dibromochloromethane	EPA 624	Volatile Organics	NELAP	2/13/2002
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Dibromofluoromethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Dibromomethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Dicamba	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Dichlorodifluoromethane	EPA 8260	Volatile Organics	NELAP	7/1/2003.
Dichloroprop (Dichlorprop)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Dieldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Dieldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Diesel range organics (DRO)	EPA 8015	Extractable Organics	NELAP	10/26/2005

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Diethyl ether	EPA 8260	Volatile Organics	NELAP	7/1/2003
Diethyl phthalate	EPA 625	Extractable Organics	NELAP	2/13/2002
Diethyl phthalate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Dimethyl phthalate	EPA 625	Extractable Organics	NELAP	2/13/2002
Dimethyl phthalate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Di-n-butyl phthalate	EPA 625	Extractable Organics	NELAP	2/13/2002
Di-n-butyl phthalate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Di-n-octyl phthalate	EPA 625	Extractable Organics	NELAP	2/13/2002
Di-n-octyl phthalate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Endosulfan I	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endosulfan I	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Endosulfan II	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endosulfan II	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Endosulfan sulfate	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endosulfan sulfate	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Endrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Endrin aldehyde	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endrin aldehyde	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Endrin ketone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	3/2/2005
Ethyl acetate	EPA 8260	Volatile Organics	NELAP	7/1/2003
Ethyl methacrylate	EPA 8260	Volatile Organics	NELAP	7/1/2003
Ethylbenzene	EPA 624	Volatile Organics	NELAP	2/13/2002
Ethylbenzene	EPA 8021	Volatile Organics	NELAP	7/1/2003
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Famphur	EPA 8270	Extractable Organics	NELAP	7/1/2003
Fluoranthene	EPA 625	Extractable Organics	NELAP	2/13/2002
Fluoranthene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Fluoranthene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Fluorene	EPA 625	Extractable Organics	NELAP	2/13/2002
Fluorene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Fluorene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Fluoride	EPA 300.0	General Chemistry	NELAP	2/13/2002
Fluoride	EPA 9056	General Chemistry	NELAP	7/1/2003
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002

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Analyte	Method/Tech	Category	Certification Type	Effective Date
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
gamma-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	3/2/2005
Gasoline range organics (GRO)	EPA 8015	Volatile Organics	NELAP	10/26/2005
Gross-alpha	EPA 900	Radiochemistry	NELAP	12/1/2006
Gross-beta	EPA 900	Radiochemistry	NELAP	12/1/2006
Hardness	EPA 130.2	General Chemistry	NELAP	2/13/2002
Hardness	SM 2340 C	General Chemistry	NELAP	5/4/2007
Heptachlor	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Heptachlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Heptachlor epoxide	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Heptachlor epoxide	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Hexachlorobenzene	EPA 625	Extractable Organics	NELAP	2/13/2002
Hexachlorobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Hexachlorobutadiene	EPA 625	Extractable Organics	NELAP	2/13/2002
Hexachlorobutadiene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Hexachlorobutadiene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Hexachlorocyclopentadiene	EPA 625	Extractable Organics	NELAP	2/13/2002
Hexachlorocyclopentadiene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Hexachloroethane	EPA 625	Extractable Organics	NELAP	2/13/2002
Hexachloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Hexachloroethane	EPA 8270	Extractable Organics	NELAP	7/1/2003
Hexachlorophene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Hexachloropropene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Ignitability	EPA 1010	General Chemistry	NELAP	7/1/2003
Indeno(1,2,3-cd)pyrene	EPA 625	Extractable Organics	NELAP	2/13/2002
Indeno(1,2,3-cd)pyrene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Indeno(1,2,3-cd)pyrene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Iron	EPA 200.7	Metals	NELAP	2/13/2002
Iron	EPA 6010	Metals	NELAP	7/1/2003
Iron	EPA 6020	Metals	NELAP	11/7/2003
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Isodrin	EPA 8270	Extractable Organics	NELAP	7/1/2003
Isophorone	EPA 625	Extractable Organics	NELAP	2/13/2002
Isopropylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Isosafrole	EPA 8270	Extractable Organics	NELAP	7/1/2003
Kepone	EPA 8270	Extractable Organics	NELAP	7/1/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Lead	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Lead	EPA 200.8	Metals	NELAP	2/13/2002
Lead	EPA 6010	Metals	NELAP	7/1/2003
Lead	EPA 6020	Metals	NELAP	7/1/2003
Lithium	EPA 6010	Metals	NELAP	7/1/2003
m/p-Xylenes	EPA 8260	Volatile Organics	NELAP	7/24/2006
Magnesium	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Magnesium	EPA 200.8	Metals	NELAP	2/13/2002
Magnesium	EPA 6010	Metals	NELAP	7/1/2003
Magnesium	EPA 6020	Metals	NELAP	11/7/2003
Manganese	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Manganese	EPA 200.8	Metals	NELAP	2/13/2002
Manganese	EPA 6010	Metals	NELAP	7/1/2003
Manganese	EPA 6020	Metals	NELAP	7/1/2003
MCPA	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
MCPP	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Mercury	EPA 245.1	Metals	NELAP	2/13/2002
Mercury	EPA 7470	Metals	NELAP	7/1/2003
Methacrylonitrile	EPA 8260	Volatile Organics	NELAP	7/1/2003
Methapyrilene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Methoxychlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Methyl bromide (Bromomethane)	EPA 624	Volatile Organics	NELAP	2/13/2002
Methyl bromide (Bromomethane)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Methyl chloride (Chloromethane)	EPA 624	Volatile Organics	NELAP	2/13/2002
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Methyl methacrylate	EPA 8260	Volatile Organics	NELAP	7/1/2003
Methyl parathion (Parathion, methyl)	EPA 8270	Extractable Organics	NELAP	7/1/2003
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Methylene chloride	EPA 624	Volatile Organics	NELAP	2/13/2002
Methylene chloride	EPA 8260	Volatile Organics	NELAP	7/1/2003
Molybdenum	EPA 200.7	Metals	NELAP	2/13/2002
Molybdenum	EPA 200.8	Metals	NELAP	2/13/2002
Molybdenum	EPA 6010	Metals	NELAP	7/1/2003
Molybdenum	EPA 6020	Metals	NELAP	7/24/2006
Naphthalene	EPA 625	Extractable Organics	NELAP	2/13/2002
Naphthalene	EPA 8260	Volatile Organics	NELAP	7/1/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Naphthalene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Naphthalene	EPA 8310	Extractable Organics	NELAP	7/1/2003
n-Butyl alcohol	EPA 8260	Volatile Organics	NELAP	7/1/2003
n-Butylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Nickel	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Nickel	EPA 200.8	Metals	NELAP	2/13/2002
Nickel	EPA 6010	Metals	NELAP	7/1/2003
Nickel	EPA 6020	Metals	NELAP	7/1/2003
Nitrate	EPA 9056	General Chemistry	NELAP	7/1/2003
Nitrate as N	EPA 300.0	General Chemistry	NELAP	2/13/2002
Nitrate as N	EPA 353.1	General Chemistry	NELAP	2/13/2002
Nitrate as N	SM 4500-NO3 H	General Chemistry	NELAP	5/4/2007
Nitrate-nitrite	EPA 300.0	General Chemistry	NELAP	2/13/2002
Nitrobenzene	EPA 625	Extractable Organics	NELAP	2/13/2002
Nitrobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Nitrobenzene	EPA 8330	Extractable Organics	NELAP	7/1/2003
n-Nitrosodiethylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosodimethylamine	EPA 625	Extractable Organics	NELAP	2/13/2002
n-Nitrosodimethylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitroso-di-n-butylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosodi-n-propylamine	EPA 625	Extractable Organics	NELAP	2/13/2002
n-Nitrosodiphenylamine	EPA 625	Extractable Organics	NELAP	2/13/2002
n-Nitrosodiphenylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosomethylethylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosomorpholine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosopiperidine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosopyrrolidine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Propylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
o,o,o-Triethyl phosphorothioate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	EPA 8330	Extractable Organics	NELAP	7/1/2003
Oil & Grease	EPA 1664	General Chemistry	NELAP	2/13/2002
Oil & Grease	EPA 413.1	General Chemistry	NELAP	2/13/2002
Oil & Grease	SM 5520 B	General Chemistry	NELAP	5/4/2007
Orthophosphate as P	EPA 300.0	General Chemistry	NELAP	2/13/2002
Orthophosphate as P	EPA 9056	General Chemistry	NELAP	7/1/2003
o-Toluidine	EPA 8260	Volatile Organics	NELAP	7/1/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
o-Toluidine	EPA 8270	Extractable Organics	NELAP	7/1/2003
o-Xylene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Pentachlorobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Pentachloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Pentachloronitrobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Pentachlorophenol	EPA 625	Extractable Organics	NELAP	2/13/2002
Pentachlorophenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
Perchlorate	EPA 314.0	General Chemistry	NELAP	7/24/2006
pH	EPA 150.1	General Chemistry	NELAP	2/13/2002
pH	EPA 9040	General Chemistry	NELAP	7/1/2003
pH	SM 4500-H+-B	General Chemistry	NELAP	5/4/2007
Phenacetin	EPA 8270	Extractable Organics	NELAP	7/1/2003
Phenanthrene	EPA 625	Extractable Organics	NELAP	2/13/2002
Phenanthrene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Phenanthrene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Phenol	EPA 625	Extractable Organics	NELAP	2/13/2002
Phenol	EPA 8270	Extractable Organics	NELAP	7/1/2003
Phorate	EPA 8270	Extractable Organics	NELAP	7/1/2003
Phosphorus, total	EPA 365.2	General Chemistry	NELAP	7/24/2006
Picloram	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
p-Isopropyltoluene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Potassium	EPA 200.7	Metals	NELAP	2/13/2002
Potassium	EPA 6010	Metals	NELAP	7/1/2003
Potassium	EPA 6020	Metals	NELAP	11/7/2003
Pronamide (Kerb)	EPA 8270	Extractable Organics	NELAP	7/1/2003
Propionitrile (Ethyl cyanide)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Pyrene	EPA 625	Extractable Organics	NELAP	2/13/2002
Pyrene	EPA 8270	Extractable Organics	NELAP	7/1/2003
Pyrene	EPA 8310	Extractable Organics	NELAP	7/1/2003
Pyridine	EPA 8270	Extractable Organics	NELAP	7/1/2003
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	EPA 8330	Extractable Organics	NELAP	7/1/2003
Reactive cyanide	Sec. 7.3 SW-846	General Chemistry	NELAP	7/24/2006
Reactive sulfide	Sec. 7.3 SW-846	General Chemistry	NELAP	7/24/2006
Residue-filterable (TDS)	EPA 160.1	General Chemistry	NELAP	2/13/2002
Residue-filterable (TDS)	SM 2540 C	General Chemistry	NELAP	5/4/2007
Residue-nonfilterable (TSS)	EPA 160.2	General Chemistry	NELAP	2/13/2002

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Residue-nonfilterable (TSS)	SM 2540 D	General Chemistry	NELAP	5/4/2007
Residue-total	EPA 160.3	General Chemistry	NELAP	2/13/2002
Residue-total	SM 2540 B	General Chemistry	NELAP	5/4/2007
Safrole	EPA 8270	Extractable Organics	NELAP	7/1/2003
sec-Butylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Selenium	EPA 200.7	Metals	NELAP	2/13/2002
Selenium	EPA 200.8	Metals	NELAP	2/13/2002
Selenium	EPA 6010	Metals	NELAP	7/1/2003
Selenium	EPA 6020	Metals	NELAP	11/7/2003
Silicon	EPA 200.7	Metals	NELAP	2/13/2002
Silicon	EPA 6010	Metals	NELAP	7/1/2003
Silver	EPA 200.7	Metals	NELAP	2/13/2002
Silver	EPA 200.8	Metals	NELAP	2/13/2002
Silver	EPA 6010	Metals	NELAP	7/1/2003
Silver	EPA 6020	Metals	NELAP	7/1/2003
Silvex (2,4,5-TP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Sodium	EPA 200.7	Metals	NELAP	2/13/2002
Sodium	EPA 6010	Metals	NELAP	7/1/2003
Sodium	EPA 6020	Metals	NELAP	11/7/2003
Strontium	EPA 200.7	Metals	NELAP	7/24/2006
Strontium	EPA 6010	Metals	NELAP	7/1/2003
Strontium	EPA 6020	Metals	NELAP	7/24/2006
Styrene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Sulfate	EPA 300.0	General Chemistry	NELAP	2/13/2002
Sulfate	EPA 9056	General Chemistry	NELAP	7/1/2003
Sulfide	EPA 376.1	General Chemistry	NELAP	2/13/2002
Sulfide	EPA 9030/9034	General Chemistry	NELAP	5/4/2007
Sulfide	SM 4500-S F (20th Ed.)	General Chemistry	NELAP	5/4/2007
Sulfotepp	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Synthetic Precipitation Leaching Procedure	EPA 1312	General Chemistry	NELAP	7/24/2006
tert-Butylbenzene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Tetrachloroethylene (Perchloroethylene)	EPA 624	Volatile Organics	NELAP	2/13/2002
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Tetryl (methyl-2,4,6-trinitrophenylnitramine)	EPA 8330	Extractable Organics	NELAP	7/1/2003
Thallium	EPA 200.7	Metals	NELAP	2/13/2002
Thallium	EPA 200.8	Metals	NELAP	2/13/2002

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State Laboratory ID: E87689 **EPA Lab Code: MO00054** **(314) 298-8566**

E87689
TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Thallium	EPA 6010	Metals	NELAP	7/1/2003
Thallium	EPA 6020	Metals	NELAP	7/1/2003
Thionazin (Zinophos)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Thorium	EPA 200.8	Metals	NELAP	7/24/2006
Tin	EPA 200.7	Metals	NELAP	7/24/2006
Tin	EPA 6010	Metals	NELAP	7/1/2003
Tin	EPA 6020	Metals	NELAP	7/24/2006
Titanium	EPA 200.7	Metals	NELAP	7/24/2006
Titanium	EPA 6010	Metals	NELAP	7/24/2006
Titanium	EPA 6020	Metals	NELAP	7/24/2006
Toluene	EPA 624	Volatile Organics	NELAP	2/13/2002
Toluene	EPA 8021	Volatile Organics	NELAP	7/1/2003
Toluene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Total cyanide	EPA 9010	General Chemistry	NELAP	7/1/2003
Total cyanide	EPA 9012	General Chemistry	NELAP	7/1/2003
Total nitrate-nitrite	SM 4500-NO3 H	General Chemistry	NELAP	5/4/2007
Total organic carbon	EPA 415.1	General Chemistry	NELAP	5/14/2003
Total organic carbon	EPA 9060	General Chemistry	NELAP	7/1/2003
Total organic carbon	SM 5310B	General Chemistry	NELAP	5/4/2007
Total organic halides (TOX)	EPA 9020	General Chemistry	NELAP	7/1/2003
Total sulfides	EPA 9034	General Chemistry	NELAP	7/1/2003
Toxaphene (Chlorinated camphene)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Toxaphene (Chlorinated camphene)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Toxicity Characteristic Leaching Procedure	EPA 1311	General Chemistry	NELAP	7/24/2006
trans-1,2-Dichloroethylene	EPA 624	Volatile Organics	NELAP	2/13/2002
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	7/1/2003
trans-1,3-Dichloropropylene	EPA 624	Volatile Organics	NELAP	2/13/2002
trans-1,3-Dichloropropylene	EPA 8260	Volatile Organics	NELAP	7/1/2003
trans-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Trichloroethene (Trichloroethylene)	EPA 624	Volatile Organics	NELAP	2/13/2002
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Trichlorofluoromethane	EPA 624	Volatile Organics	NELAP	12/16/2002
Trichlorofluoromethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
Uranium	EPA 200.8	Metals	NELAP	2/13/2002
Vanadium	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Vanadium	EPA 200.8	Metals	NELAP	2/13/2002

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Earth City, MO 63045

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Vanadium	EPA 6010	Metals	NELAP	7/1/2003
Vanadium	EPA 6020	Metals	NELAP	11/7/2003
Vinyl acetate	EPA 8260	Volatile Organics	NELAP	7/1/2003
Vinyl chloride	EPA 624	Volatile Organics	NELAP	2/13/2002
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	7/1/2003
Xylene (total)	EPA 624	Volatile Organics	NELAP	2/13/2002
Xylene (total)	EPA 8021	Volatile Organics	NELAP	7/1/2003
Xylene (total)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Zinc	EPA 200.7	General Chemistry,Metals	NELAP	2/13/2002
Zinc	EPA 200.8	Metals	NELAP	2/13/2002
Zinc	EPA 6010	Metals	NELAP	7/1/2003
Zinc	EPA 6020	Metals	NELAP	7/1/2003

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TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045**

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,1-Dichloropropene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2,3-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2,3-Trichloropropane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2,4,5-Tetrachlorobenzene	EPA 8270	Extractable Organics	NELAP	2/13/2002
1,2,4-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2,4-Trichlorobenzene	EPA 8270	Extractable Organics	NELAP	2/13/2002
1,2,4-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2005
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,3,5-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8270	Extractable Organics	NELAP	2/13/2002
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8330	Extractable Organics	NELAP	2/13/2002
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,3-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2005
1,3-Dichloropropane	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,3-Dinitrobenzene (1,3-DNB)	EPA 8330	Extractable Organics	NELAP	12/9/2002
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,4-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2005
1,4-Dioxane (1,4-Diethyleneoxide)	EPA 8260	Volatile Organics	NELAP	2/13/2002
1,4-Naphthoquinone	EPA 8270	Extractable Organics	NELAP	2/13/2002
1-Naphthylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
2,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	2/13/2002
2,3,4,6-Tetrachlorophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
2,4,5-T	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
2,4,5-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	10/26/2005
2,4,6-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002

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Earth City, MO 63045

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
2,4,6-Trinitrotoluene (2,4,6-TNT)	EPA 8330	Extractable Organics	NELAP	2/13/2002
2,4-D	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
2,4-DB	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
2,4-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
2,4-Dimethylphenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
2,4-Dinitrophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270	Extractable Organics	NELAP	2/13/2002
2,4-Dinitrotoluene (2,4-DNT)	EPA 8330	Extractable Organics	NELAP	2/13/2002
2,6-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	5/14/2003
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270	Extractable Organics	NELAP	5/14/2003
2,6-Dinitrotoluene (2,6-DNT)	EPA 8330	Extractable Organics	NELAP	5/14/2003
2-Amino-4,6-dinitrotoluene (2-am-dnt)	EPA 8330	Extractable Organics	NELAP	5/14/2003
2-Aminoanthraquinone	EPA 8270	Extractable Organics	NELAP	2/13/2002
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260	Volatile Organics	NELAP	2/13/2002
2-Chloroethyl vinyl ether	EPA 8260	Volatile Organics	NELAP	2/13/2002
2-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	2/13/2002
2-Chlorophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
2-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	2/13/2002
2-Hexanone	EPA 8260	Volatile Organics	NELAP	2/13/2002
2-Methylphenol (o-Cresol)	EPA 8270	Extractable Organics	NELAP	2/13/2002
2-Naphthylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
2-Nitroaniline	EPA 8270	Extractable Organics	NELAP	2/13/2002
2-Nitrophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
2-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	2/13/2002
2-Picoline (2-Methylpyridine)	EPA 8270	Extractable Organics	NELAP	2/13/2002
3,3'-Dichlorobenzidine	EPA 8270	Extractable Organics	NELAP	2/13/2002
3,3'-Dimethoxybenzidine	EPA 8270	Extractable Organics	NELAP	2/13/2002
3,3'-Dimethylbenzidine	EPA 8270	Extractable Organics	NELAP	2/13/2002
3/4-Methylphenols (m/p-Cresols)	EPA 8270	Extractable Organics	NELAP	7/24/2006
3-Methylcholanthrene	EPA 8270	Extractable Organics	NELAP	2/13/2002
3-Nitroaniline	EPA 8270	Extractable Organics	NELAP	2/13/2002
3-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	2/13/2002
4,4'-DDD	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
4,4'-DDE	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
4,4'-DDT	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
4-Amino-2,6-dinitrotoluene (4-am-dnt)	EPA 8330	Extractable Organics	NELAP	5/14/2003

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TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
4-Aminobiphenyl	EPA 8270	Extractable Organics	NELAP	2/13/2002
4-Chloro-3-methylphenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
4-Chloroaniline	EPA 8270	Extractable Organics	NELAP	2/13/2002
4-Chlorophenyl phenylether	EPA 8270	Extractable Organics	NELAP	2/13/2002
4-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	2/13/2002
4-Dimethyl aminoazobenzene	EPA 8270	Extractable Organics	NELAP	2/13/2002
4-Methyl-2-pentanone (MIBK)	EPA 8260	Volatile Organics	NELAP	2/13/2002
4-Nitroaniline	EPA 8270	Extractable Organics	NELAP	2/13/2002
4-Nitrophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
4-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	2/13/2002
7,12-Dimethylbenz(a) anthracene	EPA 8270	Extractable Organics	NELAP	2/13/2002
a-a-Dimethylphenethylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
Acenaphthene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Acenaphthene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Acenaphthylene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Acenaphthylene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Acetone	EPA 8260	Volatile Organics	NELAP	2/13/2002
Acetonitrile	EPA 8260	Volatile Organics	NELAP	2/13/2002
Acetophenone	EPA 8270	Extractable Organics	NELAP	2/13/2002
Acrolein (Propenal)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Acrylonitrile	EPA 8260	Volatile Organics	NELAP	2/13/2002
Aldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Allyl chloride (3-Chloropropene)	EPA 8260	Volatile Organics	NELAP	2/13/2002
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
alpha-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	3/2/2005
Aluminum	EPA 6010	Metals	NELAP	2/13/2002
Aluminum	EPA 6020	Metals	NELAP	2/13/2002
Aniline	EPA 8270	Extractable Organics	NELAP	2/13/2002
Anthracene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Anthracene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Antimony	EPA 6010	Metals	NELAP	2/13/2002
Antimony	EPA 6020	Metals	NELAP	2/13/2002
Aramite	EPA 8270	Extractable Organics	NELAP	2/13/2002
Aroclor-1016 (PCB-1016)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1221 (PCB-1221)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1232 (PCB-1232)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	2/13/2002

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13715 Rider Trail North
Earth City, MO 63045

Matrix: **Solid and Chemical Materials**

Analyte	Method/Tech	Category	Certification Type	Effective Date
Aroclor-1242 (PCB-1242)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1248 (PCB-1248)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1254 (PCB-1254)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Aroclor-1260 (PCB-1260)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Arsenic	EPA 6010	Metals	NELAP	2/13/2002
Arsenic	EPA 6020	Metals	NELAP	2/13/2002
Barium	EPA 6010	Metals	NELAP	2/13/2002
Barium	EPA 6020	Metals	NELAP	2/13/2002
Benzene	EPA 8021	Volatile Organics	NELAP	2/13/2002
Benzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Benzidine	EPA 8270	Extractable Organics	NELAP	2/13/2002
Benzo(a)anthracene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Benzo(a)anthracene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Benzo(a)pyrene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Benzo(a)pyrene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Benzo(b)fluoranthene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Benzo(b)fluoranthene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Benzo(g,h,i)perylene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Benzo(g,h,i)perylene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Benzo(k)fluoranthene	EPA 8270	Extractable Organics	NELAP	5/14/2003
Benzo(k)fluoranthene	EPA 8310	Extractable Organics	NELAP	5/14/2003
Benzoic acid	EPA 8270	Extractable Organics	NELAP	2/13/2002
Benzyl alcohol	EPA 8270	Extractable Organics	NELAP	2/13/2002
Beryllium	EPA 6010	Metals	NELAP	2/13/2002
Beryllium	EPA 6020	Metals	NELAP	2/13/2002
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
bis(2-Chloroethoxy)methane	EPA 8270	Extractable Organics	NELAP	2/13/2002
bis(2-Chloroethyl) ether	EPA 8270	Extractable Organics	NELAP	2/13/2002
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270	Extractable Organics	NELAP	2/13/2002
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270	Extractable Organics	NELAP	2/13/2002
Boron	EPA 6010	Metals	NELAP	5/14/2003
Boron	EPA 6020	Metals	NELAP	7/24/2006
Bromide	EPA 9056	General Chemistry	NELAP	2/13/2002
Bromobenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Bromochloromethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
Bromodichloromethane	EPA 8260	Volatile Organics	NELAP	2/13/2002

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Bromoform	EPA 8260	Volatile Organics	NELAP	2/13/2002
Butyl benzyl phthalate	EPA 8270	Extractable Organics	NELAP	2/13/2002
Cadmium	EPA 6010	Metals	NELAP	2/13/2002
Cadmium	EPA 6020	Metals	NELAP	2/13/2002
Calcium	EPA 6010	Metals	NELAP	12/9/2002
Calcium	EPA 6020	Metals	NELAP	11/7/2003
Carbazole	EPA 8270	Extractable Organics	NELAP	2/13/2002
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	2/13/2002
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	2/13/2002
Chlordane (tech.)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Chloride	EPA 9056	General Chemistry	NELAP	5/28/2003
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Chloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
Chloroform	EPA 8260	Volatile Organics	NELAP	2/13/2002
Chloroprene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Chromium	EPA 6010	Metals	NELAP	2/13/2002
Chromium	EPA 6020	Metals	NELAP	2/13/2002
Chromium VI	EPA 7196	General Chemistry	NELAP	2/13/2002
Chrysene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Chrysene	EPA 8310	Extractable Organics	NELAP	2/13/2002
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	2/13/2002
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	2/13/2002
cis-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Cobalt	EPA 6010	Metals	NELAP	2/13/2002
Cobalt	EPA 6020	Metals	NELAP	2/13/2002
Conductivity	EPA 9050	General Chemistry	NELAP	2/13/2002
Copper	EPA 6010	Metals	NELAP	2/13/2002
Copper	EPA 6020	Metals	NELAP	2/13/2002
Dalapon	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
delta-BHC	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Diallate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Dibenz(a,h) anthracene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Dibenz(a,h) anthracene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	12/16/2002
Dibromofluoromethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
Dibromomethane	EPA 8260	Volatile Organics	NELAP	2/13/2002

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E87689
TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045

Matrix: **Solid and Chemical Materials**

Analyte	Method/Tech	Category	Certification Type	Effective Date
Dicamba	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Dichlorodifluoromethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
Dichloroprop (Dichlorprop)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Dieldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Diesel range organics (DRO)	EPA 8015	Extractable Organics	NELAP	10/26/2005
Diethyl ether	EPA 8260	Volatile Organics	NELAP	2/13/2002
Diethyl phthalate	EPA 8270	Extractable Organics	NELAP	2/13/2002
Dimethyl phthalate	EPA 8270	Extractable Organics	NELAP	2/13/2002
Di-n-butyl phthalate	EPA 8270	Extractable Organics	NELAP	2/13/2002
Di-n-octyl phthalate	EPA 8270	Extractable Organics	NELAP	2/13/2002
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endosulfan I	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endosulfan II	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endosulfan sulfate	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endrin aldehyde	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Endrin ketone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	3/2/2005
Ethyl acetate	EPA 8260	Volatile Organics	NELAP	2/13/2002
Ethyl methacrylate	EPA 8260	Volatile Organics	NELAP	2/13/2002
Ethylbenzene	EPA 8021	Volatile Organics	NELAP	2/13/2002
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Extractable organic halides (EOX)	EPA 9023	General Chemistry	NELAP	2/13/2002
Famphur	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Fluoranthene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Fluoranthene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Fluorene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Fluorene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Fluoride	EPA 9056	General Chemistry	NELAP	2/13/2002
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
gamma-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	3/2/2005
Gasoline range organics (GRO)	EPA 8015	Volatile Organics	NELAP	10/26/2005
Gross-alpha	EPA 9310	Radiochemistry	NELAP	12/1/2006
Gross-beta	EPA 9310	Radiochemistry	NELAP	12/1/2006
Heptachlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	5/28/2003
Heptachlor epoxide	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Hexachlorobenzene	EPA 8270	Extractable Organics	NELAP	2/13/2002

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Hexachlorobutadiene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Hexachlorobutadiene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Hexachlorocyclopentadiene	EPA 8270	Extractable Organics,Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Hexachloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
Hexachloroethane	EPA 8270	Extractable Organics	NELAP	2/13/2002
Hexachlorophene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Hexachloropropene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Ignitability	EPA 1010	General Chemistry	NELAP	2/13/2002
Indeno(1,2,3-cd)pyrene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Indeno(1,2,3-cd)pyrene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Iron	EPA 6010	Metals	NELAP	2/13/2002
Iron	EPA 6020	Metals	NELAP	11/7/2003
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Isodrin	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Isopropylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Isosafrole	EPA 8270	Extractable Organics	NELAP	2/13/2002
Kepone	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Lead	EPA 6010	Metals	NELAP	2/13/2002
Lead	EPA 6020	Metals	NELAP	2/13/2002
Lithium	EPA 6010	Metals	NELAP	2/13/2002
m/p-Xylenes	EPA 8260	Volatile Organics	NELAP	7/24/2006
Magnesium	EPA 6010	Metals	NELAP	2/13/2002
Magnesium	EPA 6020	Metals	NELAP	11/7/2003
Manganese	EPA 6010	Metals	NELAP	2/13/2002
Manganese	EPA 6020	Metals	NELAP	2/13/2002
MCPA	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
MCPP	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Mercury	EPA 7471	Metals	NELAP	2/13/2002
Methacrylonitrile	EPA 8260	Volatile Organics	NELAP	2/13/2002
Methapyrilene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Methoxychlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Methyl bromide (Bromomethane)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Methyl methacrylate	EPA 8260	Volatile Organics	NELAP	2/13/2002
Methyl parathion (Parathion, methyl)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Methylene chloride	EPA 8260	Volatile Organics	NELAP	2/13/2002
Molybdenum	EPA 6010	Metals	NELAP	12/9/2002
Molybdenum	EPA 6020	Metals	NELAP	7/24/2006
Naphthalene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Naphthalene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Naphthalene	EPA 8310	Extractable Organics	NELAP	2/13/2002
n-Butyl alcohol	EPA 8260	Volatile Organics	NELAP	2/13/2002
n-Butylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Nickel	EPA 6010	Metals	NELAP	2/13/2002
Nickel	EPA 6020	Metals	NELAP	2/13/2002
Nitrate	EPA 9056	General Chemistry	NELAP	2/13/2002
Nitrite	EPA 9056	General Chemistry	NELAP	2/13/2002
Nitrobenzene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Nitrobenzene	EPA 8330	Extractable Organics	NELAP	2/13/2002
n-Nitrosodiethylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Nitrosodimethylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Nitroso-di-n-butylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Nitrosodiphenylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Nitrosomethylethylamine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Nitrosomorpholine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Nitrosopiperidine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Nitrosopyrrolidine	EPA 8270	Extractable Organics	NELAP	2/13/2002
n-Propylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
o,o,o-Triethyl phosphorothioate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	EPA 8330	Extractable Organics	NELAP	2/13/2002
Orthophosphate as P	EPA 9056	General Chemistry	NELAP	2/13/2002
o-Toluidine	EPA 8260	Volatile Organics	NELAP	2/13/2002
o-Toluidine	EPA 8270	Extractable Organics	NELAP	12/9/2002
o-Xylene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Paint Filter Liquids Test	EPA 9095	General Chemistry	NELAP	2/13/2002
Parathion, ethyl	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Pentachlorobenzene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Pentachloroethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
Pentachloronitrobenzene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Pentachlorophenol	EPA 8270	Extractable Organics	NELAP	2/13/2002

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
pH	EPA 9040	General Chemistry	NELAP	2/13/2002
pH	EPA 9045	General Chemistry	NELAP	2/13/2002
Phenacetin	EPA 8270	Extractable Organics	NELAP	2/13/2002
Phenanthrene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Phenanthrene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Phenol	EPA 8270	Extractable Organics	NELAP	2/13/2002
Phorate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Phosphorus	EPA 6020	Metals	NELAP	7/24/2006
Phosphorus, total	EPA 365.2	General Chemistry	NELAP	7/24/2006
Picloram	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
p-Isopropyltoluene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Potassium	EPA 6010	Metals	NELAP	2/13/2002
Potassium	EPA 6020	Metals	NELAP	11/7/2003
Pronamide (Kerb)	EPA 8270	Extractable Organics	NELAP	2/13/2002
Propionitrile (Ethyl cyanide)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Pyrene	EPA 8270	Extractable Organics	NELAP	2/13/2002
Pyrene	EPA 8310	Extractable Organics	NELAP	2/13/2002
Pyridine	EPA 8270	Extractable Organics	NELAP	2/13/2002
Radium-228	EPA 9320	Radiochemistry	NELAP	12/1/2006
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	EPA 8330	Extractable Organics	NELAP	2/13/2002
Reactive cyanide	EPA 7.3.3.2	General Chemistry	NELAP	2/13/2002
Reactive sulfide	EPA 7.3.4.2	General Chemistry	NELAP	2/13/2002
Safrole	EPA 8270	Extractable Organics	NELAP	2/13/2002
sec-Butylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Selenium	EPA 6010	Metals	NELAP	2/13/2002
Selenium	EPA 6020	Metals	NELAP	11/7/2003
Silicon	EPA 6010	Metals	NELAP	2/13/2002
Silver	EPA 6010	Metals	NELAP	2/13/2002
Silver	EPA 6020	Metals	NELAP	2/13/2002
Silvex (2,4,5-TP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Sodium	EPA 6010	Metals	NELAP	2/13/2002
Sodium	EPA 6020	Metals	NELAP	11/7/2003
Strontium	EPA 6010	Metals	NELAP	12/9/2002
Strontium	EPA 6020	Metals	NELAP	7/24/2006
Styrene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Sulfate	EPA 9056	General Chemistry	NELAP	2/13/2002

Charlie Crist
Governor

HEALTH

Ana M. Viamonte Ros, M.D., M.P.H.
State Surgeon General

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Earth City, MO 63045

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Sulfotepp	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Synthetic Precipitation Leaching Procedure	EPA 1312	General Chemistry	NELAP	2/13/2002
tert-Butylbenzene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Tetryl (methyl-2,4,6-trinitrophenylnitramine)	EPA 8330	Extractable Organics	NELAP	2/13/2002
Thallium	EPA 6010	Metals	NELAP	2/13/2002
Thallium	EPA 6020	Metals	NELAP	2/13/2002
Thionazin (Zinophos)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Tin	EPA 6010	Metals	NELAP	5/14/2003
Tin	EPA 6020	Metals	NELAP	7/24/2006
Titanium	EPA 6010	Metals	NELAP	7/24/2006
Titanium	EPA 6020	Metals	NELAP	7/24/2006
Toluene	EPA 8021	Volatile Organics	NELAP	2/13/2002
Toluene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Total cyanide	EPA 9010	General Chemistry	NELAP	2/13/2002
Total cyanide	EPA 9012	General Chemistry	NELAP	2/13/2002
Total nitrate-nitrite	EPA 9056	General Chemistry	NELAP	2/13/2002
Total organic carbon	EPA 9060	General Chemistry	NELAP	2/13/2002
Total organic halides (TOX)	EPA 9020	General Chemistry	NELAP	2/13/2002
Total radium	EPA 9315	Radiochemistry	NELAP	12/1/2006
Total sulfides	EPA 9034	General Chemistry	NELAP	2/13/2002
Toxaphene (Chlorinated camphene)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	2/13/2002
Toxicity Characteristic Leaching Procedure	EPA 1311	General Chemistry	NELAP	2/13/2002
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	2/13/2002
trans-1,3-Dichloropropylene	EPA 8260	Volatile Organics	NELAP	2/13/2002
trans-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	2/13/2002
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Trichlorofluoromethane	EPA 8260	Volatile Organics	NELAP	2/13/2002
Vanadium	EPA 6010	Metals	NELAP	2/13/2002
Vanadium	EPA 6020	Metals	NELAP	11/7/2003
Vinyl acetate	EPA 8260	Volatile Organics	NELAP	2/13/2002
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	2/13/2002
Xylene (total)	EPA 8021	Volatile Organics	NELAP	2/13/2002
Xylene (total)	EPA 8260	Volatile Organics	NELAP	2/13/2002
Zinc	EPA 6010	Metals	NELAP	2/13/2002
Zinc	EPA 6020	Metals	NELAP	2/13/2002

Appendix B: Experimental Design for Hexavalent Chromium Removal Using Reduction with Ferrous Sulfate, Coagulation, and Filtration (RCF) Process: A Demonstration-Scale Study

Glendale Water and Power
141 North Glendale Ave, 4th Floor • Glendale, CA 91206

Experimental Design for Hexavalent Chromium Removal using Reduction with Ferrous Sulfate, Coagulation, and Filtration (RCF) Process:

A Demonstration-Scale Study

June 2008

Report Prepared By:

Malcolm Pirnie, Inc.

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5337008

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Appendices

A. The Treatment of Hexavalent Chromium (Cr(VI)) in the City of Glendale, California Ground Water Supply: Phase III Demonstration-Scale Reduction with Ferrous Sulfate, Coagulation, Filtration Treatment Technology Evaluation Quality Assurance Project Plan

1. Introduction

The City of Glendale's groundwater supply in the San Fernando Valley has been contaminated with a wide variety of chemicals, including hexavalent chromium [Cr(VI)], trichloroethylene (TCE), perchloroethylene (PCE), 1,2,3-trichloropropane (TCP), and others, mainly as a result of improper disposal of industrial waste products. Extraction and treatment of volatile organic compounds (VOCs) is underway in the San Fernando Valley using air stripping and granular activated carbon (GAC), and the treated water is served to customers. Although Cr(VI) was also found in the groundwater supplies, levels were below the total Cr maximum contaminant level (MCL) of 50 μg/L in California. No Cr(VI) treatment was included with the VOC facilities at the time they were constructed.

Until June 2007, the health effects of Cr(VI) in drinking water were uncertain; Cr(VI) was a proven carcinogen by inhalation but little evidence existed to demonstrate the impact of Cr(VI) ingestion. However, a recent study conducted by the National Toxicology Program (NTP) showed that Cr(VI) is a carcinogen by ingestion in animal studies (NTP 2007). Even prior to this study, the Legislature of California mandated that the California Department of Public Health (DPH) establish a Cr(VI) MCL. First, the Office of Environmental Health Hazard Assessment (OEHHA) must set a public health goal (PHG), which will likely be based on the new NTP findings. In Glendale, public concern about Cr(VI) in the groundwater supply led the city to embark on a multi-phase study to identify and install Cr(VI) treatment in anticipation of a Cr(VI) MCL lower than the current total Cr MCL in California.

In the year 2000, the City of Glendale, along with the Cities of Los Angeles, Burbank, and San Fernando, initiated a testing program to develop a full-scale Cr(VI) treatment system capable of removing Cr(VI) to low parts-per-billion levels. The **Phase I Bench-scale study** was conducted to improve the understanding of fundamental chromium chemistry and to screen promising technologies for their ability to remove Cr(VI) to very low levels. The Phase I study is complete and the final report was published by AwwaRF (Brandhuber et al. 2004).

The **Phase II Pilot-scale study** was initiated in the summer of 2003 to further test the promising Cr(VI) removal technologies at pilot scale (i.e., several gallons-per-minute flows) using Glendale groundwater. A final report on the Phase II pilot-scale study was completed in 2005 (MEC 2005). Selected results were also published in peer-reviewed scientific journals (Qin et al. 2005, McGuire et al. 2006).

The **Phase III Demonstration-scale study** will finalize the treatment evaluation, residuals assessment, and cost estimate development by implementing one or more Cr(VI) removal technologies. The initial part of the Phase III effort was designated as the

Phase III Bridge Project, which included additional studies to finalize testing of weak-base anion (WBA) exchange resins for Cr(VI) treatment, refinement of treatment technology cost estimates based on Phase III Bridge Project results, and assembly of an expert panel to recommend one or more treatment processes for demonstration-scale testing. The Phase III Bridge Project was completed in early 2007 and the project report was published by AWWA (McGuire et al. 2007).

The Phase III Demonstration-scale study will start with testing WBA resin for Cr(VI) removal from a 425 gallons per minute (gpm) groundwater well. The WBA resin evaluation is funded in part by the US Environmental Protection Agency (USEPA) State and Tribal Assistance Grant (STAG) and California Proposition 50. The Experimental Plan and Quality Assurance Project Plan (QAPP) for WBA resin evaluation are currently under review by different stakeholders including USEPA Region 9, California DPH, City of Glendale, and Glendale Respondent's Group (GRG). Construction of the WBA demonstration-scale system is expected to begin in 2008.

Reduction with ferrous sulfate, coagulation, and filtration (RCF) was recommended for demonstration-scale testing by the expert panel convened as part of the Phase III Bridge Project. The recommendation was based on process effectiveness, a thorough understanding of the RCF technology, and ease of permitting. Consequently, the City of Glendale intends to design and build a demonstration-scale RCF treatment facility to treat part or all of the water from two high-chromium wells from the North Operable Unit (i.e., GN-2 and GN-3), depending on additional funding availability.

The purpose of this project is to demonstrate the effectiveness of the RCF process in removing Cr(VI) to low part-per-billion levels. The system will be operated for one year under the Proposition 50 grant and other available grants. Treated water will be put to beneficial use by serving Glendale's consumers. Treatment cost information developed in the Phase II Pilot-scale and Phase III Bridge studies will be updated as a result of this effort. This information is intended to be of use to other utilities requiring Cr(VI) treatment and to the state of California in setting a Cr(VI) MCL.

This document provides the experimental design for the RCF technology evaluation at demonstration scale. Chapter 2 briefly describes the RCF process. Chapter 3 depicts the overall study objectives. Data collection and sampling protocols for water quality and process-related parameters are described in Chapters 4 and 5, respectively. Operations evaluation and optimization of the RCF system are presented in Chapter 6.

2. RCF Process Description

2.1. Conceptual Design

In the RCF process, Cr(VI) is first reduced to Cr(III) with the addition of excess ferrous iron (Fe^{2+}), which is oxidized to ferric iron (Fe^{3+}) by the electron transfer during the reduction of Cr(VI) and by dissolved oxygen present in the water. Ferrous iron doses found to be acceptable in Phase II testing ranged from 1.5 to 2.5 mg/L for reducing 100 μg/L of Cr(VI) to less than 5 μg/L. Cr(III) either precipitates, forms a co-precipitate with the ferric iron, or adsorbs onto the ferric floc. The ferric iron/Cr(III) particles form larger floc during the aeration and coagulation (with the use of a polymer) stages. Particles are then removed by filtration.

RCF is a mature treatment process for removing of high concentrations of Cr(VI) from industrial wastewaters. RCF minus the reduction step (i.e., just coagulation/filtration) is an accepted technology for arsenic removal in drinking water treatment. Unfortunately, only limited studies have been conducted to examine the possibility of achieving low chromium treatment goals using the RCF process for drinking water. Recent studies investigating the reduction of Cr(VI) with ferrous sulfate in bench-scale experiments yielded mixed results (Brandhuber et al. 2004, Lee and Hering 2003). The process was effective for the removal of Cr from drinking water in one study (Lee and Hering 2003) but not in the other (Brandhuber et al. 2004). Both studies demonstrated that ferrous sulfate effectively reduces Cr(VI) but that subsequent Cr(III) removal by filtration is not effective under all conditions. In Phase II testing, a pilot-scale RCF unit (approx. 2-gpm capacity) successfully removed total chromium to below detectable levels for 23 to 46 hours (Qin et al. 2005).

Based on the Phase II pilot results, a demonstration-scale RCF system was conceptually designed with a treatment capacity of 500 gpm (i.e., one of the likely configurations to treat one well). Figure 2-1 illustrates the proposed flow schematic for a 500-gpm RCF system.

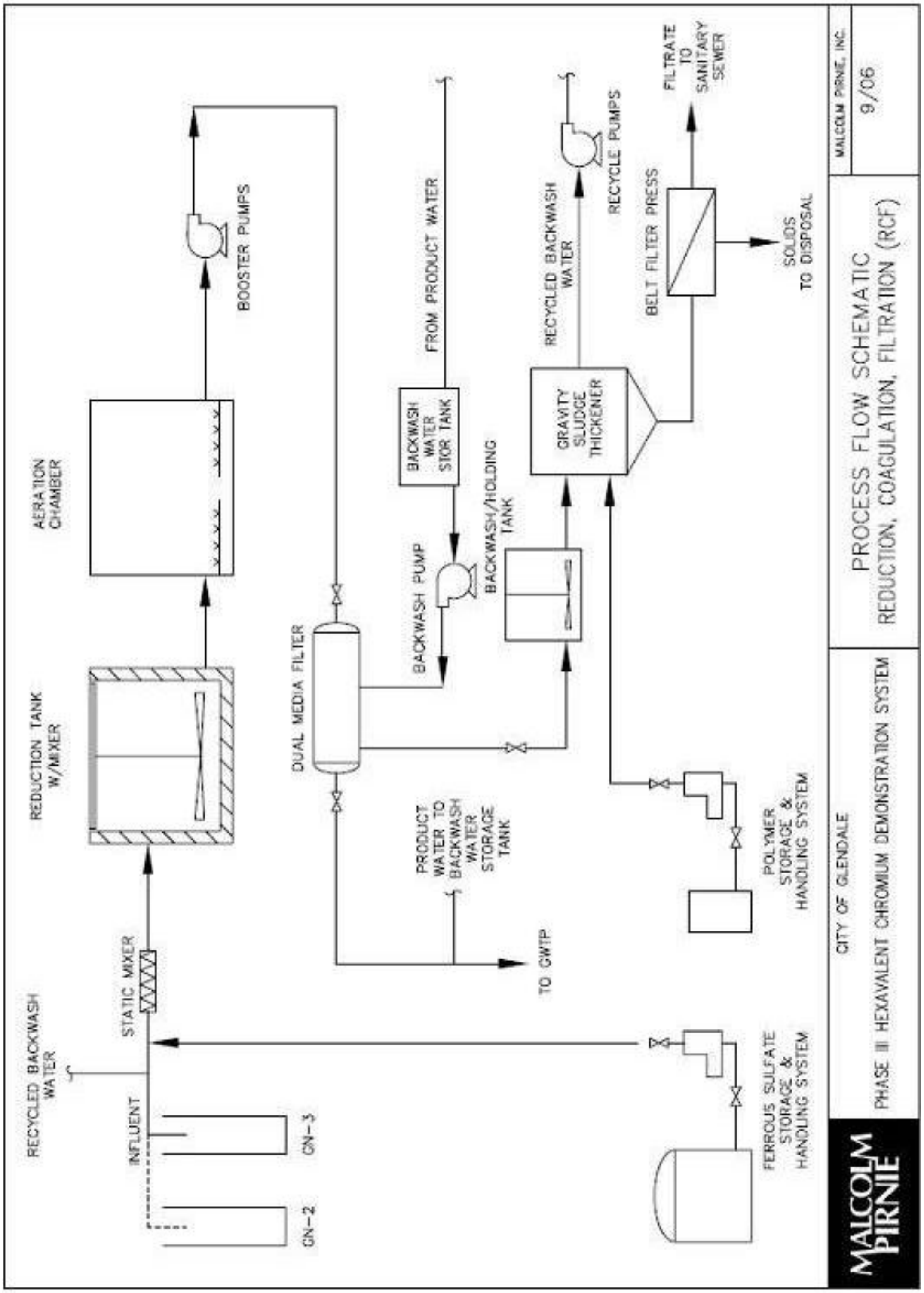

Figure 2-1: Schematic of the conceptually designed RCF demonstration-scale system (500 gpm)

2.2. Additional RCF Pilot Testing to Optimize Design

According to a recent cost estimate by Malcolm Pirnie, the total capital cost for the conceptually designed 500-gpm RCF system was $3.05 million and the annual operations and maintenance (O&M) cost was estimated at $164,000. Due to limited funding availability, the treatment capacity of the demonstration-scale system may have to be reduced to 100 gpm. Further optimization of the RCF system was also necessary to reduce the overall capital cost. As part of the optimization effort, an additional RCF pilot system with 2-gpm capacity was tested during February and March of 2008 to identify the most effective and least costly design.

The additional pilot testing results revealed that an RCF process with 45 minutes of reduction time followed by filtration was successful in consistently reducing Cr(VI) and removing total Cr to concentrations below 1 μg/L (i.e., the method reporting level for total Cr) without the need for an aeration step. In addition, the pilot testing demonstrated that the RCF system could be operated for extended hours (more than 24 hours) with little pressure drop across the filters, further reducing the frequency of backwashing and the quantity of wash water produced. Figure 2-2 shows a simplified schematic of the pilot-scale treatment process. Refer to the “Report on Additional RCF Pilot Testing to Optimize Design” for more details.

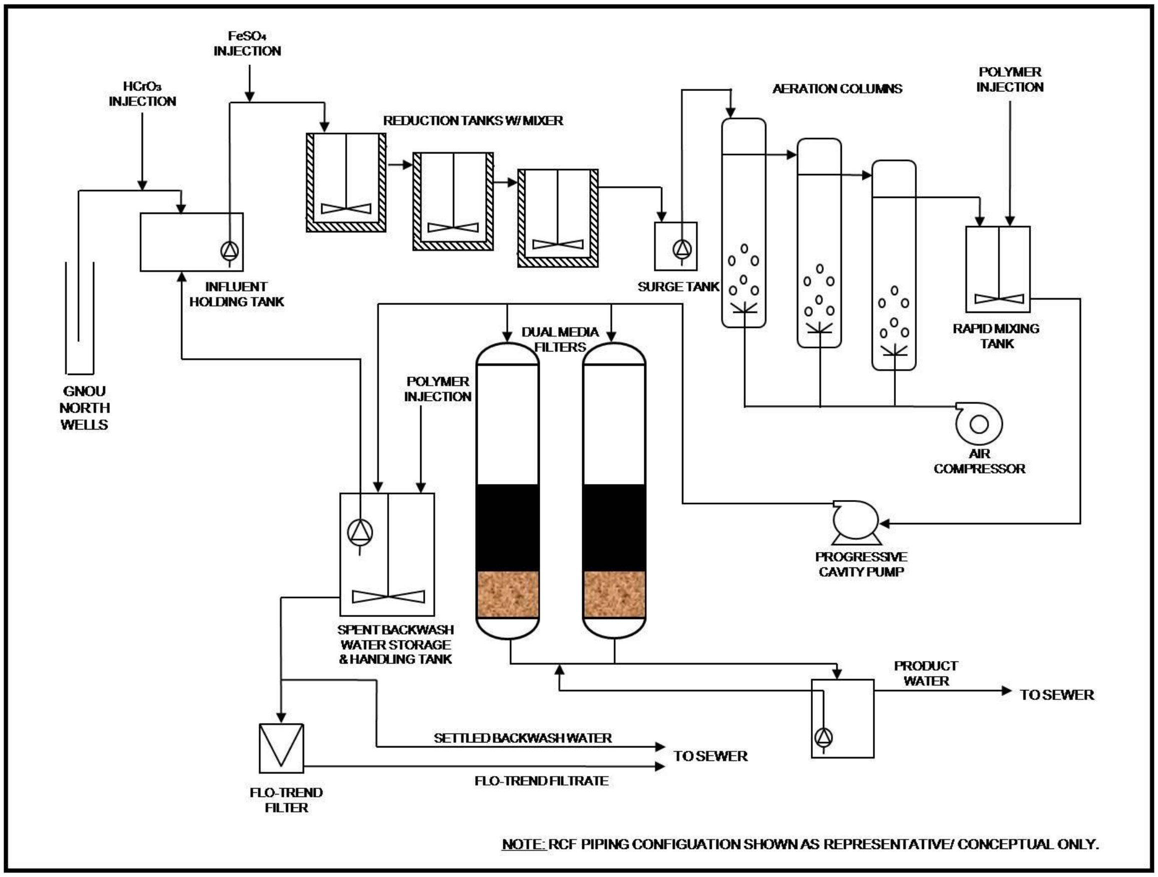

Figure 2-2: Simplified schematic of the system tested during the additional RCF pilot study (2 gpm)

2.3. Optimized Demonstration-Scale RCF System (100 GPM)

Figure 2-3 provides the process flow schematic of a 100-gpm demonstration-scale RCF system, which incorporates the design concepts of the 500-gpm system and modifications based on additional pilot study findings.

Raw water from GN-2 and/or GN-3 will flow to the RCF demonstration site at a rate of 100 gpm. Ferrous sulfate will be injected into the water at a dose of 1.25 mg/L as Fe. The Fe dosage is based on the influent Cr(VI) concentration of 50 µg/L, and the 25:1 ratio of Fe to Cr(VI) shown to be effective in both Phase II and the additional RCF pilot study[1].

After going through a static mixer, the Fe-spiked influent water will flow to three identical reduction tanks piped in series. Each reduction tank will be equipped with a mechanical mixer and have a volume of 1,500 gallons. The three reduction tanks in series provide a total detention time of 45 minutes for the 100 gpm water flow. The purpose of using three tanks in series is to increase mixing efficiency by minimizing short circuiting and back flow problems. The three reduction tanks will also be designed with the ability to bypass one or two tanks so that any maintenance or malfunction issues with the tank and/or mechanical mixer will not cause a shut-down of the whole RCF system.

One of the most important findings from the additional pilot study was that no pH adjustment or additional aeration (beyond that provided by the dissolved oxygen in the water) was necessary. Therefore, Malcolm Pirnie recommended the exclusion of those two components in the demonstration-scale RCF system design for cost saving purposes. However, physical space and hydraulic capacity for pH adjustment and aeration will be included in the design process in case the two components are needed at a later time.

After going through the reduction tanks, the water will flow to a 500-gallon rapid mixing tank, into which polymer is injected for enhanced Fe and Cr floc formation. The mixing tank will provide an additional 5 minutes for floc formation. Different anionic polymers, Magnafloc Ciba E38, E40, and Nalco 9901, were tested during the additional RCF pilot study. Under optimized condition, 0.1 mg/L of Magnafloc Ciba E38 polymer was determined to be an effective dose for floc formation in the RCF process.

After mixing tank, water containing Fe and Cr floc will be pumped by progressive cavity pump to two pressurized dual media filters in down-flow mode. One lesson learned from the additional pilot study is that the use of progressive cavity pump is necessary for enhanced filtration performance by minimizing the break-up of Fe and Cr floc that has already been formed. In fact, any pumping of process water in which floc formation has occurred should employ a progressive cavity pump. The dual media filters will consist of approximately 24 inches of anthracite and 12 inches of sand, with a supportive underdrain. The design hydraulic loading rate for both filters is about 3 gallons per

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[1] Fe dosage will be adjusted during the demonstration-scale study to account for the actual influent water Cr(VI) concentration.

[2] Phase II RCF pilot testing showed that the settled backwash solids failed the California WET test and

minute per square foot (gpm/sf). Conceptually, two 4.5-foot diameter vertical pressure vessels will be needed for the 100 gpm system.

The majority of filtered water will blend with water from other GOU wells and undergo further VOC treatment at the Glendale Water Treatment Plant. A small portion of filtered water will be diverted to a product water storage tank for backwash purpose or product water from the GWTP will be used for backwash.

During backwash, stored product water will be pumped through the filters in an up-flow mode at a loading rate of 21 gpm/sf or higher for 5 to 10 minutes. Concurrent air scouring is also desirable during backwash. Spent backwash water will overflow to a separate storage tank, where polymer is injected and mixed so that the solids in the backwash water will settle efficiently. During the additional RCF pilot study, backwash water was effectively settled using 1.0 mg/L Magnafloc Ciba E38 anionic polymer. It should be noted that the same polymer was also effective for promoting floc formation in the rapid mixing tank. Therefore, it is possible to design a common polymer storage system for use in both the rapid mixing tank and spent backwash water storage tank at the demonstration-scale facility. Supernatant from the backwash storage tank contained approximately 30 µg/L total Cr and 1 mg/L Fe as determined during the addition pilot study. The supernatant water quality was considered acceptable to be recycled to the head of the RCF system at a rate of 4 – 5 % of the influent flow (i.e., 4 – 5 gpm).

Settled backwash solids will be sent to a passive filtration system using a technology akin to the Flo-Trend system. The filtrate is expected to have a water quality similar to the backwash supernatant and can be recycled to the spent backwash water storage tank while dewatered solids captured on the filter will be shipped for disposal at a hazardous waste landfill[2].

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[2] Phase II RCF pilot testing showed that the settled backwash solids failed the California WET test and were characterized as hazardous waste in California.

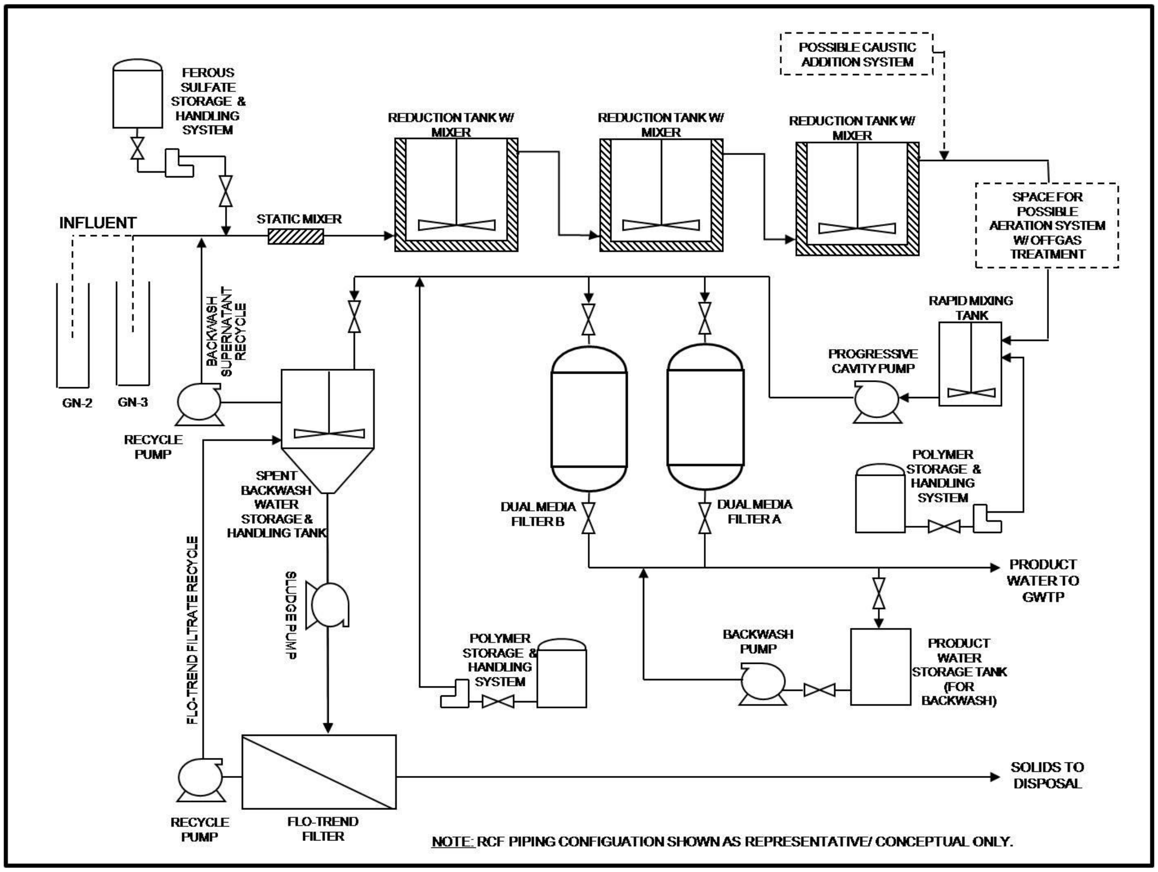

Figure 2-3: Schematic of the proposed demonstration-scale RCF plant (100 gpm)

2.4. Location of the RCF System

The demonstration-scale RCF system is proposed to be located adjacent to the Glendale Water Treatment Plant (GWTP) to treat water from GN-2 and/or GN-3. The wells GN-2 and GN-3 each have a capacity of 567 gpm. Cr(VI) concentration in these two wells ranges from 40 to 60 µg/L and is expected reach as high as 170 µg/L according to a CH2MHILL report. High Cr(VI) levels in the well water make them good candidates for the demonstration study.

Well GN-2 is located on the site of the Dream Works Animation Studios and Well GN-3 is located on the new Disney Animation Studios site now under development. For both locations, no property is available at the well sites for the demonstration-scale RCF system.

A dedicated pipeline will be constructed from the well site(s) to the proposed demonstration facility next to the GWTP. The site of this potential RCF demonstration facility is owned by the City of Glendale and is part of the City's Corporate Yard for the water and power field personnel. The City has "fee" title to this property that has been designated as the location for a demonstration facility. Figure 2-4 shows the location of proposed demonstration-scale RCF system.

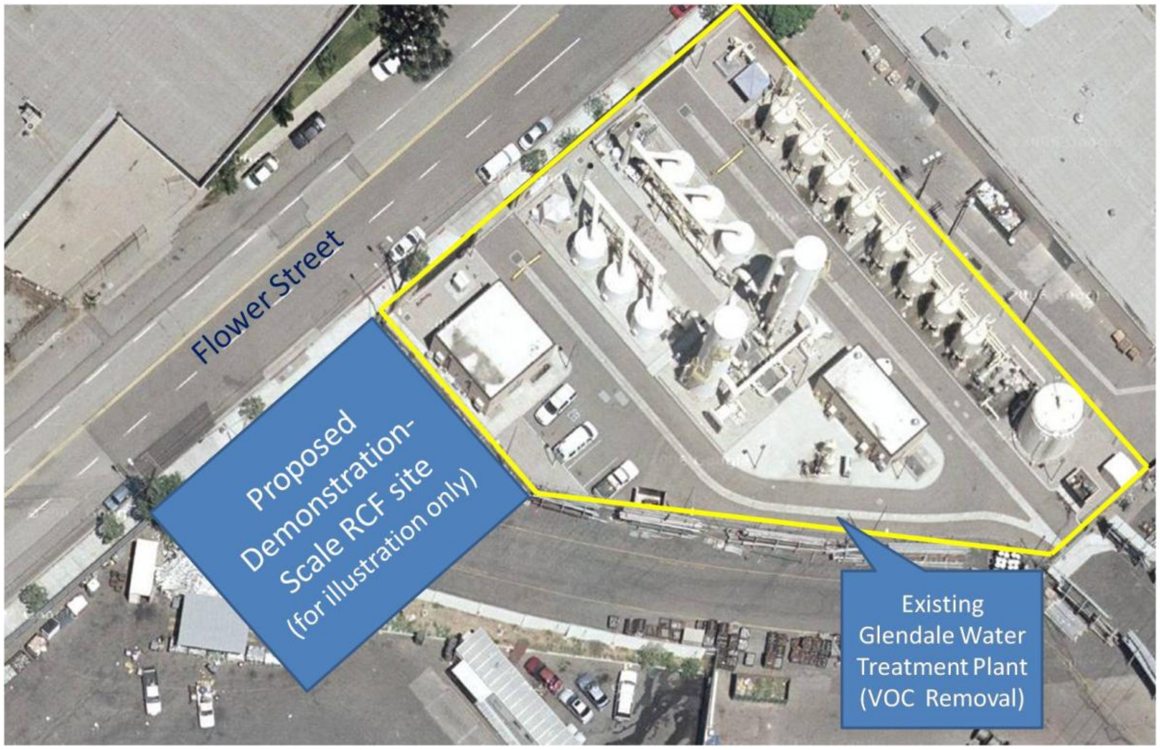

Figure 2-4: Map showing the location of proposed RCF system (100 gpm)

3. Study Objectives

The primary goal of the study is to demonstrate that a 100-gpm RCF system can reduce Cr(VI) concentration in the GN-2 and/or GN-3 wells, and Cr(VI) and total Cr concentrations from the RCF system effluent remain below 1 µg/L over extended periods of time. It should be noted that total Cr and/or Cr(VI) concentration in the RCF effluent might exceed 1 µg/L due to possible system upsets. However, as a Cr(VI) –specific MCL does not currently exist and the 100-gpm RCF effluent will be blended with approximately 4,900 gpm GOU well water for subsequent VOC removal, total Cr concentrations in the GWTP effluent are not expected to exceed the 50 µg/L California MCL.

In addition, the objectives of the Phase III Demonstration-scale RCF study include:

- Minimizing operational costs of the RCF system through treatment process optimization
- Optimizing residuals handling and disposal strategies
- Drafting a comprehensive operations and maintenance (O&M) manual for the system
- Updating unit cost information developed in the Phase II Pilot-scale study with actual treatment cost, and
- Publicly disseminating project plans and findings to a wide audience, including water agencies also concerned with Cr(VI) in water supplies, California DPH, USEPA, and consumers

4. Sampling Plan for Water Quality Parameters

During the demonstration-scale RCF study, we will focus on measuring key water quality and process related parameters (including residuals) to fully evaluate the treatment process. This chapter describes the sampling plan for water quality parameters in the study. The plan provides details on sampling location, sampling parameters, sampling frequency, and analytical approaches. Chapter 5 describes the sampling plan for process-related parameters (including residuals), and Chapter 6 provides the RCF start-up plan and outline for ongoing optimization. The sampling plans for water quality and process related parameters do not include a quality assurance/ quality control (QA/QC) section. A comprehensive Quality Assurance Project Plan (QAPP), which focuses on QA/QC issues, has been prepared separately to fulfill USEPA requirements and is provided as Appendix A to this document.

4.1. Sampling Locations

Sampling ports will be installed as part of the RCF system and water quality samples will be collected from these ports during the demonstration-scale study. Figure 4-1 shows a schematic of the RCF system with sampling ports highlighted in red. A brief description of each sampling port is listed in Table 4-1.

Table 4-1. Water quality sampling location identification

Sampling Port Identification	Description
SP-001	GN-2 and/or GN-3 Well/Plant Influent
SP-100	Influent after Ferrous Sulfate Addition
SP-101	Reduction Tank #1 Effluent
SP-102	Reduction Tank #2 Effluent
SP-103	Reduction Tank #3 Effluent
SP-201	Dual Media Filter A Influent
SP-202	Dual Media Filter B Influent
SP-301	Dual Media Filter A Effluent
SP-302	Dual Media Filter B Effluent
SP-303	Combined Filter Effluent
SP-401	Backwash Supernatant
SP-501	Settled Backwash Solids
SP-502	Flo-Trend Filtrate

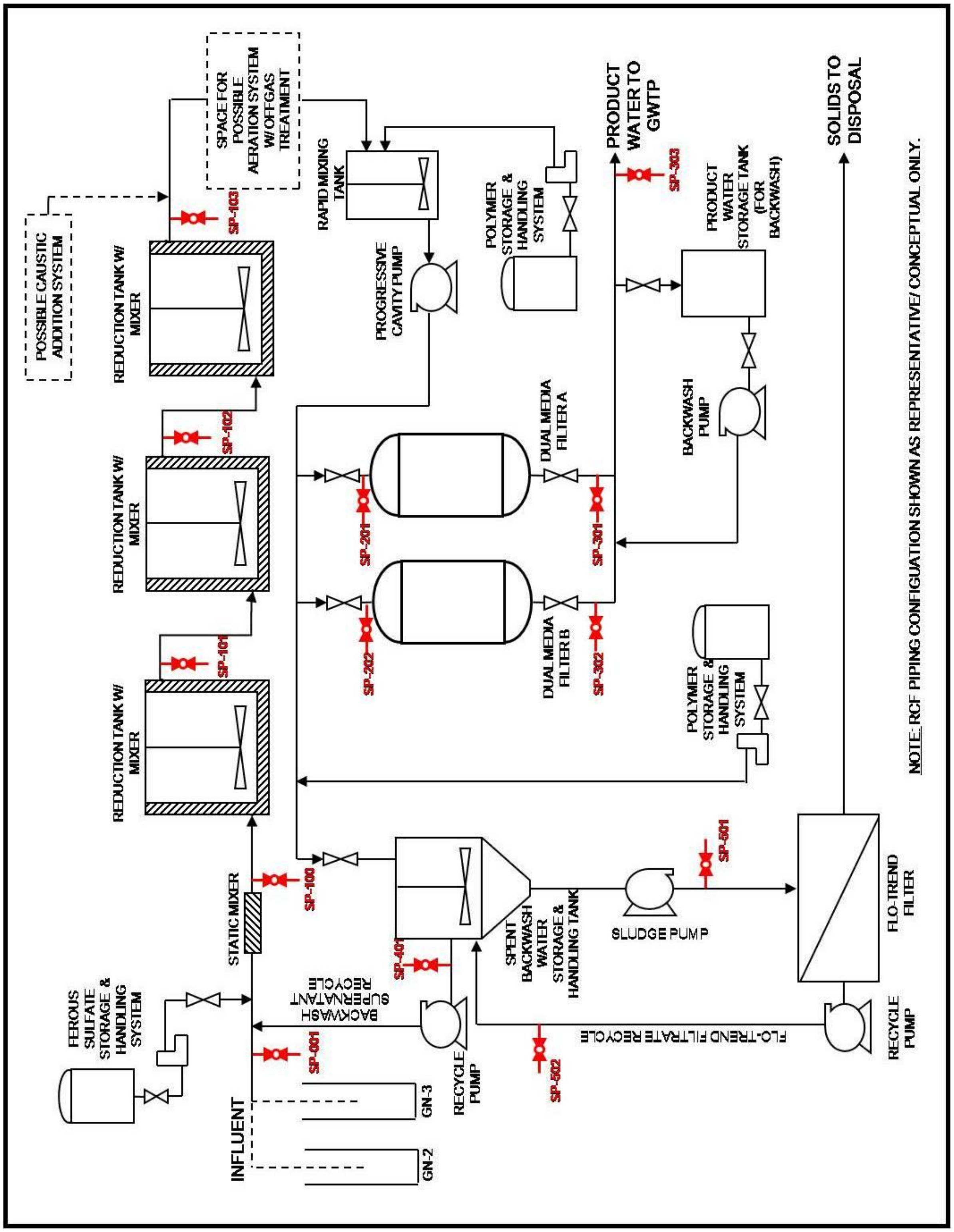

Figure 4-1: Demonstration-scale RCF schematic with sampling ports highlighted in red

4.2. Water Quality Parameters

Critical water quality parameters of the demonstration-scale RCF study include Cr(VI), total Cr, total Fe, turbidity, dissolved oxygen (DO), and pH. Cr(VI) and total Cr concentrations in process influent and effluent samples are measured to determine whether the treatment goal of less than 1 μg/L Cr(VI) and total Cr is achieved and to determine Cr removal efficiencies. Total Fe, turbidity, and DO from selected sampling ports are important because they are good indicators of the RCF system performance and can be easily measured using onsite instruments. The additional RCF pilot study demonstrated that total Cr concentration in the filter effluent greater than 5 μg/L was coupled with high filter effluent turbidity (i.e., greater than 1 NTU) and high total Fe concentration (i.e., greater than 0.19 mg/L). A high DO concentration in the influent (above ~5 mg/L) would ensure that enough dissolved oxygen is available to oxidize excess ferrous sulfate in the treatment process. pH from selected sampling ports is another important parameter which needs to be monitored routinely.

Other chemical and physical parameters, including ferrous iron (Fe^{2+}), pH, temperature, and total suspended solids (TSS) will be routinely measured to monitor any drastic water quality changes within the RCF process and investigate the possible causes for water quality changes. Table 4-2 summarizes the proposed water quality parameters to be monitored in the demonstration-scale RCF study. Water quality parameters from each sampling port are identified as critical (C), non-critical (N/C), or not necessary (-).

Table 4-2. Water quality parameters to be monitored in the RCF demonstration-scale Study [parameters identified as Critical (C), non-Critical (N/C), and not necessary (-)]

Sampling Port	Cr(VI)	Total Cr	Total Fe	Fe^{2+}	Turbidity	pH	Temp	DO	TSS
SP-001	C	C	N/C	N/C	N/C	C	N/C	C	
SP-100	-	-	C	C	-	-	-	-	-
SP-101	-	-	N/C	N/C	-	C	N/C	-	-
SP-102	-	-	N/C	N/C	-	C	N/C	-	-
SP-103	C	-	C	C	-	C	N/C	C	-
SP-201	-	-	-	-	-	C	N/C	C	-
SP-202	-	-	-	-	-	C	N/C	C	-
SP-301	C	C	C	C	C	N/C	N/C	N/C	-
SP-302	C	C	C	C	C	N/C	N/C	N/C	-
SP-303	C	C	C	C	C	C	C	C	-
SP-401	C	C	C	C	C	N/C	N/C	-	-
SP-501	-	-	-	-	-	-	-	-	N/C
SP-502	C	C	N/C	N/C	C	N/C	N/C	-	-

4.3. Sampling Frequency

The planned sampling frequency for water quality parameters, shown in Table 4-3, is based on treatment process design and the expected duration of testing (approximately one year for the demonstration-scale study). Water quality samples will be collected at sufficient frequency to provide enough information to achieve the project's stated objectives.

Generally, measuring of the critical water quality parameters at each sampling port will occur on a weekly basis, except for parameters that will be monitored continuously. The weekly sampling frequency will generate 52 sets of Cr(VI) and total Cr data from various locations of the RCF system over one-year period, which will enable us to have a comprehensive evaluation of the system performance. Dual media effluent turbidity is a good indicator of total Cr removal performance and will be monitored continuously during the one-year study. Other non-critical parameters will be monitored on a monthly basis, unless noted otherwise in Table 4-3. It should be noted that the sampling frequency listed in Table 4-3 will be adopted once the RCF system has reached a steady-state condition. During system start-up and other operation optimization periods, the sampling frequency may vary. Chapter 6 provides more information on sampling frequency during system start-up and operation optimization periods.

Table 4-3. Sampling frequency for water quality parameters

Sampling Port	**Laboratory Analysis**			**Field Analysis**					
	Cr(VI)	**Total Cr**	**TSS**	**Cr(VI)**	**Total Fe**	**Fe^{2+}**	**Turbidity**	**pH/ Temp[3]**	**DO**
SP-001	1/W[1]	1/W		1/W	1/M[2]	1/M	1/M	Continuous	Continuous
SP-100	-	-	-	-	1/W	1/W	-	-	-
SP-101	-	-	-	-	1/M	1/M	-	1/W	-
SP-102	-	-	-	-	1/M	1/M	-	1/W	-
SP-103	1/W	-	-	-	1/W	1/W	-	1/W	1/W
SP-201	-	-	-	-	-	-	-	1/W	1/W
SP-202	-	-	-	-	-	-	-	1/W	1/W
SP-301	1/W	1/W	-	1/W	1/W	1/W	Continuous	1/M	1/M
SP-302	1/W	1/W	-	1/W	1/W	1/W	Continuous	1/M	1/M
SP-303	1/W	1/W	-	1/W	1/W	1/W	Continuous	1/W	1/W
SP-401	1/W	1/W	-	1/W	1/W	1/W	1/W	1/M	-
SP-501	-	-	1/M	-	-	-	-	-	-
SP-502	1/W	1/W	-	1/W	1/M	1/M	1/W	1/M	-

[1] 1/W = Once per week

[2] 1/M = Once per month

[3] pH and temperature will be monitored at the same frequency because the pH meter selected for the RCF study has temperature compensation function to ensure more accurate measurement.

4.4. Analytical Approach

Analytical methods for the water quality parameters will conform to USEPA guidelines and recommended test methods, including those in Standard Method for the Examination of Water and Wastewater (SM, APHA 1999). This section briefly describes the analytical approach used in the demonstration-scale study. Refer to the QAPP document in Appendix A for more detailed information (e.g., sample handling and transportation methods, and QA/QC measures).

During the demonstration-scale study, chemical and physical analytes will be measured either in a laboratory or in the field. ELAP – certified Montgomery Watson Harza Laboratories (MWH Labs) will be the contract lab for analysis of selected water quality parameters (see Table 4-4). Laboratory analysis of total Cr will be performed by ICP-MS (EPA Method 200.8). Cr(VI) will be analyzed using EPA Method 300.0. TSS will be measured gravimetrically using EPA Method 160.2. The Method Reporting Level (MRL) at MWH Labs for Cr(VI), total Cr, and TSS are 0.1 μg/L, 1.0 μg/L, and 4 mg/L, respectively. Samples found to be less than these values are reported as "<MRL."

Standard-tested Hach and other equipment will be used for field monitoring. Table 4-4 also lists the analytical approaches for water quality parameters measured using online or field instruments.

Table 4-4. Analytical methods, locations of analyses, and detection limits

Sample Analysis	Analytical Method	Analysis Location	Method Detection Level (MDL)	Method Reporting Level (MRL)
Cr(VI) – Lab	EPA 218.6 (IC)	MWH Labs	0.015 μg/L	0.1 μg/L
Total Cr	EPA 200.8 (ICP-MS)	MWH Labs	0.192 μg/L	1.0 μg/L
TSS	EPA 160.2 (Gravimetric)	MWH Labs	4 mg/L	4 mg/L
Cr(VI) – Field	Hach Method 8023 (Diphenylcarbohydrazide)	Field	10 μg/L	10 μg/L
Total Iron	Hach Method 8008 (FerroVer)	Field	0.02 mg/L	0.02 mg/L
Ferrous Iron	Hach Method 8146 (1,10-Phenanthroline)	Field	0.02 mg/L	0.02 mg/L
pH	SM 4500H+ B (Electrometric)	Field	N/A	N/A
pH (Continuous)[1]	SM 4500H+ B (Electrometric)	Online	N/A	N/A
Temperature	SM 2550 (Thermometric)	Field	N/A	N/A
Turbidity[2]	SM 2130 B (Nephelometric)	Field	0.02 NTU	0.02 NTU
Turbidity (Continuous)[3]	SM 2130 B (Nephelometric)	Online	0.02 NTU	0.02 NTU
DO	Hach Method 8166 (HRDO)	Field	0.3 mg/L	0.3 mg/L
DO (Continuous)[4]	Hach Method 10360 (Luminescence measurement)[5]	Online	0.1 mg/L	0.1 mg/L

[1] Based on Hach LGI DPC1R2A pH sensor
[2] Based on Hach 2100P Turbidimeter
[3] Based on Hach 1720E Low Range Turbidimeter
[4] Based on Hach LDO Dissolved Oxygen probe
[5] EPA approved method

5. Sampling Plan for Process-Related Parameters

In addition to chemical and physical water quality parameters, process-related parameters will be routinely monitored to evaluate the operations of the RCF system. Process parameters for the demonstration study include water flow rate, chemical feed rate, and pressure buildup through the filter columns. Treatment residuals are also categorized as process-related parameters in the study.

Figure 5-1 shows a schematic of the RCF system with monitoring locations for process-related parameters highlighted in red. Table 5-1 identifies the process parameters that will be monitored at each location and associated monitoring frequencies. It should be noted that the demonstration-scale RCF system will be designed to operate automatically with minimal operators' supervision. As a result, some of the process-related parameters will be monitored and recorded continuously and the data will be transmitted to the GWTP via the Supervisory Control and Data Acquisition (SCADA) system. However, system operators are still required to follow the monitoring plan as specified in Table 5-1 to ensure the completeness of the operational data.

Process-related parameters will be measured with appropriate instruments. For example, a flow meter will be used for flow rate and total volume measurement, a pressure transducer for pressure reading, calibration column and stop watch for chemical injection rate determination, and sight-glass or level indicators for liquid level reading. All instruments used for the RCF study will be specified during the preliminary design phase.

The treatment residual – dewatered sludge captured on the passive filtration system – will be assessed at Test America Labs to confirm disposal options using the Toxicity Characteristic Leaching Procedure (TCLP, EPA Method 1311 as mandated by 40 CFR 261) and the California Waste Extraction Test (CWET). The Phase II pilot-scale testing indicated that the sludge would be classified as hazardous waste in the State of California because total Cr concentration in the leachate exceeded the regulatory limit during CWET.

The quantity of dewatered sludge captured on the passive filtration system will also be determined during the study. Tare weight of the passive filter will be determined or provided by the vendor before any sludge loading. The gross weight of the filter with dewatered sludge will also be determined each time an off-site disposal occurs. The net weight of dewatered sludge can thus be calculated by subtracting the tare weight from the gross weight and the daily sludge production rate can be calculated by dividing the net weight by the filter operation duration. In addition, the dewatered sludge will be sent to Test America Labs for moisture content determination. As a result, the solids content in the dewatered sludge can be easily calculated (i.e., 100 - % of moisture content).

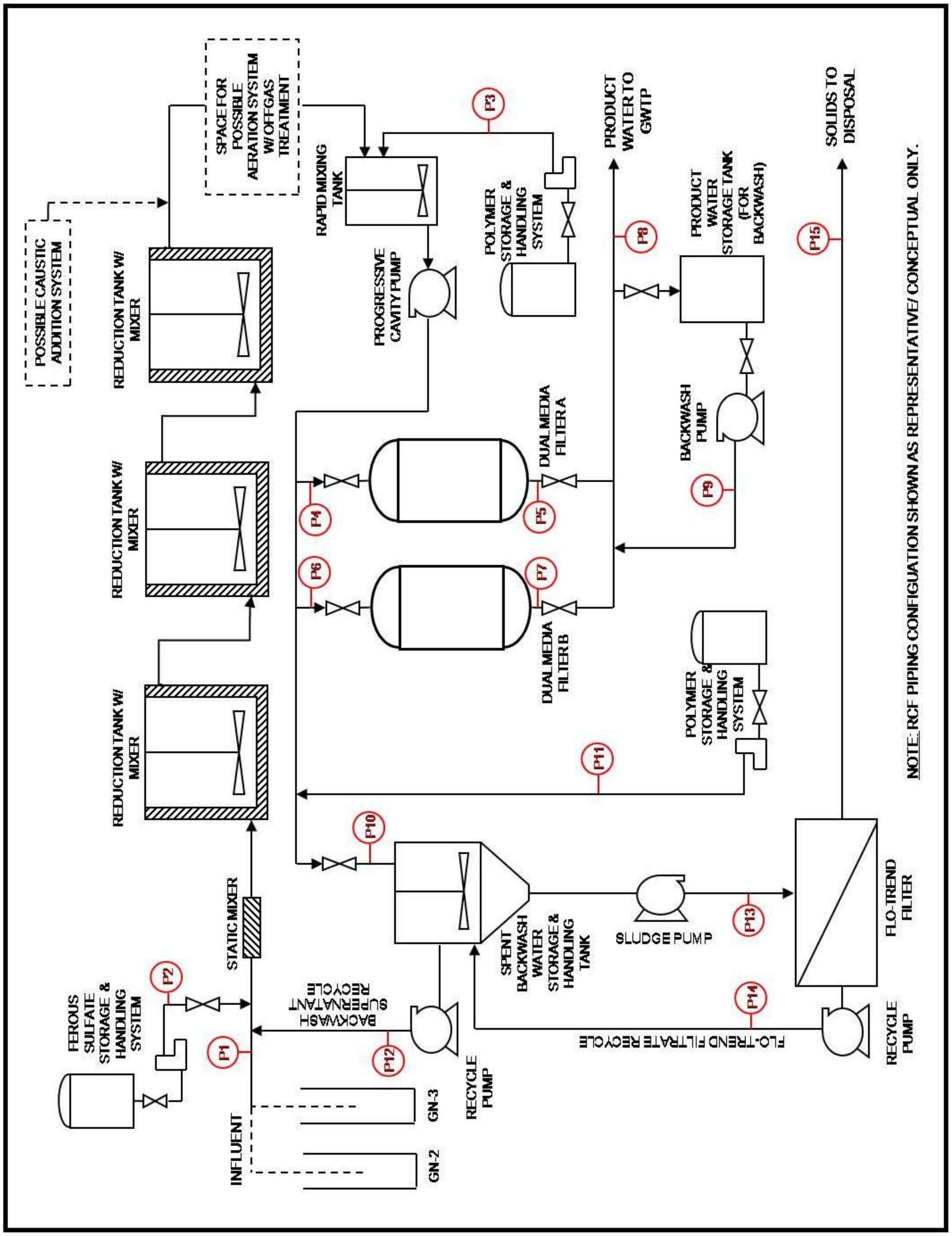

Figure 5-1: RCF schematic with monitoring locations for process-related parameters highlighted

Table 5-1. Monitoring locations and frequencies for process-related parameters

Monitoring Location	Process-related parameters	Frequency
P1	Influent water flow rate and total volume	Once Daily
P2	Ferrous sulfate injection rate and liquid level	Once Daily
P3	Polymer injection rate and liquid level	Once Daily
P4	Dual Media Filter A influent flow rate and inlet pressure	Once Daily
P5	Dual Media Filter A outlet pressure	Once Daily
P6	Dual Media Filter B influent flow rate and inlet pressure	Once Daily
P7	Dual Media Filter B outlet pressure	Once Daily
P8	Combined filter effluent flow rate and total volume	Once Daily
P9	Backwash water flow rate and total volume	Once every backwash cycle
P10	Spent backwash water total volume	Once every backwash cycle
P11	Polymer injection rate and liquid level	Once every backwash cycle
P12	Backwash supernatant recycle flow rate and total volume	Once every backwash cycle
P13	Settled backwash solids total volume	Once every backwash cycle
P14	Flo-Trend filtrate recycle total volume	Once every backwash cycle
P15	Dewatered sludge total quantity, moisture content, and TCLP and WET test on dewatered sludge	Once every off-site disposal

6. Operations Evaluation and Optimization

6.1. Start-up Period

The first week of the demonstration-scale RCF study will be dedicated to system start-up. Engineers and operators will be onsite during the start-up period to perform critical tasks, including initial filling of the treatment chemicals, calibrating the system flow rate and chemical injection rate, testing all monitoring instruments, and verifying the communication and control systems on the RCF plant. Water quality and process-related parameters sampling more frequently than specified in Tables 4-3 and 5-2 will be necessary to evaluate the system performance during the start-up period.

Some start-up conditions for the RCF system are suggested:

- 25:1 Fe to Cr(VI) ratio
- 45-minute reduction time
- 5-minute rapid mixing time (with polymer)
- 0.1 ppm polymer dosing (Ciba Magnafloc E38) into influent water
- 3 gpm/sf hydraulic loading rate for the dual media filters
- Daily backwash cycle
- 1 ppm polymer dosing (Ciba Mangafloc E38) into the spent backwash water

Other start-up conditions will be determined by field engineers and operators.

During the start-up period, RCF effluent samples will be collected at least twice daily (the beginning and the end of each daily run) and sent to the laboratory for Cr(VI) and total Cr measurements. A 24-hr turnaround time is desired for those analyses so that engineers and operators can use the data to adjust the operating conditions in a timely fashion.

Once the demonstration-scale RCF system can operate uninterrupted for at least 72 hours and effluent Cr(VI) and total Cr concentrations remain below 1 µg/L, engineers and operators can terminate the start-up period and switch to normal operation and sampling schedules at their discretion.

6.2. Normal Operation

During normal operation, water quality and process-related parameters should be maintained as close as possible to values required to ensure safe and efficient operation of the RCF system. The following is a list of suggested operating parameters for the RCF system. The final operating parameters will be specified in the drinking water permit issued by California Department of Public Health.

- RCF system influent not to exceed 105 gpm (100 gpm from well water plus 5 gpm recycle flow)
- Fe to Cr dosing ratio not to exceed 25:1
- Evenly distributed flow to each dual media filter
- Headloss of the filters not to exceed 100 inches of water
- Turbidity of combined filter effluent not to exceed 0.30 NTU
- Weekly Cr(VI) and total Cr concentrations in combined filter effluent not to exceed 1 µg/L

In addition, engineers and operators will perform water quality and process-related sampling as specified in Sections 4 and 5.

6.3. Operations Optimization

After the RCF plant has demonstrated a stable Cr(VI) removal performance for at least 3 months, engineers, with the approval of the CDPH, may consider performing a series of tests to further optimize the RCF system. The operating conditions to be optimized will include:

- Lowering Fe:Cr dosing ratio from 25:1 to 15:1 (or as low as possible)
- Changing polymer type and dosage for optimum dual media filtration
- Changing polymer type and dosage for optimum backwash water settling, and
- Other conditions that will result in a lower O&M cost without impairing Cr(VI) removal performance

6.4. Cost Evaluation

Cost components (including capital costs and O&M costs) of the RCF plant will be tracked carefully during the demonstration-scale study and compiled at the end of study to provide detailed and accurate cost information. Such information will be valuable to other water utilities requiring Cr(VI) treatment and to the California DPH, who will be charged with setting an MCL for Cr(VI).

6.4.1. Capital Costs

The capital cost for the demonstration-scale RCF system will be tracked using various tools. Copies of all contracts and invoices will be obtained from the construction contractors.

6.4.2. O&M Costs

6.4.2.1. Staffing Requirements

Operations staff for the demonstration-scale RCF plant will record the time spent on routine O&M duties on a daily basis. In case of an emergency related to the RCF system (e.g., chemical feed problem), the operators will also record the time spent on resuming system operation.

6.4.2.2. Chemical Expenses

The type and total volume of each chemical (i.e., ferrous sulfate and polymers) used in the study will be tracked carefully. The operations staff will record the level in the chemical feed system once per day. In addition, paper records from each chemical delivery will be collected and managed.

6.4.2.3. Other Related Expenses

All other related expenses incurred during the demonstration-scale study will also be recorded. Those expenses include, but not limited to, energy costs, water sample analytical costs, waste disposal costs, and periodic system inspection and repair costs.

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8. Appendix

Appendix A: The Treatment of Hexavalent Chromium (Cr(VI)) in the City of Glendale, California Ground Water Supply: Phase III Demonstration-Scale Reduction with Ferrous Sulfate, Coagulation, Filtration Treatment Technology Evaluation Quality Assurance Project Plan

Appendix C: SOPs

MWH LABORATORIES

Standard Operating Procedure
For

Determination of Dissolved Hexavalent Chromium in Drinking Water, Groundwater and Industrial Wastewater Effluents by Ion Chromatography

EPA Method 218.6

Approved:

(1) Analyst: ______ Date 4/5/07

(2) Group Leader: Lisa M. Ramirez Date 4 Apr 07

(3) QA Officer: ______ Date 4/4/07

(4) Technical Director/: Laboratory Director Andy Eaton Date 4/4/07

(5) Issue Date 4/5/07

(6) Effective Date 4/19/07

Annual Review Signatures:

Analyst: ______ Date ______

Group Leader: ______ Date ______

QA Officer: ______ Date ______

Technical Director/: Laboratory Director ______ Date ______

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I. TITLE

Determination of dissolved Hexavalent chromium in drinking water, groundwater and industrial wastewater effluents by ion chromatrography.

II. SCOPE AND APPLICATION

A. This method provides procedures for the determination of dissolved hexavalent chromium in drinking water, groundwater and industrial wastewater effluents.

B. The Method Detection Limit (MDL, defined in section XIX) for the above matrices are listed in Attachment II. The MDL obtained by MWH Laboratories for a specific matrix may differ from those listed in the method depending on the nature of the sample and the instrumentation used.

C. Samples containing high levels of anionic species such as sulfate and chloride may cause column overload. Samples containing high levels of organics or sulfides cause rapid reduction of soluble Cr(VI) to Cr(III). Samples must be stored at 4°C and analyzed within 28 days if properly preserved (If sample is unpreserved, it must be preserved with 24 hours of collection time).

D. This method should be used by analysts experienced in the use of ion chromatography and the interpretation of ion chromatograms.

III. METHOD SUMMARY

An aqueous sample is filtered through the filter cap during injection. The pH is adjusted prior to injection. A measured volume of the sample (1000 uL) is introduced into the ion chromatograph. Post-column derivatization of the Cr(VI) with diphenylcarbazide is followed by detection of the colored complex at 530 nm.

IV. INTERFERENCES

A. Interferences which affect the accurate determination of Cr(VI) may come from several sources.
   1. Contamination – A trace amount of Cr is sometimes found in reagent grade salts. Since a concentrated buffer solution is used in this method to adjust the pH of samples, reagent blanks should be analyzed to assess for potential Cr(VI) contamination. Contamination can also come from improperly cleaned glassware or contact of caustic or acidic reagents or samples with stainless steel or pigmented material.

capable of delivering a constant flow in the range of 1-5 mL/min and containing no metal parts in the sample, eluent or reagent flow path is used with an AD25 Absorbance Detector (S/N 00120138).

2. Nitrogen gas supply (high purity, 99% or greater).
3. Pressurized eluent container, plastic, one or two liter size.
4. Sample loop at 1000 uL.
5. A pressurized reagent delivery module with a mixing tee and beaded mixing coil.
6. Separator Column – A column packed with a high capacity anion exchange resin capable of resolving CrO_4^{2-} from other sample constituents (Dionex IonPac AS7 or equivalent).
7. A low-volume flow-through cell visible lamp detector containing no metal parts in contact with the eluent flow path. Detection wavelength is at 530 nm.
8. Chromeleon 6.7 software with a Pentium computer for receiving digital signals for modulewares.
9. AS40 Automated Sampler (S/N 00120005).

B. Labware – All reusable glassware (glass, quartz, polyethylene, Teflon, etc.) including the sample containers should be cleaned thoroughly and monitored by the LRB.

1. Glassware – Class A volumetric flasks and a graduated cylinder.
2. Assorted Class A calibrated pipettes
3. 10 mL male luer-lock disposable syringes
4. 0.45 um syringe filters
5. Storage bottle-high density polypropylene, 1 liter capacity

C. Sample Processing Equipment

1. Liquid sample transport containers – high density polypropylene, 125 mL capacity.
2. Supply of dry ice or refrigerant packing and styrofoam shipment boxes.
3. pH meter – to read pH range 0-14, or a narrow range pH indicator within 6.5 – 10 range with sensitivity within 0.2 – 0.3 pH units.
4. 0.45 um filter discs.
5. Plastic syringe filtration unit.

VII. REAGENTS AND STANDARDS

A. Reagents – All chemicals are ACS grade unless otherwise indicated.

1. Ammonium hydroxide, NH_4OH, (sp.gr. 0.902), (CAS RN 1336-21-6), EMD# AX1303-11.
2. Ammonium sulfate, $(NH_4)_2SO_4$, (CAS RN 7783-20-2), JT Baker #0792-05.
3. 1,5 Diphenylcarbazide, (CAS RN 140-22-7), Fiuka #42860.
4. Methanol, HPLC grade, Burdick & Jackson Cat. 230-1 (CAS 67-56-1).
5. Sulfuric acid, concentrated (sp.gr. 1.84), JT Baker #9673-33.

A. Prior to sample collection, consideration should be given to the type of data required so that appropriate preservation and pretreatment steps can be taken. Filtration and pH adjustment should be performed at the time of sample collection or as soon thereafter as practically possible.

B. For determination of dissolved Cr(VI), the sample should be filtered through a 0.45 um filter. Use a portion of the sample to rinse the syringe filtration unit and filter and then collect the required volume of filtrate. Adjust the pH of the sample to between 9 – 9.5 by adding the buffer solution, periodically checking the pH with the pH meter or narrow range pH strip. Approximately 10 mL of sample are sufficient for two IC analyses.

C. Ship and store the samples at 4°C. Bring to ambient temperature prior to analysis. Sample should be run within 28 days if properly preserved (if the sample arrives at the lab unpreserved, it must be preserved within 24 hours).

IX. CALIBRATION PROCEDURE

A. Initial Instrument Calibration

1. A calibration curve is prepared for hexavalent chromium by plotting instrument area count against standard concentration. Sample concentration is computed by using the equation for the curve prepared during calibration. A linear regression curve is used to plot and calculate the results. A minimum of three calibration solutions that bracket the anticipated concentration range of the samples is required. Calibration standards should be prepared from the stock standard (section 8.3) by appropriate dilution with ASTM Type I water (Section 8.2) in volumetric flasks. The solution should be adjusted to a pH of 9 – 9.5 with the buffer solution (Section 8.9) after final dilution by adding 1 mL of buffer to 100 mL of standard. Standards are used to plot the curve which the origin is included.
2. The flow rate of the eluent pump is set at 1.2 mL/min and the pressure of the reagent delivery module adjusted so that the final flow rate from the detector is 2.0 mL/min. This requires manual adjustment and measurement of the flow using a graduated cylinder and a stop watch. A warm up period of approximately 30 minutes after the flow rate is adjusted is recommended and the flow rate should be checked prior to calibration and sample analysis. One can also check the area count of the lowest standard compared to historical ones.
3. Injection loop size is chosen based on standard and sample concentrations and the selected attentuator. A 1000 uL loop was used to establish the method detection limits in Attachment I. The sample volume used to load the injection loop should be at least 3X the loop size so that all tubing in contact with the sample is thoroughly flushed with new sample to prevent cross contamination.

3. To verify that the instrument is properly calibration on a continuing basis, run an Instrument Performance Check (IPC) and LRB after every 10 samples. The results of the analyses of the standards will indicate whether the calibration remains valid. If the measured concentration of the analyte deviates from the true concentration by more than ± 5%, the instrument must be recalibrated and the previous ten samples re-analyzed. The instrument response from the calibration check may be used for recalibration purposes.
4. Sufficient raw data records must be retained to permit reconstruction of the continuing instrument calibration verification, e.g., test method, instrument, analysis date, each analyte name, concentration and response, calibration curve or response factor.
5. Criteria for the acceptance of all IPC is 95 – 105% recovery, with the exception of the MRL which is 50 – 150%.
6. If the IPC results obtained are outside established acceptance criteria, corrective actions must be performed. If routine corrective action procedures fail to produce a second consecutive (immediate) calibration verification within acceptance criteria, then either the analyst has to demonstrate performance after corrective action with two consecutive successful calibration verifications, or a new initial instrument calibration must be performed. If the analyst/laboratory has not demonstrated acceptable performance, sample analyses shall not occur until a new initial calibration curve is established and verified. However, sample data associated with an unacceptable calibration verification may be reported as qualified data under the following special conditions.
7. When the acceptance criteria for the IPC are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

X. ANALYTICAL PROCEDURE

A. Make sure the eluent reservoir and the reagent delivery system are filled and the autosampler relay control button and the sampling tubing is connected to the AD25 UV/VIS detector and IP25 Isocratic Pump.

B. Be sure that the nitrogen tanks are turned on (they are normally never turned off) and there is sufficient pressure to complete an analytical run.

C. Samples should be brought to ambient temperature if refrigerated prior to analysis.

D. Initiate instrument operation configuration and calibration (Section IX).

Where:

t = students' t value for 99% confidence level and a standard deviation estimate with n-1 degrees of freedom [t = 3.143 for seven replicates].
S = standard deviation of the replicate analyses.

3. Linear dynamic range – Linear dynamic ranges are governed by Beer's law. A set of at least five standards covering the estimated linear range should be prepared fresh from the stock solution and one analysis of each performed. The percent recovery should be within 90 – 110% to indicate within linearity. MWH Laboratories dilutes any sample that is great than the highest calibration standard used for that day.
4. One Laboratory Reagent Blank and four Laboratory Fortified Blanks are also needed to complete the IDC for precision and accuracy.

C. Negative Controls

1. Laboratory Reagent Blank (LRB) shall be performed at a frequency of one per 5% of a batch of samples per matrix type per sample extraction or preparation method. The results of this analysis shall be one of the QC measures to be used to asses batch acceptance. The source of contamination must be investigated and measures take to correct, minimize or eliminate the problem if detected above MDL.
2. If the blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated sample batch, any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.
3. If the blank contamination exceeds the concentration present in the samples and is greater than 1/10 of the specified regulatory limit, any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

D. Positive Controls

1. Laboratory Control Sample (LCS) – (QC Check Samples). Minimum one LCS is to be reported per batch of 20 or less samples per matrix type per sample extraction or preparation method. LCS results are compared to the known values and recorded on the QC data sheet. Recoveries must agree within 90 – 110%. The matrix spike may be used in place of this control as long as the acceptance criteria are as stringent as the LCS.
2. Matrix Spike (MS) – Shall be performed at a frequency of one in 10 samples per matrix type per sample extraction or preparation method. The selected sample(s) shall be rotated among client samples so that the various matrix problems may be noted and/or addressed. MS results are subtracted from the background

B. Values which are between the lowest point and the highest point on the curve are reported. If the concentration of a sample does not fall within the limits of the curve the sample is rerun using an appropriate aliquot. If the sample matrix is poor then the appropriate dilution taking into account sample matrix is performed. The reporting level, and the sample result should be adjusted by the dilution factor using the following formula"

Reported MRL = MRL X Dilution Factor

Where:
MRL = Minimum reporting limit, lowest calibration standard.
Dilution Factor = Final Volume/Initial Volume.

Reported unknown Sample = Unknown sample raw result X Dilution Factor

Results are reported in ug/l.

XIII. METHOD PERFORMANCE

A. Attachment I, Documentation of Demonstration of Precision and Accuracy

B. Attachment II, Documentation of Method Detection Limit Study

C. The above Attachments are initial studies only to demonstrate method performance. A more recent study is on file with the QA department and is available for review upon request.

XIV. REFERENCES

A. United States Environmental Protection Agency, Environmental Monitoring and Systems Laboratory, Cincinnati, OH, 45268. Method 218.6, Determination of Dissolved Hexavalent Chromium in Drinking Water, Groundwater and Industrial Wastewater Effluents by Ion Chromatography, Revision 3.3, 1994.

B. 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.

XV. DEVIATIONS FROM REFERENCED METHODOLOGY

and by carefully following the instructions in the Waste Management Section of this document.

B. Reduce disposal costs by ordering quantities of reagents and standards that will be approximately consumed by the expiration date.

C. Practice spill prevention by storing chemicals in secondary containment. Do not store incompatible chemicals in close proximity.

D. Reuse solvents for the first step in glassware cleaning if possible.

XIX. WASTE MANAGEMENT

A. It is the responsibility of the laboratory to determine whether its wastes are hazardous and to assure safe handling and disposal. The laboratory works closely with the Treatment, Storage, Disposal Facility to ensure that certain wastes are recycled where possible, that the source of waste is reduced to the lowest possible level and that stringent land disposal restrictions are followed.

B. Refer to the following documents for additional information regarding waste management:

1. Hazardous Waste Management and Sample Disposal Procedures
2. Resource Conservation and Recovery Act (RCRA)-Title 40 of the Code of Federal Regulations, Parts 260 through 270 (40 CFR 260-270)
3. California Hazardous Waste Control Law (HWCL)-CCR Title 22 where 40 CFR was duplicated into CCR Title 22, Parts 66260-66270.

XX. REVISIONS

A. Revision 0 (01/25/2001)
New SOP

B. Revision 1.0 (01/03/07)

1. Updated SOP to be consistent with current MWH format
2. Changed PeakNet Software to Chromeleon
3. Deleted all information on how to run Chromeleon
4. Changed LFB and QCS to LCS
5. Section III – Changed "is filtered through a 0.45 um filter and the filtrate is adjusted to a pH of 9 to 9.5 with a buffer solution" to "is filtered through the sample cap during injection. The pH is adjusted prior to injection." Deleted "A guard column removes organics from the sample before the Cr(VI) as CrO_4^{2-} is separated on an anion exchange separator column.
6. Section VI.A – Added serial and specific instrument components for IC.

Attachment I, Documentation of Demonstration of Precision and Accuracy

Date Reported: 10/10/06
Units: ug/l

Instrument Code: INIL
Method: EPA 218.6
Group#: 181926

	MRL	Actual	DOC1	DOC2	DOC3	DOC4	Avg	%Rcvy	%Rcvy Limits	Stdv	%RSD	%RSD Limit
Preparation Date			NA	NA	NA	NA						
Preparation Analyst			NA	NA	NA	NA						
Analytical Date			08/18	08/21	08/25	08/25						
Analyst			tlh	tlh	tlh	tlh						
Hexavalent chromium(Diss	0.100	2.0	1.96	1.94	1.90	1.90	1.925	96.2	90.0 - 110	0.030	1.6	< 20%

Attachment III, QA/QC Summary

Parameter	**Analytes**	**QC Limits**	**Frequency**
Initial Calibration	Cr(VI)	Corr. Coefficient ≥ 0.999 For Linear reg.	At the beginning of each run. Or whenever response varies from the expected value more than 10%.
IPC	Cr(VI)	Percent recovery 95 – 105%	At the beginning of the run and after every 10 samples and at the end of the run.
Method blank, LRB	Cr(VI)	Values should be less than the reporting limit	After every IPC
LCS	Cr(VI)	Percent recovery of 90 – 110%	One LCS per batch of 20 or less samples
MS	Cr(VI)	Percent recovery of 90 – 110%	An MS per every 10 samples
MSD	Cr(VI)	Percent recovery of 90 – 110%	An MSD per every 20 samples

MWH LABORATORIES

Standard Operating Procedure
For

TRACE METALS ANALYSIS BY ICP/MS

EPA Method 200.8/6020

Approved:

(1) Analyst: [redacted] Date 1/8/08

(2) Group Leader: [redacted] Date 1/8/08

(3) QA Officer: Linda Geddes Date 1/8/08

(4) Technical Director/: Laboratory Director Andy Eaton Date 1/11/08

(5) Issue Date 1/11/2008

(6) Effective Date 1/25/2008

Annual Review Signatures:

Analyst: ______________________ Date ________

Group Leader: ______________________ Date ________

QA Officer: ______________________ Date ________

Technical Director/: Laboratory Director ______________________ Date ________

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TABLE OF CONTENTS

I. TITLE

Trace Metal Analysis by Inductive Coupled Argon Plasma – Mass Spectroscopy (ICP/MS), EPA Method 200.8/6020.

II. SCOPE AND APPLICATION

A. This method determines total or dissolved elements in drinking water, groundwater and wastewater matrices by inductive coupled argon plasma-mass spectroscopy (ICP/MS).

B. The elements listed in Attachment III may be determined by this method.

III. METHOD SUMMARY

A. An acid preserved sample is introduced via pneumatic nebulization into a radio frequency plasma where energy transfer causes desolvation, atomization and ionization.

B. Ions are extracted from the plasma by a differentially pumped vacuum interface. Ions are then separated, based on their mass-to-charge ratio, by the quadropole-MS.

C. Dissolved elements are determined after filtration in the field, and acid preservation.

D. Acid digestion is performed on samples where the turbidity is > 1 NTU. All wastewater samples for trace metal analyses should be digested regardless of the turbidity reading.

E. Digestion of dissolved metals filtrate is exempted only for those samples that meet the following criteria (40 CFR part 136.6, Table 1B, footnote #4):

1. Has a low COD (<20ppm)
2. Is visibly transparent with turbidity of 1 NTU or less
3. Is colorless with no perceptible odor
4. Is of one liquid phase and free of particulate or suspended matter following acidification

F. This method should be used by experienced analysts only. Analyst must demonstrate satisfactory performance on a calibration, MRL check, external performance sample, and LFM/LFM duplicate prior to running client samples.

IV. INTERFERENCES

A. Argon - Chloride - Argon 40 and chloride 35 can cause an interference in quantitating arsenic 75, which is isobaric. An interference correction factor has been programmed to eliminate chloride interference for concentrations up to 200 ppm. If chloride concentrations exceed 200 ppm, then arsenic will be diluted accordingly. Alternatively, using the new Elan 9000 DRC ICPMS, arsenic could also be analyzed in DRC mode using mass 91 (AsO).

B. Physical Interferences - High levels of dissolved solids may cause physical interferences. High TDS may contribute deposits of material on the extraction and/or skimmer cones reducing the effective diameter of the orifice and therefore the ion transmission. Internal standards are used to compensate for the physical interference effects (see section 10 for acceptance criteria). If internal standards are outside of limits, either the sample is diluted and rerun or the nebulizer is cleaned/rinsed until acceptable IS response is obtained. To alert the analyst for physical interferences, As and Se mass 77 and 78 are monitored. High TDS is suspected when precision obtained is >30 % RSD for concentrations >10x MDL of As and Se. If high TDS is suspected, the sample is either diluted or determined by GFAA. Samples that contain high particulate matter are digested to remove physical interferences.

C. See Method Deviations for other potential interferences.

V. SAFETY CONSIDERATIONS

A. Many of the elements being analyzed are toxic; thus all standard solutions should be handled with appropriate caution. If the analyst is in doubt about the relative toxicity of a particular element, he/she should consult the appropriate MSDS sheet before proceeding with the analysis.

B. Additionally, samples scheduled for trace metals analysis are typically preserved with nitric acid. Consequently, precautions typically taken when working with acids should be employed.

C. Assume all samples contain toxic material and take necessary precautions. Be careful to avoid contact with fans, which are spinning inside the housing. Note there are lethal voltage levels in the RF Generator. Never attempt to perform any maintenance on the generator without first unplugging the unit. Persons wearing pace-makers should not be allowed in the metals laboratory due to potential interference. Do not look directly at the lit ICP torch without eye protection due to UV radiation. The Torch is extremely hot.

D. Refer to the MWH Laboratories SOP "Hazardous Waste Management and Sample Disposal Procedures" and OSHA Standard 29 CFR 1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories; Final Rule for additional safety information.

E. MSDSs must be reviewed for information pertaining to the proper treatment and precautionary measure prior to handling any reagents. They are located in red binders on the second floor outside the Health and Safety office or on the internet at http://msds.ehs.cornell.edu/msdssrch.asp.

VI. INSTRUMENT/APPARATUS

A. Sample Containers - 1000 mL, 500 mL, 250 mL or 125 mL bottles containing nitric acid

B. Auto-pipettes - adjustable volume from 10 uL to 1000 uL

C. Volumetric flasks - Class A, various sizes

D. Argon gas supply – High Purity or better. Liquid argon recommended

E. Digestion Block – Hotblock, or Modblock with digestion vessel (Hot Plate)

F. ICP-MS Instrumentation: Perkin Elmer Elan 6000 or Elan 9000 DRC

1. Plasma forward power - 1.4 kW
2. Auxilliary flow rate - 1.5 L/ minute
3. Nebulizer flow rate - 0.90 L/minute
4. Solution uptake rate - 1.5 ml/ minute
5. Spray chamber temperature - Room Temperature
6. Data acquisition
7. Detector mode - Analog/Pulse counting
8. Replicate integrations - 3
9. Mass Range - 6 – 209 atomic mass unit
10. Dwell Time - 30 microseconds
11. Number of scan sweeps - 30
12. Total acquisition time - 3 minutes per sample

G. Data acquisition computer with printer

H. Analytical Balance

I. Evaporation Disks

J. Drying oven

K. Mortar and Pestle

L. ICP-MS Instrumentation: Agilent 7500ce (Serial #JP51201349)

Agilent application chemist Craig Jones recommends the following conditions, though minor tuning or adjustment should be performed to meet method criteria.

1. RF Power: 1550W
2. Carrier Gas: 0.88 L/min
3. Makeup Gas: 0.17 L/min
4. S/C Temp.: 2 C

Ion Lens
5. Extract 1: 0 V
6. Extract 2: -120 V
7. Omega Bias: -18 V
8. Omega Lense: 1 V
9. Cell Entrance: -30 V
10. QP Focus: -10 V
11. Cell Exit: -40 V

Octopole Parameters
12. OctP RF: 180 V
13. OctP Bias: -18 V

Other
14. Discriminator: 8 mV
15. H2 / He gas: 2 mL/min

Agilent recommends increasing the helium gas flow to reduce interferences as measured by analyzing a 1% hydrochloric acid solution at mass 75 (ArCl) and mass 78 (Ar-diamer). The signal at mass 75 should be less than 20 counts and mass 78 should be less than 500 counts in a blank solution. However, if the helium gas flow is too high, sensitivity may be loss; therefore, the analyst should balance the flow to reduce interference without compromising analytical sensitivity.

VII. REAGENTS AND STANDARDS

A. Water - Laboratory reagent water is used for dilution and sample preparation. This water has been passed through granular activated carbon, an anitiscalent unit, particle filters, a reverse osmosis unit, de-ionizing resin beds, post DI filters and UV filtration.

B. Nitric Acid % (v/v) – trace metal grade or better. Available from JT Baker or VWR.

C. Hydrochloric Acid – trace metal grade or better. Available from JT Baker or VWR. Ultra-trace grade is preferred for ICPMS analysis.

D. Stock Calibration Standard 1- Inorganic Ventures IV-26 Second Source (Catalog #IV-26)

E. Stock Calibration Standard 2 – None required.

F. Stock LCS/LFB standard, 2nd source – CPI Custom Mix (P/N 4400-050314RH01); see Attachment V, LCS/LFB/Spike Solution for preparation

G. Interference Check Standard (ICS) – CPI (P/N 4400-ICP-MS-ICS)

H. Internal Standard (IS) Stock Standard, 1000 ppm germanium - CPI (P/N 4400-4400-010041) - and 100ppm lithium-6 – Inorganic Ventures (P/N CG6LI1-1) - standards and Tuning Solution Standard Inorganic Ventures VAR-TS-MS (P/N VAR-TS-MS)

I. Stock MRL Standard – Crescent Chemical Custom Mix (Catalog No CCS-552.1)

J. ICP-MS Working Calibration Standard - By switching to a lower concentration primary standard, MWH Laboratories no longer need to prepare a working calibration standard. The daily calibration standards are prepared directly from the primary standard.

K. ICP-MS MRL Working Standard - Pipette 1mL of Stock MRL Standard in 100 mL volumetric flask containing 50 mL DI water. Add 2 mL conc. nitric acid. Dilute to volume. The standard expires 6 months after preparation, not to exceed the expiration of the original calibration stock.

L. ICP-MS Working Internal Standard (IS) - Pipette 0.5 mL Stock Internal Standard and 0.5 mL 1000 ppm germanium standard and 0.5 mL 100ppm lithium-6 standard in 1000 mL volumetric flask containing 500 mL DI water. Add 20 mL conc. nitric acid. Dilute to volume. The standard expires 6 months after preparation, not to exceed the expiration of the original stock.

M. ICP-MS LFB/LCS Working Standard - MWH Laboratories no longer prepares LFB/LCS working standards; rather, the actual LFB/LCS solution is prepared directly from the primary standard to minimize serial dilution error.

N. ICP-MS Tuning Solution - Pipette 0.1 mL of the Stock Tuning Solution Standard in 100 mL volumetric flask containing 50 mL DI water. Add 2 mL conc. nitric acid. Dilute to volume. The standard expires 6 months after preparation, not to exceed the expiration of the original calibration stock.

O. ICP-MS Calibration Standards - MWH Laboratories utilizes 3 calibration standards levels and blank. The standards and blank are prepared in 2% nitric acid.

Standard 1: Dilute 1:100 of the MRL working solution. The final concentration of each analyte is typically the same as the reporting limit for that analyte.

Standard 2: Dilute 1:1000 of the primary calibration standard. The final concentration of each analyte is 100 ug/L.

Standard 3: Dilute 1:400 of the primary calibration standard. The final concentration of each analyte is 250 ug/L

The standards are prepared fresh daily.

See attachment X for further clarification.

P. Quality Control Sample (QCS) – The QCS should be obtained from a source outside the laboratory. As per method, QCS should be analyzed when beginning the use of this method and on a quarterly basis or as required to meet data-quality needs. The QCS is prepared by diluting the ICP calibration standard 1:1000 to achieve a final concentration of typically 100 ug/L. Since the ICP calibration standard is different from the ICPMS calibration standard, this provides an additional source of verifying the ICPMS calibration is in control. For the purpose of calculation, the QCS standard is also referred to as the MCV.

Q. For special analysis (uranium, tin, gold, platinum, iodide), two separate sources of standards must be used. One source is used to prepare the analytical calibration curve. The second source is used to prepare the laboratory control sample (LCS) to validate the first source. Typically, special analyses are analyzed separately from regular analysis; thus, freshly prepared standards are required on the day of analysis.

R. For uranium analysis, a special calibration curve is required because the reporting unit can be in ug/L or pCi/L, depending on client's requirement. Prepare a 10 mg/L intermediate uranium standard by diluting the stock 1000 mg/L 1:100 with 2% nitric acid. From the 10 mg/L standard, prepare three calibration standards as specified in Attachment IV.

S. Reagent – Stock Tuning Solution Standard

VIII. SAMPLE COLLECTION, PRESERVATION AND HANDLING

A. Samples are collected in 500 ml plastic containers pre-preserved with 5 mL 1:2 HNO_3. Sample pH as measured in the lab must be < 2. If pH is > 2, then the sample is acidified with HNO_3 and allowed to sit for at least 16 hours at room temperature. pH is verified to be <2 before an aliquot is drawn for analysis. Samples are stored at room temperature.

B. Holding time is 6 months. A minimum of 100 mL aliquot is desired for analysis.

IX. CALIBRATION PROCEDURE

A. The ICP-MS is calibrated daily with three standards and a blank. The lowest standard (standard 1) concentration is set at the method reporting limit concentration. Linear regression is performed on the calibration. To be acceptable, the correlation coefficient must be 0.995 or greater. If not, the problems are diagnosed and the instrument recalibrated.

B. Immediately following calibration, a second source standard is analyzed as the initial calibration verification (ICV). The acceptance criteria for passing ICV is a 95 -105 percentage recovery of the true value. If the result is not within this range, the instrument must be recalibrated and no data from that failed element(s) may be reported.

C. Sufficient raw data records are retained to permit reconstruction of the initial instrument calibration, e.g., calibration date, test method, instrument, analysis date, each analyte name, concentration and response, calibration curve or response factor.

D. Sample results must be quantitated from the initial instrument calibration and may not be quantitated from any continuing instrument calibration verification.

E. Prior to analysis of real samples, a second source verification standard traceable to NIST is analyzed as the LFB/LCS. The acceptance criterion is 85-115% of the true value.

F. A continuing instrument calibration verification (CCV) and blank (CCB) must be repeated at the beginning, every 10 samples and end of each analytical run. To be acceptable, the CCV result must be within 90%-110% of true value. For the CCB, the result must be less than ½ of the method reporting limit. If either condition failed, the instrument is considered out of calibration and no result since the last successful CCV/CCB check may be reported. Re-calibrate the instrument and reanalyze all affected samples.

1. If the continuing instrument calibration verification results obtained are outside established acceptance criteria, corrective actions must be performed. If routine corrective action procedures fail to produce a second consecutive (immediate) calibration verification within acceptance criteria, then either the laboratory has to demonstrate performance after corrective action with two consecutive successful calibration verifications, or a new initial instrument calibration must be performed. If the laboratory has not demonstrated acceptable performance, sample analyses shall not occur until a new initial calibration curve is established and verified. However, sample data associated with unacceptable calibration verification may be reported as qualified data under the following special conditions.

2. When the acceptance criteria for the continuing calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then the non-detects may be reported. Otherwise the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.
3. When the acceptance criteria for the continuing calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.
4. The concentration of the CCV is rotated between 0.5 x ICV level and 2.0 x ICV level. The acceptable criteria are 90 -110% of true value.

X. ANALYTICAL PROCEDURE

A. Turn on the ICPMS, allow the system to purge with argon for at least 90 seconds, and light the plasma using the computer controlled software. Allow instrument to warm-up for at least 30 minutes prior to any analysis.

B. Instrumental parameters - The following instrument settings are typical. They may be adjusted in order to provide better sensitivity, lower oxides and double-charge interferences, and improve stability.

For Perkin-Elmer ICPMS

1. Plasma forward power - 1.4 kW
2. Auxiliary flow rate - 1.5 L/ minute
3. Nebulizer flow rate - 0.90 L/minute
4. Solution uptake rate - 1.5 ml/ minute
5. Spray chamber temperature - Room Temperature
6. Data acquisition
7. Detector mode - Analog/Pulse counting
8. Replicate integrations - 3
9. Mass Range - 6 – 209 atomic mass unit
10. Dwell Time - 30 microseconds
11. Number of scan sweeps – 30
12. Total acquisition time - 3 minutes per sample

For Agilent ICPMS

13. Plasma forward power - 1.50 kW
14. Auxiliary flow rate - 1.0 L/ minute
15. Nebulizer flow rate - 0.70 L/minute

16. Solution uptake rate - 1.0 ml/ minute
17. Spray chamber temperature – 2 C
18. Data acquisition
19. Detector mode - Analog/Pulse counting
20. Replicate integrations - 3
21. Mass Range - 6 – 209 atomic mass unit
22. Dwell Time - Variable from 10uS to 50uS
23. Number of scan sweeps – 3 mass range centered around primary mass

C. Preparation

1. After the sample receiving department has logged in the samples, they will be placed on the receiving shelf in the metals department. Prior to analysis, the samples are checked for pH and turbidity, then logged into a notebook designated for this purpose.
2. If the sample pH is 2 or less and the turbidity is less than 1.0 NTU, then the sample may be analyzed as is.
3. If the sample pH is greater than 2 and the turbidity is less than 1.0 NTU, then the sample is first preserved with nitric acid until the pH is less than 2. Allow at least 16 hours to equilibrate and re-check. Repeat until the sample pH is less than 2. The sample is now ready for analysis.
4. If the turbidity is greater than 1.0 NTU, a 200.8 digestion is required. Consult the digestion SOP for additional detail.
5. Refer to the Hot-Block Metals Digestion SOP for details on sample digestion procedures.

D. Analytical Sequence

1. Prior to analysis, the instrument must be profiled in order to ensure the instrument is in good working condition. Aspirate the tuning solution for 30 seconds, profile the instrument using the Tuning method that has been setup within the software. Be sure to provide hardcopy for future reference.
2. The minimum acceptable criteria is as follow:

   For Perkin-Elmer ICPMS

   a. The Mg peaks at 24, 25, 26 and Pb peaks at 206, 207, 208 should have baseline resolution.
   b. The peak width should be approximately 0.75 amu at 5% peak height on the assigned mass.

   For Agilent ICPMS

a. The Mass calibration for Be-9, Mg-24, Co-59, In-115 and Pb-208 should be within 0.1 amu of actual, with a peak width at 10% peak height of no more than 1.0 amu, as specified by Agilent recommendation.

b. Five replicate of a tuning solution containing 100ppb of Be-9, Mg-24, Co-59, In-115 and Pb-208 should have an %RSD of less than 5%.

3. If the daily tuning meets criteria, perform a daily performance check with the same solution using the daily performance method. The minimum acceptance counts should be as follows:

For Perkin-elmer ICPMS

a. Background @ 220 ≤ 30
b. In 114.9 > 150000
c. Mg 23.985 > 20000
d. Pb 207.977 > 100000
e. CeO 155.9 / Ce 139.905 ≤ 0.03
f. Ba++ / Ba ≤ 0.03

For Agilent ICPMS

a. Background @ 220 ≤ 30
b. Be-9 > 500 counts
c. Ce-140 > 20000 counts
d. Tl-205 > 10000 counts
e. CeO-156 / Ce-140 ≤ 3%
f. Ba++-69 / Ba-138 ≤ 3%

4. If the instrument failed to meet the criteria, troubleshoot the instrument to resolve the problem before proceeding with analysis.
5. On each day of analysis, the run sequence must be set up to include a specific number and type of QC samples at the beginning of the run (prior to the analysis of the first environmental sample), after every ten environmental samples and at the conclusion of the run. A typical sequence is detailed in Attachment XI.
6. The Elan software version 3.0 introduced a new built-in optimization tool called SmartTune. This procedure will automatically optimize the instrument for mass calibration and resolution, nebulizer gas flow, lens voltage, and autolens voltage. It will also analyze the daily performance check standard following optimization. SmartTune should be used regularly to ensure the instrument is properly optimized.

E. Reporting Requirements

1. Samples are reported on an "as is" basis, with no blank subtraction applied.
2. Any sample containing an analyte at a concentration greater than the upper linear range must be diluted and analyzed to report a value for that analyte. A linearity check solution may be analyzed to extend the linear-range beyond the high standard. If the percent recovery of the linearity check solution is within 10% of theoretical value, the instrument is considered linear to that level and any results below it may be reported.
3. Any results less than the method reporting limit shall be reported as "ND". For trace-level elements, report the result to two significant figures.
4. If the sample has been logged in for matrix spike/spike duplicate (MS/MSD), calculate the percent recovery to two significant figures. Report the percent recovery value only.
5. Unless the sample is a known QC check sample (i.e. PT sample), the chemist should review the data for unusual hits for certain elements (e.g. Be, Co, Ag, Sb, Tl) that would normally not be found in drinking water matrices. If interferences/problems are suspected, confirm the result by re-analyzing the sample. For arsenic and selenium positive results, reanalyze the samples in DRC-mode unless they were already analyze in that mode or if historical data indicated the results were real. The 'AUTOLINK' program has been updated to check for unusual hits to assist the chemist.

XI. QUALITY CONTROL REQUIREMENTS

A. Negative Controls

1. There are 4 types of blank analysis required for this method:

    a. Calibration blanks/Instrument blanks are used to establish the analytical calibration curve. Calibration blanks consist of 2% (v/v) nitric acid in reagent water. The calibration blank shall be performed before the initial calibration standards at a frequency of one per sample batch per matrix type or preparation method. All analytes of interest must be found below ½ of the MRL. The source of contamination must be investigated and measures taken to correct, minimize or eliminate the problem.

    b. Laboratory Reagent Blank (LFB) method blank must contain all the reagents in the same volumes as used in processing the samples. It is used to assess possible contamination from the sample preparation procedure and to assess spectral background. The LRB must be carried through the same preparation, including digestion if performed, as the samples. The LRB shall be performed at a frequency of one per sample batch, prior to analysis of any real samples. All analytes of interest must be found below ½ of the MRL.

    c. Rinse blanks are used to flush the instrument between samples in order to reduce memory interferences. Rinse blanks shall be performed on an as needed frequency after analysis of high analyte concentration samples. Rinse blanks consist of 2% (v/v) nitric acid in reagent water.

d. Continuing calibration blank is analyzed 1 in 10 samples following the continuing calibration verification sample. Results must be less than ½ of the MRL, otherwise instrument recalibration and associated sample reanalysis is required.

2. If the blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated sample batch, any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.
3. If the blank contamination exceeds the concentration present in the samples and is greater than 1/10 of the specified regulatory limit, any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

B. Laboratory Control Sample (LCS) - (aka LFB) Shall be analyzed at a minimum of 1 per batch of 20 or less samples per matrix type per sample digestion. MWH routinely prepares and analyzes 2 LCS per batch. When both LCS fail, those samples whose element(s) failed to meet criteria, 85-115 percent, must be re-digested and reanalyzed.

C. Matrix Spikes (MS) - Shall be performed at a frequency of one in 20 samples per matrix type per sample digestion. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. The control limit has been established as 70-130% recovery of the true value, as stipulated in the EPA method. Poor performance in matrix spike may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the spike. If the batch contains more than 10 samples, an additional matrix spike is performed.

D. Quality Control Sample (QCS) – Shall be analyzed at least weekly. The acceptance criterion is ± 10% of the true value. If the QCS is not within the required limits, an immediate second analysis of the QCS is recommended to confirm unacceptable results. If the calibration standards and/or acceptable instrument performance cannot be verified, the source of the problem must be identified and corrected before either proceeding on with the initial determination of method detection limits or continuing with on-going analysis.

E. Matrix Spike Duplicates (MSDs) or Laboratory Duplicates – Shall be analyzed at a minimum of 2 in 20 samples per matrix type per sample digestion. The control limit has been established as 70 - 130% recovery of the true value, as stipulated in the EPA method, and with a RPD of < 20%. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in matrix spike may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the spike.

F. (For EPA 6020) Analyze the Interference Check Solution A and AB (ICSA / ICSAB) at the start of an analytical run. Although the EPA method does not specify acceptance criteria, the analyst should make every attempt to minimize interference as measured by ICSA and demonstrate good analytical recoveries as measured by ICSAB.

G. (For EPA 6020) Chose one sample per analytical or digested batch to perform a serial dilution test. Dilute the chosen sample fivefold (1+4), then reanalyze as a sample. If the concentration of an element is sufficiently high – typically 100x of the calculated concentration of the reagent blank – then the diluted result should agree with the undiluted result to within 10%. If the two results are not within 10% of each other, the analyst should attempt to determine any potential interference that could cause discrepancies, correct for them, and reanalyzed the sample.

H. See Attachment XII for additional QC requirements, frequencies, and acceptance criteria.

I. Contingencies for handling out of control data.

   1. Submit a Quality Investigation Report (QIR) with any data associated with failed batch or instrument QC.
   2. Details regarding use of the QIR can be found in the MWH Laboratories Comprehensive Quality Assurance Plan, Chapter 11, Section 11.2.1.6 and Chapter 13, Sections 13.3, 13.4 and 13.5.
   3. See the MWH Laboratories Comprehensive Quality Assurance Plan, Chapter 13, Section 13.5 for a list of data qualifiers and a discussion of report comments.

XII. CALCULATIONS

A. The software automatically calculates the result, express in concentration unit of ug/L, based on the calibration curve obtained prior to sample analysis.

B. If sample dilution is required, the software will also calculate the final result based upon the calculated result multiplied by the dilution factor as provided by the analyst.

C. See Attachment II for an algebraic expression representing the result calculation based on a linear relationship and an optional uranium calculation use as per client requests.

D. The calibration curve is printed on each run at the beginning of analysis for future reference.

E. Relative percent difference (RPD) is calculated as:

$$RPD = \frac{ABS(Value1 - Value2)}{(Value1 + Value2)/2} \times 100$$

XIII. METHOD PERFORMANCE

A. Prior to sample analysis, analysts must perform satisfactory initial demonstration of performance. Initial demonstration of performance or initial demonstration of capabilities includes establishing a linear calibration range, analysis of quality control sample (QCS), and acceptable MDL study.

B. The enclosed attachments of the method performance are initial studies to demonstrate method performance. A more recent study is kept on file with QA and is available for review upon request.

1. Attachment I, Documentation of Precision and Accuracy
2. Attachment XIV, Documentation of Method Detection Limit Study

XIV. REFERENCES

A. EPA 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry, Revision 5.4, April 1994, EMSL - USEPA, Cincinnati, Ohio.

B. Memo, Digestion of Drinking Water Samples Prior to Analysis for Metals, from James Conlon - Director of Drinking Water Standards Division, to Environmental Services Division Directors, 1/92

C. Standard Method 3020B, Metals: Quality Control Practices. *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, American Public Health Association, Washington, DC, 1998.

D. EPA 6020, Inductively Coupled Plasma – Mass Spectrometry, Revision 0, September 1994, EMSL – USEPA, Cincinnati, Ohio.

XV. DEVIATIONS FROM REFERENCED METHODOLOGY

A. Cu 65 - Argon 40 and sodium 23 complex to form an interference at mass 63, which is the method prescribed mass for copper. To properly quantify copper, the Cu 65 mass is used. This is a deviation from the method. However, Cu 65 is free from interference.

B. Ge73 - Scandium45 is one of the method recommended internal standards. Based on data generated from real world samples, background contributions from what is believed to be an organic compound, occur at mass 45. This consistently interferes with the recovery of Sc45. Another common interferent is Ca44. In house studies indicate that this isotope of calcium does not interfere when Ge 73 is used. Germanium is used as a IS because it has not been found in samples, and is free from interference. Ge 73 is used to quantitate chromium, cobalt, copper, nickel, selenium, strontium, vanadium and zinc.

C. LFM/LFM dup. - A LFM and LFM duplicate are performed at a frequency of 1 pair per twenty samples, or 1/batch, whichever is greater. EPA 200.8 states a LFM be performed at a frequency of 1 per 10 samples or 1/batch. MWH Laboratories is running the duplicate so that precision data may be obtained from replicate measurements. An in-house limit of 20% RPD has been assigned to this replicate pair. The frequency of the LFM, LFM dupl is equivalent, or greater than the frequency required by EPA 200.8. As this analysis is being used solely for drinking water samples, matrix effects should be minimal and consistent over time.

D. Sample Digestion - In the final dilution step for total recoverable analytes as per method 200.8, 20 ml of prepared sample is diluted to 50 ml. MWH dilutes 25 ml of prepared sample to 50 ml.

E. Dynamic Reaction Cell (DRC) – The laboratory purchased a Perkin-Elmer Elan 9000 DRC, an ICPMS-MS, to minimize interference. The DRC system consists of a reaction cell, located between the main quadrupole and sample introduction system, where gas (ammonia, methane or oxygen) is injected. The interferences react with the gas to form a different species, which is then mass filtered with a small quadrupole within the DRC. For example, the argon-carbon species would normally interfere with chromium analysis at mass 52. But the species reacts with ammonia to form a different compound, which is then mass filtered by the front quadrupole, allowing chromium analysis as mass 52 with minimal interference from carbon. This laboratory utilize DRC technology to analyze arsenic at mass 91 by using oxygen as the reactant gas, as arsenic combined with oxygen to generate AsO (mass = 91). This technique eliminates the ArCl interference on mass 75.

F. Sulfur has been found to interfere with zinc and copper analysis. Carbon, as argon carbide, has been found to interfere with chromium. Thus, the laboratory employs interference correction factor for carbon on chromium and sulfur on zinc and copper. A carbon-sulfur interference check is analyzed daily, and the correction factor updated as necessary to minimize the interference.

G. Octopole Reaction System (ORS) – The laboratory purchased an Agilent 7500ce with Octopole Reaction System to minimize interference. The ORS consist of a reaction chamber, located between the main quadrupole and sample introduction system, where gas (hydrogen or helium) is injected. The interferences either reacts with (in case of hydrogen) or collides with (in case of helium) the gas, thereby reducing its effects.

H. Tellurium Internal Standard - As per Agilent application chemist recommendation, tellurium should be used as an internal standard to analyze arsenic and selenium in samples containing extremely high carbon content as it is affected by the carbon signal enhancement in very similar fashion as arsenic and selenium.

XVI. METHOD DETECTION LIMIT

A. 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. 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). It is recommended to extract/digest/analyze over a period of at least three days to provide a more reasonable MDL.

B. An MDL study must be repeated for each new analyst trained in the method, when there is a change in the instrumentation that is used for the analysis in question, and when there is a significant change in the instrument response or background measurement.

C. Select a fortifying concentration that provides an instrument signal 2 to 5 times above the noise level.

D. The spike concentration must not exceed 10x the calculated MDL and must be greater then the calculated MDL or the process must be repeated at a lower spike concentration.

E. 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.

F. The MRL should be ≥ the calculated MDL

G. All the replicates that are analyzed should be used to calculate the MDL unless there is a valid reason (Example: QC failure or missed extract holding time).

H. If MRL level is the same as the spiking level, the calculated MDL needs to be within ± 50% (guideline only) of the spiking level. The acceptance criteria for MRL check is also ± 50%.

XVII. DEFINITIONS

Refer to the MWH Laboratories Comprehensive Quality Assurance Plan Glossary for a complete list of terms and definitions.

XVIII. POLLUTION PREVENTION

A. Because this analysis is performed to meet United States Government and/or local regulatory requirements, reduction in volume of samples, reagents or standards is not possible. Practice pollution prevention by implementing the suggestions listed below and by carefully following the instructions in the Waste Management Section of this document.

B. Reduce disposal costs by ordering quantities of reagents and standards that will be approximately consumed by the expiration date.

C. Practice spill prevention by storing chemicals in secondary containment. Do not store incompatible chemicals in close proximity.

D. Reuse solvents for the first step in glassware cleaning if possible.

XIX. WASTE MANAGEMENT

A. It is the responsibility of the laboratory to determine whether its wastes are hazardous and to assure safe handling and disposal. The laboratory works closely with the Treatment, Storage, Disposal Facility to ensure that certain wastes are recycled where possible, that the source of waste is reduced to the lowest possible level and that stringent land disposal restrictions are followed.

B. Refer to the following documents for additional information regarding waste management:

1. Hazardous Waste Management and Sample Disposal Procedures
2. Resource Conservation and Recovery Act (RCRA)-Title 40 of the Code of Federal Regulations, Parts 260 through 270 (40 CFR 260-270)
3. California Hazardous Waste Control Law (HWCL)-CCR Title 22 where 40 CFR was duplicated into CCR Title 22, Parts 66260-66270.

XX. REVISIONS

A. Changes made before version control was enforced.

1. (4/20/1999) SOP 1st draft written, based on a modified 200.8 SOP, to include non-aqueous sample types for the procedure.
2. 12/04/95: Minor update to nomenclature
3. 08/15/97: Added the 40 CFR Part 136.6, Table 1B, footnote #4 regarding all wastewater's need to be digested regardless of the turbidity reading, including the dissolved metals with the exempt criteria statement.
4. 10/16/97: Added C1xV1=C2xV2 calc. to the SOP.
5. 07/09/98: Change QCS, LFB, LFM, LFMDup standards to EM Science custom inorganic standard. Add Quality Control section to augment the Quality Control Table of previous version.
6. 10/07/98: Include a linear dynamic range (LDR) procedure to the SOP.
7. 11/11/98: Update SOP to reflect current practices. Calibration standard is now prepared from JT Baker ICAL Solution I+II. Instrument is now used in analog mode. Most standards changed from EM Science and VWR to JT Baker Plasma-grade.
8. 5/5/1999 ICSA/ICSAB added to SOP as part of the QC program. The source of some standards changed to reflect current laboratory practices. In particular, the internal standard is now purchased from Crescent Chemicals. The tuning solution is now analyzed on a daily basis. The Perkin-Elmer ELAN 6000 is added to the instrument list.
9. 05/11/99 Added to section 9.4 that tuning needs to be done on the daily basis. The percent RSD needs to be less than 5% prior to start of the daily run.
10. 6/18/99 Major SOP revision to account for the Perkin-Elmer ELAN 6000 ICP-MS, including updates to the equipment parameter (section 7.0), tuning section (section 9.4) and linearity check standard (section 8.7). The Hot-Block digestion method is mentioned in the deviation section (section 14.6). Also, silver is now incorporated into the main standard instead of a separate standard.
11. 09/02/99 Hot Block digestion procedure is added as the primary digestion procedure for Aqueous samples. Updated MRL and Tuning solution from individual 1000ppm stock solution to custom-mixed standard. Section 14.3 the 3020 digestion is a none-routine and project specific. Changed in preventative maintenance the miles to hours.
12. Section 15C updated that the new analyst needs to generate a new MDL study in addition to precision and accuracy. Section 14.4 changed the sentencing to reflect the laboratory practice of analyzing an LFM per each ten sample.

B. Revision 13.0 (01/31/00)

1. SOP Updated to reflect NELAC format. Added the sections listed in paragraphs 2-6 below.

2. Definitions section added
3. Safety section expanded to included references to additional resources.
4. Pollution Prevention section added.
5. Waste Management section added.
6. Method Performance section added

C. Revision 14.0 (06/01/00)

1. SOP updated with attachment IV – IX to detail concentration of standards used. The attachment provides a comprehensive list of the elements in the standards and their concentration. It also provides the dilution level required to achieve the working solution. 2. The SOP clarifies that the CCV is prepared from a second source standard. This clarification can be found in section 9B and in Quality Control Table. Deleted 50-150% criteria from MDL section. Deleted the footer. Added the tuning solution standard.

D. Revision 15.0 (07/28/00) - Revised the revision section to include the addition of the tuning standard in revision 14.

E. Revision 16.0 (11/21/00)

1. Section II, Scope and Application – Antimony method reporting Limit updated to 1 ug/L.
2. Attachment IX: Method Reporting Limit (MRL) Check Standard - Antimony concentration for this standard changed from 50 mg/L to 10 mg/L.

F. Revision 17.0 (06/22/02)

1. Section IX, Calibration Procedure - C.9, "The concentration of the CCV is rotated between the high calibration standard and the mid-point 2nd standard. The acceptable criteria is still 90%-110% of true value." Changed to "The concentration of the CCV is rotated between 0.5 x ICV level and 2.0 x ICV level. The acceptable criteria is 90%-110% of true value."
2. Section X, Analytical Procedure, B.3, "Nebulizer flow rate 0.67 L/minute" changed to "Nebulizer flow rate 0.88 L/minute". B.10, "Dwell Time 2 seconds" changed to "Dwell Time 50 microseconds". B.12, "Total acquisition time 6 minutes per sample" changed to "Total acquisition time 3 minutes per sample"
3. Section X, Analytical Procedure - D.3, "CeO $<$ 0.03" changed to "CeO $\leq$ 0.03" - Ba++ $<$ 0.03 changed to "Ba++ $\leq$ 0.03"
4. Attachment XI, Analytical Sequence - "ICV" changed to "ICV (second source)" - "Sample #1" changed to "Sample #1 | 20.0 ppm carbon for Cr interference" - "Sample #2" changed to "Sample #2 – 10" - "CCV" changed to "CCV_1 @. 0.5 x

ICV level" - "CCV" (second occurrence) changed to "CCV_2 @. 2.0 x ICV level" - "CCB" (third occurrence) changed to "CCB | 20.0 ppm carbon"

5. All Sections - Modified for web browser use. Corporate name change implemented.
6. Removed internal cross reference
7. The following changes were made in response the State of Arizona on-site audit, May 2002
    a. Section IX.B.4 and Section XI.B.1, Added the acceptance criteria for LCS, 85-115%
    b. Attachment XII – Deleted "MW uses LCS as QCS". Changed frequency from daily to weekly and criteria from (90-100) to (90 to 110%)
    c. Attachment III - changed chromium reporting limit from 2 ppb to 1 ppb - changed vanadium reporting limit from 10 ppb to 3 ppb.
    d. Section XI, QC requirements – Added QCS (B.3)
    e. Section VII, Reagents and Standards – Q, added the preparation of QCS (1:2000 dilution of the 50ppm stock standard) and that it is run once a week.
    f. Attachment IX, Included the final concentrations (after dilution) of all the analytes for ICS solutions
8. Section XI, QC Requirements – Deleted B.3 (Surrogates) and B.4 (spiking multi components) as the two sections are not applicable to this method.
9. To the header, added "SOP ID" and changed the "Date" to "Revision Date". On the cover page, added "Effective/Issue Date". The changes were made in response to the Air Force audit conducted May 7-9, 2002.
10. Section XIII and Section XXI, Attachments - removed Attachment II (MDL) and Attachment III (Summary of Ongoing Control Chart Data)
11. Section XVI, Method Detection Limit –
    a. B, added the requirement that MDL will be repeated when there is a significant change in the instrument response or background.
    b. D, added the requirement that the spike level needs to be > the calculated MDL.
    c. F, added MRL ≥ calculated MDL
    d. Added G, and H to discuss the basis of rejecting data points and referenced Attachment XIII for Grubbs Test.
    e. Added I, ±50% criteria (a guideline only) for MDL recovery if the MRL is the same as the spiking level. Also, added the MRL criteria (±50%)
12. Section XXI (Attachments) - Attachment III, changed the title to "Analyte/MRL List". Added Attachment XIII (Grubbs Test). Deleted reference to MDL.

G. Revision 18 (10/15/02)

Attachment I, Analyst's Qualifications and Training – Added in response to the airforce audit (May7-9, 2002)

H. Revision 19 (06/27/03)

1. The laboratory replaced the TJA POEMS ICPMS with the latest generation Perkin-Elmer Elan 9000 DRC ICPMS-MS. The operating condition has been updated to reflect this replacement. The instrument calibration standard has been changed from JT Baker 6100 series calibration solution to a custom-mix High-Purity Standard solution as JT Baker no longer manufacture these standards. Add a recommendation of using ultra-trace HCl for ICPMS work as normal metal-trace grade acid may not meet the stringent requirement of ICPMS.
2. To the header, added "SOP ID" and changed the "Date" to "Revision Date". These changes were made to be consistent with AF format.
3. Section VI.G – deleted TJA POEMS included Elan 9000 DRC.
4. Section IX, Calibration Procedure – C.1, deleted the statement "when an initial calibration is not performed" as the instrument is calibrated daily
5. Section X, Analytical Procedure – C.5, added to reference the metals digestion SOP.
6. Section XIII, Added the statement that the MDLs and IDOCs are only initial studies. Added Attachment XV
7. Section XV.F – Added letter E to sequence, Dynamic Reaction Cell (DRC). Deleted the discussion on Method 3020 as it is not applicable.
8. Section XVI – MDL: A, Updated to state that it is recommended to do MDLs over at least 3 days
9. Attachment IV – changed JT Baker to High – Purity Solution.

I. Revision 20 (06/07/04)

1. The SOP has been updated to include special analysis for non-regular metals, including uranium, platinum and iodide including changes to -
   Section VII R & S. Reagents and Standards
   Sec XII.E. Uranium calculation
   Att I. Uranium Precision and Accuracy (DOC) added
   Att II. Uranium calculation ug/L to pCi/L
   Att III. U238 MRL added to list
   Att IV. Uranium Standard
   Att V. Uranium LCS
   Att XV. Added Uranium MDL Study
2. The SmartTune feature in version 3.0 of the Elan software has been added to Section X.D6.
3. The Spex CertiPrep Instrument Calibration Standard 2 is now used for general analytical analysis, as per Perkin-Elmer's recommendation.

4. Attachment VIII. Updated to add Germanium Internal Standard
5. Attachment X. Updated to remove alternate Spex calibration standard

J. Revision 21 (10/18/06)

1. The SOP has been updated to reflect current laboratory practices.
2. Cover page updated per May 2005 SOP Training and added "analysis" to title
3. All attachments are now integrated into the SOP
4. The calibration standard is now prepared by Inorganic Ventures.
5. The Laboratory Control Standard solution has been updated to include uranium in the mix.
6. The QCS standard can be prepared from the ICP calibration standard.
7. The daily tune section has been updated to reflect Perkin-Elmer's recommended criteria.
8. The MRL stock solution is now prepared by Crescent Chemicals.
9. The instrument conditions have been updated to reflect current laboratory practices.
10. Section IV.A- changed "determined by GFAA" to "Diluted accordingly"
11. Section V- Added E –MSDS section from Section VII and updated MSDS documents to be in "red binders" and updated Cornell MSDS website address.
12. Section VI-
    a. D- changed Welding grade to "High Purity"
    b. E- Added "(Hot Plate)"
    c. F
        i. 1- Changed 1.3 to 1.4kW
        ii. 10- Changed 50 to 30
        iii. 11- Changed 20 to 30
    d. Added H through VI.K
13. Section VII
    a. B- Added % (v/v)
    b. F- Added "See Attachment V… for Preparation"
    c. H and L- The internal standard may be fortified with the addition of lithium-6 to increase signal response
    d. H and L- The tuning solution is from Inorganic Ventures (VAR-TS-MS). Previously the laboratory required two tuning standards whereas the VAR-TS-MS standard contained all the tuning analytes in one solution.
    e. J and M- The laboratory no longer prepares calibration or LCS/LFB working standards. The final standards are prepared directly from the primary standards to minimize serial dilution errors. The MRL working standard is still prepared.
    f. O and P- Added dilution and preparation for calibration standards and QCS.
    g. S- inserted
14. Section IX has been updated and reformatted to reflect bench practices
15. Section X.B- Added "are typical … improve stability"
    a. 1- changed 1.3 to 1.4

   b. 10- changed 50 to 30
   c. 11- changed 20 to 30

16. Section X.D.3- deleted sections g through i
17. Section X.E.- Reporting requirement updated to include checks for unusual hits for elements normally absent in drinking water matrices
18. Section XI has been updated to include the 3 different types of blanks in Section XI.A.1, an RPD <20% acceptance criteria added to section XI.E and Item XI.F now reads, "See attachment XII for additional QC requirements, frequencies, and acceptance criteria."
19. Section XII.C combined with item E to add, "based on a linear… per client requests"
20. Section XII.E (new) added RPD calculation formula.
21. Section XIII.A, added "Prior to sample analysis, analysts must perform satisfactory … and acceptable MDL study."
22. Section XIII.B- added sections 1 and 2
23. Section XIV- added reference method SM 3020B
24. Section XV.C- deleted "RPD (ABS (Value 1 – Value 2)/Average Value 1 and Value 2) X 100"
25. Deleted use of Grubbs Test from the Attachments and Section XVI
26. Updated Attachment II
27. Updated Attachment XII with rinse blank and instrument blank.
28. The SOP updated to include recommended internal standards for elements analyzed by ICPMS. See Attachment 3 for internal standard update.

K. Revision 22 (01/25/07)

1. MWH Laboratories recently purchased a new Agilent 7500ce ICPMS with Octopole Reaction System technology. The SOP is updated to include this instrument.
2. Section VI.L – Added
3. Section X.B and D – Added Agilent
4. Section X.E.5 – Added
5. Section XV.G and H – Added

L. Revision 23 (08/13/07)

1. Section XI E – Change from 1 in 20 samples to 2 in 20 samples.
2. Section XI.A – Added requirement of blank must be less than ½ MRL
3. Attachment X – Removed reference to ICSA and ICSAB

M. Revision 24 (12/07/07)

1. Section 10 F & G - Added for the purpose of EPA 6020 compliance
2. Section 12 F – Added to properly document the conversion of ug/L to pCi/L for Uranium by ICPMS analysis.

XXI. ATTACHMENTS

A. Attachment I, Documentation of Precision and Accuracy

B. Attachment II, Calculations

C. Attachment III, Analyte/MRL List

D. Attachment IV, Calibration Standard Solution

E. Attachment V, LCS-LFB / Spike Standard Solution

F. Attachment VI, ICS / SIC Standard Solution

G. Attachment VII, Tuning Standard Solution

H. Attachment VIII, Internal Standard Solution

I. Attachment IX, Method Reporting Limit (MRL) Standard Solution

J. Attachment X, Calibration Standards

K. Attachment XI, Analytical Sequence

L. Attachment XII, QC Table

M. Attachment XIII, Analyst's Qualifications and Training

N. Attachment XIV, Documentation of Method Detection Limit Study

Attachment I: Documentation of Precision and Accuracy

Element	Mass	Actual	Unit	DOC1	DOC2	DOC3	DOC4	Average	% Recovery
				05/18/04	05/18/04	05/28/04	05/28/04		
Uranium	238	20.00	ug/L	19.8	20.4	18.8	19.6	19.7200	99%

Date Reported: 07/18/06
Units: ug/l

Instrument Code: ELAN
Method: ML/EPA 200.8
Group#: 176217

	Actual	DOC1	DOC2	DOC3	DOC4	Avg	%Rcvy	Stdv	%RSD
Preparation Date		NA	NA	NA	NA				
Preparation Analyst		NA	NA	NA	NA				
Analytical Date		01/09	01/09	01/09	01/09				
Analyst		jps	jps	jps	jps				
Aluminum, Total, ICAP/MS	200	186	206	194	194	195.000	97.5	8.246	4.2
Antimony, Total, ICAP/MS	50	47.7	50.4	50.3	51.1	49.875	99.7	1.493	3.0
Arsenic, Total, ICAP/MS	20	19.1	19.1	19.5	20.1	19.450	97.3	0.473	2.4
Barium, Total, ICAP/MS	100	100	104	104	107	103.750	103.8	2.872	2.8
Beryllium, Total, ICAP/M	5.00	5.00	5.40	4.88	4.86	5.035	100.7	0.251	5.0
Cadmium, Total, ICAP/MS	20	20.5	21.0	18.9	19.3	19.925	99.6	0.988	5.0
Chromium, Total, ICAP/MS	100	100	101	97	101	99.750	99.8	1.893	1.9
Cobalt, Total, ICAP/MS	100	98	102	99	101	100.000	100.0	1.826	1.8
Copper, Total, ICAP/MS	100	101	102	101	105	102.250	102.2	1.893	1.9
Lead, Total, ICAP/MS	20	20.7	20.9	20.5	21.0	20.775	103.9	0.222	1.1
Manganese, Total, ICAP/M	50	51.5	50.6	50.4	51.4	50.975	102.0	0.556	1.1
Molybdenum, Total, ICAP/	100	99	102	97	101	99.750	99.8	2.217	2.2
Nickel, Total, ICAP/MS	50	51.5	50.6	50.0	51.6	50.925	101.8	0.763	1.5
Selenium, Total, ICAP/MS	20	19.8	21.1	20.4	21.2	20.625	103.1	0.655	3.2
Silver, Total, ICAP/MS	50	51.2	51.2	49.6	51.0	50.750	101.5	0.772	1.5
Thallium, Total, ICAP/MS	20	19.2	19.5	18.7	19.1	19.125	95.6	0.330	1.7
Vanadium, Total, ICAP/MS	100	100	103	101	104	102.000	102.0	1.826	1.8
Zinc, Total, ICAP/MS	100	103	103	99	100	101.250	101.2	2.062	2.0

Attachment II: Calculations

The calculation is based on a linear relationship in the form of

[Result] = Peak Intensity * Correlation factor + Intercept

Where

Peak Intensity = strength of signal measured by the detector
Correlation Factor = slope of the calibration curve established prior to analysis
Intercept = the Intercept of the calibration curve

The Peak Intensity is measured as the Net Mean Intensity that takes into account both the internal standard used in the method and the blank signal measured at time of calibration.

The Net Mean Intensity is calculated as

[Net Mean Intensity] = (Measured Mean Intensity / Measured Intensity of the IntStd) - (Measured Mean Intensity of Blank / Measured Intensity of IntStd of blank)

The Slope of the calibration curve is determined by plotting the Net Mean Intensity of the standards versus its concentration.

Example:

The Calibration blank for Chromium reads 6933 and the IntStd of Ge-73 reads 169554.
The sample for Chromium reads 413503 and the intStd of Ge-73 reads 154803.

The Net Mean Intensity = (413503 / 154803) – (6933 / 169554) = 2.63

For Uranium analysis, the instrument is calibrated in ug/L but the client may want the result to be reported in pCi/L. The conversion calculation is as follows:

[result, pCi/L] = [result, ug/L] x 0.67 pCi/ug

Example:
a 50 ug/L uranium result, in pCi/L, is calculated as follows:

[result, pCi/L] = [result, ug/L] x 0.67 = 50 ug/L x 0.67 pCi/ug = 33.5 pCi/L

Attachment III: Analyte and MRL list

The following elements may be determined by EPA Method 200.8:

Analyte	MRL - ppb in drinking water	Recommended Internal Standard	Mass monitored
aluminum*	25	Li-6 or Sc-45	**27****
antimony*	1	In-115	**121**,123
arsenic*	1	Ge-73	**75**
barium*	2	In-115	135,**137**
beryllium*	1	Li-6	**9**
cadmium*	0.5	In-115	106,108,**111**,114
chromium*	1	Ge-73	**52**,53
cobalt	2	Ge-73	**59**
copper*	2	Ge-73	63,**65**
lead*	0.5	Bi-209	206,207,**208**
manganese*	2	Ge-73	**55**
molybdenum	2	Ge-73	95,97,**98**
nickel*	5	Ge-73	**58**,60,62
selenium*	5	Ge-73	77,**78**, 82
silver*	0.5	In-115	**107**,109
strontium	1	Ge-73	**87**
thallium*	1	Bi-209	203,**205**
uranium	1	Bi-209	**238**
vanadium	3	Sc-45 or Ge-73	**51**
zinc*	5	Ge-73	64,**66**,67,68

* EPA 200.8 has been approved for the reporting compliance monitoring data for these elements.

**Quantitation Isotope -underlined.

Attachment IV: Calibration Standards Solution

High – Inorganic Ventures 2nd Source (Catalog # IV-26) Unit: mg/L

Element	**ICL Solution 1**	**Element**	**ICL Solution I**
Silver (Ag)	100	Aluminum (Al)	100
Barium (Ba)	100	Arsenic (As)	100
Beryllium (Be)	100	Calcium (Ca)	100
Cadmium (Cd)	100	Chromium (Cr)	100
Cobalt (Co)	100	Potassium (K)	100
Copper (Cu)	100	Magnesium (Mg)	100
Iron (Fe)	100	Sodium (Na)	100
Manganese (Mn)	100	Antimony (Sb)	100
Nickel (Ni)	100	Selenium (Se)	100
Lead (Pb)	100	Vanadium (V)	100
Thallium (Tl)	100	Molybdenum (Mo)	100
Zinc (Zn)	100	Titanium (Ti)	100

Prepare the mid-level standard by diluting 1:1000 of the primary calibration standard.
Prepare the high-level standard by diluting 1:400 of the primary calibration standard.

Alternative Calibration Solution

Spex Certiprep Instrument Calibration Standard 2 (Catalog # CL-CAL-2) Unit: mg/L
Dilute 1:100 in 2% HNO3 to produce intermediate calibration standard.

Element	**ICS 2**	**Element**	**ICS 2**
Silver (Ag)	100	Aluminum (Al)	100
Barium (Ba)	100	Arsenic (As)	100
Beryllium (Be)	100	Calcium (Ca)	100
Cadmium (Cd)	100	Chromium (Cr)	100
Cobalt (Co)	100	Potassium (K)	100
Copper (Cu)	100	Magnesium (Mg)	100
Iron (Fe)	100	Sodium (Na)	100
Manganese (Mn)	100	Antimony (Sb)	100
Nickel (Ni)	100	Selenium (Se)	100
Lead (Pb)	100	Vanadium (V)	100
Thallium (Tl)	100	Molybdenum (Mo)	100
Zinc (Zn)	100	Molybdenum (Mo)	100

Prepare the mid-level standard by diluting 1:1000 of the stock calibration standard.
Prepare the high-level standard by diluting 1:400 of the stock calibration standard.

This standard has been recommended by Perkin-Elmer's Senior Product Specialist, Ewa Pruszkowski. Perkin-Elmer also recommends preparing the standards in either pre-leached glass volumetric flask reserved specifically for standards preparation or preferably in plastic volumetric flask to minimize leeching problems.

Uranium standard preparation

Calibration source: 1000 mg/L Uranium (JT Baker Cat # 5788-04) Unit: mg/L
Dilute 1:100 in 2% HNO3 to produce 10 mg/L intermediate calibration standard.

Element	**Calibration Source**	**Element**	**Calibration Source**
Uranium (U)	1000		

Prepare the high-level standard by diluting 1:100 of the intermediate standard
Prepare the mid-level standard by diluting 1:200 of the intermediate standard
Prepare the low-level standard by diluting 1:100 of the high-level standard.

Example:

Standard Level	**Amount required**	**Final Volume**	**Final Concentration**
High-level	1 mL of 10mg/L intermediate	100 mL	100 ug/L (67 pCi/L)
Mid-level	0.5 mL of 10 mg/L intermediate	100 mL	50 ug/L (33.5 pCi/L)
Low-level (MRL)	1 mL of 100 ug/L High-level	100 mL	1.0 ug/L (0.67 pCi/L)

Attachment V: LCS-LFB / Spike Solution

CPI LFB Custom-Mix (P/N 4400-050314RH01) Unit: mg/L
Dilute / spike 1:1000 in 2% HNO3 to produce working LFB or spike level

Element	**mg/L**	**Element**	**Mg/L**	**Element**	**mg/L**
Fe	500	Ti	100	As	20
Al	200	V	100	Cd	20
Ba	100	Zn	100	Pb	20
Co	100	Ag	50	Se	20
Cr	100	B	50	Tl	20
Cu	100	Mn	50	Be	5
Mo	100	Ni	50	U	20
Sr	100	Sb	50		

The custom LCS / Spike standard already contained uranium as part of the mix. Therefore, a 2nd source standard for uranium is not really necessary to prepare the LCS or to spike samples.

Attachment VI: ICS / SIC Standard Solution

ICSA: CPI P/N 4400-ICP-MS-ICS. Dilute 1:5 in 5% HNO3
ICSAB: CPI P/N 4400-ICP-MS-ICS. Dilute 1:5 in 5% HNO3. Unit: mg/L

ICSA:

Element	**Concentration (mg/L)**	**Element**	**Concentration (mg/L)**
Aluminum	500 mg/L	Calcium	500 mg/L
Chlorine	3,600 mg/L	Iron	500 mg/L
Potassium	500 mg/L	Magnesium	500 mg/L
Molybdenum	10 mg/L	Sodium	500 mg/L
Phosphorus	500 mg/L	Sulfur	500 mg/L
Titanium	10 mg/L	Carbon	1000 mg/L

Final Concentration

Element	**Concentration (mg/L)**	**Element**	**Concentration (mg/L)**
Aluminum	100 mg/L	Calcium	100 mg/L
Chlorine	720 mg/L	Iron	100 mg/L
Potassium	100 mg/L	Magnesium	100 mg/L
Molybdenum	2 mg/L	Sodium	100 mg/L
Phosphorus	100 mg/L	Sulfur	100 mg/L
Titanium	2 mg/L	Carbon	200 mg/L

ICSAB:

Element	**Concentration (mg/L)**	**Element**	**Concentration (mg/L)**
Aluminum	500 mg/L	Calcium	500 mg/L
Chlorine	3,600 mg/L	Iron	500 mg/L
Potassium	500 mg/L	Magnesium	500 mg/L
Molybdenum	10 mg/L	Sodium	500 mg/L
Phosphorus	500 mg/L	Sulfur	500 mg/L
Titanium	10 mg/L	Carbon	1000 mg/L
Silver	0.100 mg/L	Arsenic	0.100 mg/L
Cadmium	0.050 mg/L	Cobalt	0.200 mg/L
Chromium	0.100 mg/L	Copper	0.100 mg/L
Manganese	0.100 mg/L	Nickel	0.200 mg/L
Selenium	0.100 mg/L	Vanadium	0.200 mg/L
Zinc	0.100 mg/L		

Final Concentration

Element	Concentration (mg/L)	Element	Concentration (mg/L)
Aluminum	100 mg/L	Calcium	100 mg/L
Chlorine	720 mg/L	Iron	100 mg/L
Potassium	100 mg/L	Magnesium	100 mg/L
Molybdenum	2 mg/L	Sodium	100 mg/L
Phosphorus	100 mg/L	Sulfur	100 mg/L
Titanium	2 mg/L	Carbon	200 mg/L
Silver	0.020 mg/L	Arsenic	0.020 mg/L
Cadmium	0.010 mg/L	Cobalt	0.040 mg/L
Chromium	0.020 mg/L	Copper	0.020 mg/L
Manganese	0.020 mg/L	Nickel	0.040 mg/L
Selenium	0.020 mg/L	Vanadium	0.040 mg/L
Zinc	0.020 mg/L		

Note: Standard 4400-ICP- MS-ICS will include both ICSA/ICSAB in the kit.

Attachment VII: Tuning Standard Solution

Tuning Solution: Inorganic Ventures VAR-TS-MS.
Dilute 1:1000 in 5% HNO_3

Unit: mg/L

Element	Concentration	Element	Concentration
Barium	10 mg/L	Beryllium	10 mg/L
Cerium	10 mg/L	Cobalt	10 mg/L
Indium	10 mg/L	Lead	10 mg/L
Magnesium	10 mg/L	Thorium	10 mg/L

Final concentration

Element	Concentration	Element	Concentration
Barium	10 ug/L	Beryllium	10 ug/L
Cerium	10 ug/L	Cobalt	10 ug/L
Indium	10 ug/L	Lead	10 ug/L
Magnesium	10 ug/L	Thorium	10 ug/L

Attachment VIII: Internal Standard Solution

Internal Standard: CPI P/N 4400-010034 Unit: mg/L

Element	Concentration	Element	Concentration
Lithium-6	100 mg/L	Scandium-45	100 mg/L
Terbium-159	100 mg/L	Yttrium-89	100 mg/L
Indium-115	100 mg/L	Bismuth-209	100 mg/L

For the Elan 6000, dilute the stock standard 1:1000 with 5% nitric acid to prepare the working solution.

For the Elan 9000, dilute the stock standard 1:2000 with 5% nitric acid to prepare the working solution.

Germanium may also be added to the standard by diluting 1:1000 of a 1000mg/L stock standard and spiking it into the working standard.

P/N 4400-010034 stock internal standard lacks holmium-165 but it is 10X more concentrate when compare to the 4400-010041 stock internal standard. If holmium-165 is not required – and it usually is not – P/N 4400-010034 is the preferred internal stock standard.

In some situation, it may be desirable to fortify the internal standard by spiking in single element stock standard such as lithium-6 because the sensitivity for lithium-6 is quite poor.

Attachment IX: Method Reporting Limit (MRL) Standard

Inorganic Ventures Custom Mix (MWH-STD-3)
Dilute 1:100 in 5% HNO3 to produce an intermediate MRL-Check solution.
Dilute 1:100 in 5% HNO3 of the intermediate solution to produce the daily working solution. The MRL solution should be prepared fresh daily.

Note: The MRL standard is also the low standard of the calibration curve.

Element	**Concentration (mg/L)**	**Element**	**Concentration (mg/L)**
Silver (Ag)	5	Aluminum (Al)	250
Barium (Ba)	20	Arsenic (As)	10
Beryllium (Be)	10	Boron (B)	100
Cadmium (Cd)	5	Chromium (Cr)	10
Cobalt (Co)	20	Potassium (K)	1000
Copper (Cu)	20	Molybdenum (Mo)	20
Manganese (Mn)	20	Antimony (Sb)	10
Nickel (Ni)	50	Selenium (Se)	50
Lead (Pb)	5	Vanadium (V)	30
Thallium (Tl)	10	Tin (Sn)	10
Uranium	10	Zinc (Zn)	50

Final Concentration

Element	**Concentration (ug/L)**	**Element**	**Concentration (ug/L)**
Silver (Ag)	0.5	Aluminum (Al)	20.0
Barium (Ba)	2.0	Arsenic (As)	1.0
Beryllium (Be)	1.0	Boron (B)	10.0
Cadmium (Cd)	0.5	Chromium (Cr)	1.0
Cobalt (Co)	2.0	Potassium (K)	100.0
Copper (Cu)	2.0	Molybdenum (Mo)	2.0
Manganese (Mn)	2.0	Antimony (Sb)	1.0
Nickel (Ni)	5.0	Selenium (Se)	5.0
Lead (Pb)	0.5	Vanadium (V)	3.0
Thallium (Tl)	1.0	Tin (Sn)	1.0
Uranium (U)	1.0	Zinc (Zn)	20.0

Attachment X: Calibration Standard

ICP-MS Calibration Standards - In 100mL volumetric flask containing 50mL DI water, pipette 2mL conc. nitric acid and the following amount of standards, then dilute to volume.

Standard Level	Amount of Standard, uL	Standard added
Standard Blank	None	
Standard 1	1000uL	MRL Working Standard
Standard 2	100uL	ICPMS Calibration
Standard 3	250uL	ICPMS Calibration
Linearity-Check	500uL or 1000uL	ICPMS Calibration

The Linearity-Check standard may be prepared at a final concentration of 500 ug/L or 1000 ug/L for all analytes. If the instrument has difficulties achieving linearity to 1000 ug/L, then prepare the linearity-check at 500 ug/L. Note: if the instrument linearity is problematic, then a dual-detector calibration should be performed.

Attachment XI: Typical Analytical Sequence

Instrument Blank	
Calibration Blank	
Standard 1	Standard is set as the MRL level
Standard 2	Also serves as the ICV/CCV
Standard 3	
ICV (second source)	Result must be within 5%; otherwise, recalibrate
Linearity-Check	Result must be within 10% to be linear
Carbon-Sulfur Chk	Carbon & sulfur check standard – 20ppm C & 300ppm S
MCV	(Optional) A 3rd source QCS type standard
MRL-Check	Result should be within 50% of true value
ICB	Result must be less than the MRL for each element
MBLANK	Method Blank
LCS-LFB	2nd source verification standard. Control limit is +/- 15%
LCSD-LFBD	Duplicate of LCS-LFB
Sample #1	20.0 ppm carbon for Cr interference
Sample #1MS	Matrix spike of sample #1. Acceptable limit is +/- 30% recovery
Sample #1MSD	Matrix spike duplicate of Sample #1
Sample #2 - 10	
CCV	CCV must be 90-110%; otherwise, recalibrate & reanalyze
CCB	CCB must be less than ½ MRL; otherwise, recalibrate & reanalyze
Next 10 Sample	
CCV	
MCV	(Optional)
MRL-Check	
CCB	

Attachment XII: QC Table

Type	Frequency	Concentration	Criteria	Analytes	Other
Quality Control Sample (QCS) Also called MCV	immediately after calibration, *weekly*	within linear range of instrument	90-110%	All	Standard must be from a source independent of the calibration standard.
Laboratory Fortified Blank(LFB)	immediately after calibration, *also* 1 with every set of samples	within linear range of instrument	85-115%	All	Standard must be from a source independent of the calibration standard.
Internal Standards (IS)	spiked into every sample, standard and blank	50 ug/L	65-125 % of the response in the calibration blank	bismuth, indium, germanium, scandium, lithium (6)	If sample dilution is performed, IS introduced after dilution.
Initial/ Continuing Calibration Verification (ICV/CCV)	1 after every 10 analyses	varies by element, see section	+/- 10 % for CCV +/- 5% for ICV	All	same source as the calibration standard
Continuing Calibration Blank (CCB)	1 after every 10 analyses following the CCV	NA	All analytes of interest found below MRL	NA	2% nitric acid in reagent water only.
Method Blank	1 with every set of samples	NA	all analytes of interest found <1/2 MRL or <1/2 CRDL	NA	Same prep. as samples.
Instrument Blank	Prior to Calibration.	NA	all analytes of interest found below MRL	NA	DI water only.
Rinse Blank	As needed between samples	NA	All analytes of interest found below MRL	NA	2% nitric acid in reagent water only.
MRL/CRDL Check	Before sample sequence	MRL/CRDL	50-150% or statistically determined from control charts as 3 sigma	All	
Linearity Check	Prior to sample sequence	At the upper limit of the linear range	90-110%	All	same std. as used in calibration
Tuning Solution	At the start of the QC program or after major maintenance or every two weeks	10 ng/L of Mg, In, Pb, Ba, Ce	Good Performance: 0.75 amu peak width at 5% peak height Mass calibration: <0.1 amu from unit mass Instrument stability: 6x run; < 5% RSD	All	

Attachment XIII: Analyst's Qualification and Training

A. Analyst Qualification

1. ICPMS requires an experience chemist to analyze samples properly. The minimum qualification is a BS degree in chemistry or related field, plus at least 2 years instrumentation experience with special emphasis on metals analysis, such as ICP and GFAA.
2. The analyst must also complete a training course from the instrument's vendor.
3. Prior to analysis, the analyst must adequately perform an IDOC (initial demonstration of capability) which involves an MDL study, 4 2nd source LCS analysis and successfully passing a blind check sample from an external company.

B. General Maintenance

1. The Elan 6000 and Elan 9000 ICPMS is a robust instrument, but it must be maintained regularly to keep it in proper working condition.
2. On a daily basis, check the tubings to ensure good working condition. Check the argon supply to ensure a minimum of 85PSI. Check the vacuum ($<1.8 * 10^{-8}$ torr)
3. On a weekly basis, check the vacuum pump oil condition and replace oil if it turns dark or stink. Open up the system to check the condition of the cones. Check the torch to ensure that it is in good condition and replace if necessary.
4. On a monthly basis, prepare a fresh batch of standards.

C. Trouble-shooting

1. If the instrument has low sensitivity: check the tubing lines for plugs; check the condition of the cones and replace if cones are coated white from salt deposit; check XYZ alignment of the cones; and as a last resort, update the optimization parameters. If all else fails, reoptimize the detector's voltage and re-peform instrument's optimization parameters. Should none of the above procedures correct the low sensitivity, then the detector may require replacement – contact Perkin-Elmer for technical assistance.
2. If the instrument fails to start, check the vacuum to make sure it is below 10^{-8} torr. Check the plug condition between the torch box and the ICPMS interface and clean if it is dirty. Check the coolant's temperature and level. Recycle the instrument's power and/or computer's power if there is a failure to communicate. The instrument's panel contains a diagnostic screen. Check it for any anomalies.
3. If the instrument drifts, check the sample and internal standard lines for plugs. Check if a high TDS sample has been recently run through the system; if so, let the system washed out before continuing the analysis. As the cones degrade, drifts will also occur. Ensure

Attachment XIII: Analyst's Qualification and Training

that the room's temperature has not changed dramatically, as that will also cause drifts.

4. If the instrument fails to calibrate, prepare a fresh set of standards and try again. Check the correction factors and update if necessary.

D. Electronic data-handling

1. The instrument stores the analytical data within a file structure database that is stored within the subdirectory of each DATASET. On a regular basis, backup the database onto CD or another hard-drive. The data must be maintained onsite for 2 years and off-site for 3 years.
2. After every analysis, transfer the data onto a floppy disc and run the Data-Link program to generate a report. Also, the Data-Link program will permit electronic data-transfer to the LIMS.

E. Computer software

The software controls the Elan 6000 and 9000 ICPMS is WinLab 32, a proprietary Windows-based program written by Perkin-Elmer Corporation. This program has been designed to control all Perkin-Elmer's inorganic analytical instruments, including the ICPMS, ICP, GFAA and Mercury Analyzer. As such, learning the software on one instrument allows for fast and easy transition to another instrument within the Perkin Elmer line.

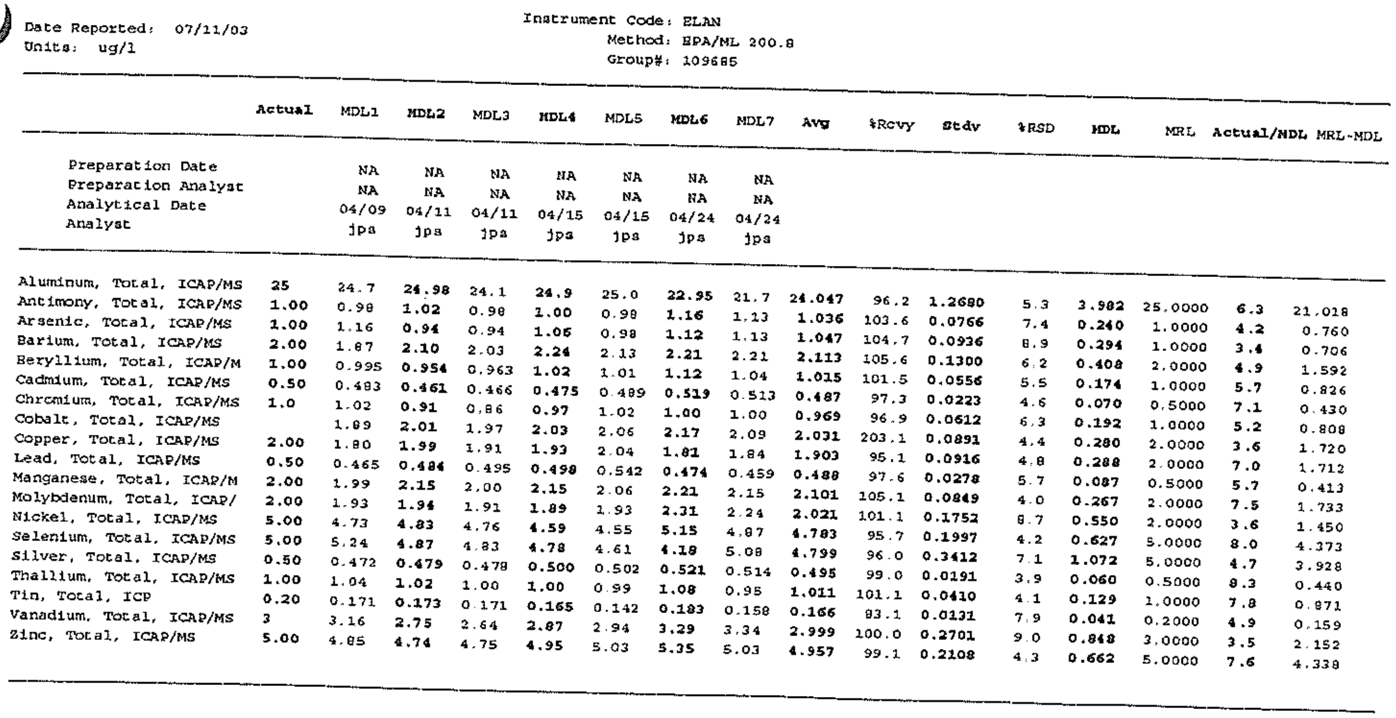
F. Instrument Hardware

The Perkin-Elmer Elan 6000 is the 4th generation of ICPMS instruments and the Perkin-Elmer Elan 9000 is the 5th generation of ICPMS instruments developed by the Perkin-Elmer Corporation. The Elan 6000 includes an ICP with an axially mounted torch and a mass spectrometer using a quadrupole design, all in a compact housing that also contains dual roughing pump and two turbo-molecular pump working in tandem. The Elan 9000 is an updated version of the Elan 6000, with an additional quadropule mounted inside a dynamic reaction cell. This cell can be used to minimize polyatomic interference. The Elan 9000 only has one turbomolecular pump. An external water recirculator is part of the instrument as the ICPMS requires a source of cooling water for its torch, electronics and temperature-stabilized nebulizer chamber.

Attachment XIV: Documentation of Method Detection Limit Study

Element	Mass	Actual	Unit	MDL1	MDL2	MDL3	MDL4	MDL5	MDL6	MDL7	MDL8	Ave	% Rec
				01/28/04	01/28/04	02/13/04	02/13/04	05/18/04	05/18/04	05/28/04	05/28/04		
Uranium	238	1	ug/L	1.0146	1.0183	0.9261	1.1626	1.0781	1.0258	1.0664	1.0998	1.049	105%

Stdev	%RSD	MDL	Actual/ MDL	Current MRL	MRL- MDL	2*MDL
0.0701	6.7	0.210	4.8	1	0.790	0.421



Date Reported: 07/11/03
Units: ug/l

Instrument Code: ELAN
Method: EPA/ML 200.8
Group#: 109685

	Actual	MDL1	MDL2	MDL3	MDL4	MDL5	MDL6	MDL7	Avg	%Rcvy	Stdv	%RSD	MDL	MRL	Actual/MDL	MRL-MDL
Preparation Date		NA	NA	NA	NA	NA	NA	NA								
Preparation Analyst		NA	NA	NA	NA	NA	NA	NA								
Analytical Date		04/09	04/11	04/11	04/15	04/15	04/24	04/24								
Analyst		jpa	jpa	jpa	jpa	jpa	jpa	jpa								
Aluminum, Total, ICAP/MS	25	24.7	24.98	24.1	24.9	25.0	22.95	21.7	24.047	96.2	1.2680	5.3	3.982	25.0000	6.3	21.018
Antimony, Total, ICAP/MS	1.00	0.98	1.02	0.98	1.00	0.98	1.16	1.13	1.036	103.6	0.0766	7.4	0.240	1.0000	4.2	0.760
Arsenic, Total, ICAP/MS	1.00	1.16	0.94	0.94	1.06	0.98	1.12	1.13	1.047	104.7	0.0936	8.9	0.294	1.0000	3.4	0.706
Barium, Total, ICAP/MS	2.00	1.87	2.10	2.03	2.24	2.13	2.21	2.21	2.113	105.6	0.1300	6.2	0.408	2.0000	4.9	1.592
Beryllium, Total, ICAP/M	1.00	0.995	0.954	0.963	1.02	1.01	1.12	1.04	1.015	101.5	0.0556	5.5	0.174	1.0000	5.7	0.826
Cadmium, Total, ICAP/MS	0.50	0.483	0.461	0.466	0.475	0.489	0.519	0.513	0.487	97.3	0.0223	4.6	0.070	0.5000	7.1	0.430
Chromium, Total, ICAP/MS	1.0	1.02	0.91	0.86	0.97	1.02	1.00	1.00	0.969	96.9	0.0612	6.3	0.192	1.0000	5.2	0.808
Cobalt, Total, ICAP/MS		1.89	2.01	1.97	2.03	2.06	2.17	2.09	2.031	203.1	0.0891	4.4	0.280	2.0000	3.6	1.720
Copper, Total, ICAP/MS	2.00	1.80	1.99	1.91	1.93	2.04	1.81	1.84	1.903	95.1	0.0916	4.8	0.288	2.0000	7.0	1.712
Lead, Total, ICAP/MS	0.50	0.465	0.484	0.495	0.498	0.542	0.474	0.459	0.488	97.6	0.0278	5.7	0.087	0.5000	5.7	0.413
Manganese, Total, ICAP/M	2.00	1.99	2.15	2.00	2.15	2.06	2.21	2.15	2.101	105.1	0.0849	4.0	0.267	2.0000	7.5	1.733
Molybdenum, Total, ICAP/	2.00	1.93	1.94	1.91	1.89	1.93	2.31	2.24	2.021	101.1	0.1752	8.7	0.550	2.0000	3.6	1.450
Nickel, Total, ICAP/MS	5.00	4.73	4.83	4.76	4.59	4.55	5.15	4.87	4.783	95.7	0.1997	4.2	0.627	5.0000	8.0	4.373
Selenium, Total, ICAP/MS	5.00	5.24	4.87	4.83	4.78	4.61	4.18	5.08	4.799	96.0	0.3412	7.1	1.072	5.0000	4.7	3.928
Silver, Total, ICAP/MS	0.50	0.472	0.479	0.478	0.500	0.502	0.521	0.514	0.495	99.0	0.0191	3.9	0.060	0.5000	8.3	0.440
Thallium, Total, ICAP/MS	1.00	1.04	1.02	1.00	1.00	0.99	1.08	0.95	1.011	101.1	0.0410	4.1	0.129	1.0000	7.8	0.871
Tin, Total, ICP	0.20	0.171	0.173	0.171	0.165	0.142	0.183	0.158	0.166	83.1	0.0131	7.9	0.041	0.2000	4.9	0.159
Vanadium, Total, ICAP/MS	3	3.16	2.75	2.64	2.87	2.94	3.29	3.34	2.999	100.0	0.2701	9.0	0.848	3.0000	3.5	2.152
Zinc, Total, ICAP/MS	5.00	4.85	4.74	4.75	4.95	5.03	5.35	5.03	4.957	99.1	0.2108	4.3	0.662	5.0000	7.6	4.338

MWH LABORATORIES

Standard Operating Procedure
For

Total Suspended Solids (TSS) in Water

Standard Methods 2540D, 20th Edition

Approved:

(1) Analyst: ______________ Date 06/20/07

(2) Group Leader: ______________ Date 6/20/07

(3) QA Officer: Ruth Geddes Date 6/20/07

(4) Technical Director/: Andrew Eaton Date 6/20/07
Laboratory Director

(5) Issue Date 6/20/2007

(6) Effective Date 7/4/2007

Annual Review Signatures:

Analyst: ______________ Date ________

Group Leader: ______________ Date ________

QA Officer: ______________ Date ________

Technical Director/: ______________ Date ________
Laboratory Director

ACCREDITED IN ACCORDANCE WITH
nelac
01114CA
Controlled Copy____
of ________ copies
MWH Laboratories
Initials Date

TABLE of CONTENTS

I. TITLE

Total Suspended Solids (TSS) in Water, Standard Methods 2540D, 20th Edition

II. SCOPE AND APPLICATION

A. This method is applicable to the determination of Total Suspended Solids and its Fixed and Volatile fractions in drinking, surface, and saline waters, and domestic and industrial wastes.

B. Total suspended solids analyses are performed as part of pilot scale evaluations designed to evaluate the optimum treatment scheme for raw water sources having high total solids content. The total suspended solids analysis is extremely useful for evaluating the strength of domestic and industrial wastewaters and the efficiency of treatment units.

C. The procedure is suitable for a solids concentration range of 1.0 mg/l to 20,000 ug/l (2%). The detection limit essentially is a function of the sample volume filtered and the smallest quantity of residue that can be accurately determined. For the purposes of this analysis, the smallest weight change which can be accurately measured is 1.0 mg. Consequently, the Method Reporting Limit (MRL) is 10 mg/L. This is based on a minimum required residue of 1.0 mg and a nominal 100 ml aliquot of sample.

III. METHOD SUMMARY

Total suspended solids refers to the portion of a sample retained on a filter after filtration through a glass fiber filter. A well-mixed sample is measured and then filtered through a glass fiber filter and the solids retained on the filter are dried at 103-105°C and weighed. The increase in weight of the filter represents the total suspended solids of the sample.

IV. INTERFERENCES

A. The suspended solids determination is inherently less accurate than most analytical methods because filtration is subject to several variables which affect the separation of the suspended material from the aqueous portion of the sample. The chemical and physical nature of the suspended matter in the sample, the area and thickness of the filter mat, the filter pore size, and the amount and physical state of the materials deposited on the filter influence the degree of separation of the suspended material from the sample.

B. Non-representative particles such as leaves, sticks, fish, or lumps of fecal matter should be removed from the sample prior to the analysis. If too large of a sample aliquot is taken for a sample high in suspended solids, then excessive solids will be collected on the filter and entrapped water may require prolonged drying.

C. If the suspended material is fine grained and clogs the filter before sufficient amount of solids has been collected, then the suspended solids can be estimated by taking the difference between the total residue solids and the total dissolved solids. NOTE: This is only an accurate approach when the TS is significantly greater than the TDS.

D. Positive interferences [leading to results biased high]
   1. If the filter is left in the open air, dust may accumulate on the filter increasing the total weight of the sample.
   2. If the dried sample exceeds 200 mg of residue, the residue initially dries from the outside and can trap moisture in the layer below.
   3. Drying temperatures considerable lower than 103-105°C will result in the loss of insufficient water from the sample.

E. Negative interferences [leading to results biased low]
   1. If drying temperatures are significantly greater than 103-105 degree C, water of crystallization may be lost.
   2. It is essential that samples be vigorously shaken before removing an aliquot for analysis of suspended solids. If samples are not thoroughly homogenized, the suspended solids will remain on the bottom or sides of the bottle and results will be biased low. In addition, it is equally as important to transfer the sample from the graduated cylinder to the filtration apparatus without losing any of the suspended solids in the process.

V. SAFETY CONSIDERATIONS

A. Some samples may be wastewater in nature. Wear gloves, goggles and lab coats when performing the analysis. This procedure requires heating to 105°C. Use tongs and high-temperature gloves when handling hot items.

B. Refer to the MWH Chemical Hygiene Plan and OSHA Standard 29 CFR 191 0.1450 Occupational Exposure to Hazardous Chemicals in Laboratories; Final Rule for additional safety information.

C. MSDSs must be reviewed for information pertaining to the proper treatment and precautionary measure prior to handling any reagents. They are located in red binders on the second floor near the copier or on the internet at http://msds.ehs.cornell.edu/msdssrch.asp

VI. INSTRUMENTATION/APPARATUS

A. Analytical balance, sensitivity to <0.1 mg. Fisher –Scientific A250. (S/N# 24276) and a set of Class S weights to calibrate it.

B. Watch glass or aluminum dish.

C. Vacuum filter flask (Pyrex 5340) approximately 2 L capacity or similar vacuum filtration unit.

D. Environmental Express Pro-Weigh Filters
   1. Volatiles 47 mm, Cat # F93447 Vol, Product Code 4056
   2. Volatiles 47 mm, Cat # F93447 MM, Product Code 4069

E. Graduated cylinders, Class A, for measuring sample volumes (25, 50, 100 mL)

F. Gelman Sciences magnetic filter, Part # 4242 funnel and support apparatus

G. Drying oven maintained at 103-105°C. Precision Vacuum Oven Model 29 (Serial # 1755, Cat # 31566-26

H. Desiccators with fresh desiccant (color indicating)
   3. Dry Keepers from SanPlatec (Sanko Plastic)
   4. Bel-Art Products Secador Dessicator

I. Glass microfibre filters 47mm ,Whatman 934-AH or equivalent.

J. Bent Tip Filter forceps , Part # HSC513-10

VII. REAGENTS AND STANDARDS

A. Celite 545 (Fisher Scientific Cat# C212-500 or equivalent)

B. LCS Solution (175mg/L) Celite 545 from Fisher Scientific (Part # C212-500). Take a piece of weighing paper and crease it down the middle. Set it within the analytical balance and tare the balance. Now weigh out 0.1750 grams of Celite 545 onto the paper, carefully depositing the white powder on the crease. Next take a 1 L graduated cylinder rated TD 1000 mL. Fill it to the 1000 mL line with DI water. Now carefully rinse the Celite along the crease in the weighing paper into a clean, dry and carefully labeled 1 L amber bottle. It is difficult and unwieldy to try to manipulate the 1L graduated cylinder in a delicate way. The analyst may, if desired, first transfer some water to a small disposable polystyrene cup and then rinse with that. Any tactic or strategy which allows the analyst to transfer all of the Celite 545 and all of the water into the 1 L amber bottle is just fine. The amber bottle contains a 175 mg/L Celite solution.

VIII. SAMPLE COLLECTION, HANDLING AND PRESERVATION

No preservation of the sample is required. Samples are stored in plastic or resistant glass bottles and refrigerated at 4°C to minimize microbiological degradation. The analysis should be performed as soon as possible to minimize changes in the solids content due to physical, chemical, and biological processes. The maximum holding time is 7 days from the date sampled. A 100 mL aliquot is used for analysis unless a large quantity of solid is apparent.

IX. CALIBRATION PROCEDURE

This procedure does not involve standards calibration; therefore the rest of this section is non-applicable. However, the balance and oven should be checked prior to use to ensure they are in good working condition and meet acceptable operational criteria. For the oven, the temperature should be checked with a NIST traceable thermometer. For the balance, the reading should be checked by a Class S weight set to an accuracy of 0.1000 g.

X. ANALYTICAL PROCEDURE

A. Preparation of Filters

1. Filters from Environmental Express have been treated, pre-weighed and labeled in unique aluminum weighing dishes. No pre-treatment is required. The unique identifier and weight must be recorded on the bench sheet next to a sample number or QC check sample.
2. If Pro-Weigh filters are unavailable, pre-treat the Whatman microfibre filters as follows: place a filter disc on the screen of a Gelman filter support apparatus and place the magnetic filter holder atop a vacuum flask. Apply a vacuum and rinse the filter with three successive 20 ml portions of DI water. Maintain the vacuum until all traces of water are removed. Discard the washings. Remove the glass fiber filter from the filtration apparatus using forceps and place it in a clean, labeled aluminum dish. Place the aluminum dish in an oven set between 103-105°C for 1 hour. Store the filters in a desiccator until needed. Weigh before using.
3. NOTE: If the sample is to be analyzed for VSS as well as TSS, the Pro-Weigh filters cannot be used, Use a glass microfibre filter that has been prepared as stated in #2 above, but place the filter in a muffle furnace at 500+50"C for a minimum of 15 minutes. Store is a desiccator before using. Environmental Express also sells microfibre filters that have been pre-treated for volatiles analysis.

B. Sample Filtration

1. Check the pH of the sample with a wide range pH strip to ensure that the sample is within the pH range required by the analysis being performed. Record the pH on the laboratory bench sheet.
2. Place the filter funnel apparatus atop the vacuum filter flask and connect the flask to the vacuum source. Remove the magnetic top of the filter unit. Using forceps, place a Pro-Weigh filter onto the filter support and seat it properly by wetting the filter

with DI water and applying a vacuum. Replace the filter funnel top. Thoroughly mix a sample by shaking the sample vigorously and measure out a 100ml aliquot using a Class A graduated cylinder. If the sample appears to be highly turbid, an appropriate smaller volume should be used. Pour this volume through the filter with the vacuum on. NOTE: If the sample is also to be analyzed for VSS, DO NOT use the Pro-Weigh filter. Use a filter prepared for VSS according to section X.A.2, and the note following, above. This also includes the blank if VSS is to be performed on any sample. Alternatively, the Environmental Express microfibre filters pre-treated for volatiles analysis may be used.

3. Rinse the graduated cylinder thoroughly with DI water to remove any loose particles adhering to the walls of the cylinder and pour this through the filter as well.
4. Rinse the filter unit and the filter with three successive 10 ml portions of DI water allowing complete drainage between rinses.
5. Continue the vacuum for about 3 minutes, or longer if necessary, until all excess water is removed.
6. Turn off the vacuum and gently remove the filter from the support using the forceps.
7. Place the filter in its aluminum weighing dish. Filter all samples, blanks and LCS in this fashion.
8. Prepare the filtration unit for another sample by rinsing the filter funnel, filter support and graduated cylinder with DI water.
9. Rinse the graduated cylinder with a small portion of the next sample before pouring in the measured aliquot.

C. Weighing the Filters

1. Place the filters in their respective aluminum pans into the 103-105°C drying oven for at least 1 hour. Note the start and end time on the bench sheet.
2. Place the pans in the desiccator until they are cooled to room temperature.
3. Weigh the filters to the nearest 0.1 mg and record the weights on the bench sheet. If more than 200 mg of residue is obtained on the filter, the sample must be re-run by filtering a smaller volume.
4. To insure proper drying, a minimum of one filter from each run must be re-weighed. Return one of the filters to the oven at 103-105°C for at least one hour. Cool the sample to room temperature in the desiccator and re-weigh. If there is a difference of more than 4% or 0.5mg (whichever is less) between the two weights, all samples in the run must be re-dried, re-weighed and this step repeated. Consequently, all filters should be returned to the desiccator following the final weighing and should be discarded only after the re-weighing of the sample has been completed. NOTE: Filters from samples to be analyzed for VSS should not be discarded until VSS has been conducted.
5. Calculate the Total Suspended Solids
6. If VSS is to be conducted, continue with the VSS procedure.

D. Quality Control Measure

1. A batch is considered to be a maximum of 20 samples.
2. A single Method Blank per batch, also known as a "filter blank", is necessary in order to determine if the process of filtering DI water through the filter introduces a significant concentration of suspended solids. Method blanks are prepared by filtering an aliquot of 50 mL of laboratory DI water through a pretreated filter, and processing the filter as any other sample. The residue must be less than 0.5mg.
3. A pair of LCS per batch are prepared by vigorously shaking the LCS solution and pouring out two separate 50 mL aliquots. These aliquots should be rapidly transferred to filter apparatus and filtered in order to minimize settling of the Celite, which will lead to low bias in the LCS results.
4. For each batch one sample is to be prepared in duplicate, and processed in the same manner as other samples. The duplicates must agree within 5% of their average (see calculation section).

XI. QUALITY CONTROL REQUIREMENTS

A. Negative Controls

1. Method blanks shall be performed at a frequency of one per batch of samples per matrix type. The results of this analysis shall be one of the QC measures to be used to assess batch acceptance. The source of contamination must be investigated and measures taken to correct, minimize or eliminate the problem
2. If the blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated sample batch, any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.
3. If the blank contamination exceeds the concentration present in the samples and is greater than 1/10 of the specified regulatory limit, any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

B. Positive Controls

1. Laboratory Control Sample (LCS) - (QC Check Samples) A pair is analyzed per batch of 20 or less samples per matrix type. The true value for the LCS is 175 mg/L with a control limit of 71 - 107% recovery. If the LCS fails, the entire batch must be reanalyzed.
2. Matrix Spikes (MS) - Matrix spikes are not performed for this analysis.
3. Matrix Spike Duplicates (MSDs) or Laboratory Duplicates - Matrix spikes are not performed for this analysis. MWH utilizes a laboratory duplicate to meet QC requirements. A laboratory duplicate shall be analyzed at a minimum of 1 in 20 samples per matrix type. The laboratory shall document their procedure to select the use of appropriate type of duplicate. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. The

relative percent difference (RPD) between two duplicates should not exceed 20%; otherwise, fill out a quality investigation report detailing the failure.

C. Contingencies for handling out of control data.
   1. Submit a Quality Investigation Report (QIR) with any data associated with failed batch or instrument QC.
   2. Details regarding use of the QIR can be found in the MWH Comprehensive Quality Assurance Plan, Chapter 11, Section 1 1.2.1.6 and Chapter 13, Sections 13.3, 13.4 and 13.5.
   3. See the MWH Comprehensive Quality Assurance Plan, Chapter 13, Section 13.5 for a list of data qualifiers and a discussion of report comments.

D. Additional Quality Control Requirement
   1. Minimum allowable residue: A minimum weight change of 1.0 mg must be obtained for each sample. If the net weight residue of a particular sample is less than 1.0 mg, then the sample must be re-prepared and analyzed using a larger sample aliquot up to a maximum of 100 mL. If the weight change using a 100 mL sample aliquot is less than 1 mg, report as "ND".
   2. Maximum allowable residue: The maximum allowable residue is 200 mg. If, upon final weighing, any sample residue is greater than 200 mg, the sample must be re-prepared and analyzed using a smaller sample aliquot.
   3. Drying Efficiency Check: With each run, a minimum of one sample must be re-dried for an additional 1 hour, again cooled in the dessicator, and then weighed again. If the difference between the initial and final weighing is greater than either 4% of the initial weight or 0.5 mg (whichever is less), then all of the samples from the run must be dried for an additional hour and weighed again.

XII. CALCULATIONS

See Attachment II

XIII. METHOD PERFORMANCE

A. Attachment I, Documentation of Demonstration of Precision and Accuracy

B. A Method Detection Limit Study is Not Applicable to this Method

C. The above Attachment (DOC) is an initial study only to demonstrate method performance. A more recent study is kept on file with the QA department and is available for review upon request.

XIV. REFERENCES

Standard Methods for the Examination of Water and Wastewater, 20th Edition, Method 2540D, 1998.

XV. DEVIATIONS FROM REFERENCED METHODOLOGY

A. MWH employs an LCS in order to monitor accuracy. Standard Methods does not require the analysis of any samples in order to evaluate accuracy.

B. Standard Methods requires the sample to pipette onto the filter. This SOP uses a class A graduated cylinder to dispense the sample onto the filter.

C. The sample is to be stirred using a magnetic stirrer. In this SOP the sample is shaken vigorously by hand and then an aliquot is immediately transferred to a graduated cylinder (Class A).

XVI. METHOD DETECTION LIMIT

(Not Applicable to this Method)

XVII. DEFINITIONS

Refer to the MWH Comprehensive Quality Assurance Plan Glossary for a complete list of terms and definitions.

XVIII. POLLUTION PREVENTION

A. Because this analysis is performed to meet United States Government and/or local regulatory requirements, reduction in volume of samples, reagents or standards is not possible. Practice pollution prevention by implementing the suggestions listed below and by carefully following the instructions in the Waste Management Section of this document.

B. Reduce disposal costs by ordering quantities of reagents and standards that will be approximately consumed by the expiration date.

C. Practice spill prevention by storing chemicals in secondary containers. Do not store incompatible chemicals in close proximity.

D. Reuse solvents for the first step in glassware cleaning if possible.

XIX. WASTE MANAGEMENT

A. Dispose all (unpreserved) samples/filtrate down the sewer. The filter paper may be disposed in the trash bin.

B. It is the responsibility of the laboratory to determine whether its wastes are hazardous and to assure safe handling and disposal. The laboratory works closely with the Treatment, Storage, Disposal Facility to ensure that certain wastes are recycled where possible, that the source of waste is reduced to the lowest possible level and that stringent land disposal restrictions are followed.

C. Refer to the following documents for additional information regarding waste management:
   1. MWH Laboratories Standard Operating Procedure for Hazwaste Management and Sample Disposal
   2. Resource Conservation and Recovery Act (RCRA)-Title 40 of the Code of Federal Regulations, Parts 260 through 270 (40 CFR 260-270)
   3. California Hazardous Waste Control Law (HWCL)-CCR Title 22 where 40 CFR was duplicated into CCR Title 22, Parts 66260-66270.

XX. REVISIONS

A. Revision 0 (04/20/97)

   The SOP written following the procedures outlined in the Standard Method 2540D and EPA 160.2 methodology.

B. Revision 1 (03/22/00)
   1. Definitions section added
   2. Safety section expanded to included references to additional resources.
   3. Pollution Prevention section added.
   4. Waste Management section added.
   5. Method Performance section added

C. Revision 2 (06/06/2000)
   1. Used bold and underline for general statements for sections that do not belong to this SOP.
   2. Deleted the SO-150% criteria for MDL study.
   3. Took out the footer.

D. Revision 3 08/27/00
   1. Added use of Pro-Weigh filters.
   2. Added note concerning use of filters prepared for VSS when samples are to be analyzed for both TSS and VSS.

3. Removed statement in DEVIATIONS section concerning the use of pre-measured sample aliquots in Standard Methods as opposed to measured aliquots after filtration. This statement is not applicable with regard to TSS.
4. Added statements concerning the use of graduated cylinders instead of pipets and hand shaking instead of stirring the sample with a magnetic stirrer in the DEVIATIONS section.

E. Revision 4 - 10/05/06
   1. Reformatted the SOP to be consistent with the MWH format. (Added SOP Unique ID, the revision date, effective/issue date, and annual review section)
   2. Section VI, Instrumentation –
      a. A, updated to include the new instrument.
      b. E, added 25mL grad cylinder
      c. Added manufacturer and Part # to C, D, F, G, H, and J.
   3. Section VII, Reagents – B, Revised to discuss the current preparation procedures for LCS solution. Added provider of Celite 545.
   4. Section X, Analytical Procedures –
      a. A.2, updated the Note to state "Environmental Express also sells microfibre filters that have been pre-treated for volatiles analysis."
      b. B.2 – Updated Note to state "Alternatively, the Environmental Express microfibre filters pre-treated for volatiles analysis may be used."
   5. Section XII, Calculations – Moved to Attachment II
   6. Section XIII, Method Performance – Deleted Attachment III, Control Charts.
   7. Section XXI, Attachments – Deleted MDLs and Control charts. Added Attachment II, Calculations

F. Revision 5.0 (06/06/07)
   1. Updated LCS limits to 71 -107% from 80 – 120%
   2. Removed reference to 160.2

XXI. ATTACHMENTS

A. Attachment I, Documentation of Demonstration of Precision and Accuracy

B. Attachment II, Calculations

C. Attachment III, Laboratory Bench Sheet

Attachment I, Documentation of Demonstration of Precision and Accuracy

Instrument Code: INOT1
Date Reported: 03/04/08
Method: ML/EPA 160.2
Units: mg/L
Group#: 143389

	Actual	DOC1	DOC2	DOC3	DOC4	Avg	%Rcvy	Stdv	%RSD
Preparation Date		NA	NA	NA	NA				
Preparation Analyst		NA	NA	NA	NA				
Analytical Date		02/23	02/23	02/23	02/23				
Analyst		esm	esm	esm	esm				
Total Suspended Solids :	175	172	170	174	178	173.500	99.1	3.416	2.0

Attachment II, Calculations

A. TSS (mg/L)

$$\text{TDS} = \frac{(B-A)}{C} \times 1{,}000{,}000$$

Where: A = initial (tare) weight of filter (g)
B = weight of dried residue + weight of filter (g)
C = sample volume (ml)

Report TSS data as follows:

Result (mg/L)	**Report to nearest**
10 – 99	1 mg/L (2 significant figures)
100 – 9999	10 mg/L (2-3 significant figures)
≥10000	100 mg/L (3 significant figures)

B. Calculation of Percentage regarding Duplicates

$$(V1 + V2)/2 = \text{Average}$$

$$\frac{|V1 - \text{Average}|}{\text{Average}} * 100 = \text{percent difference}$$

Where: V1 = first sample value in mg/L
V2 = duplicate sample value in mg/L

NOTE: where percent difference is calculated, V2 is substituted for V1 to confirm percent difference of second sample.

C. Drying Efficiency

$$\%\,D = \frac{\text{Initial weight - final weight}}{\text{Initial weight}} \times 100$$

Attachment III, Laboratory Bench Sheet

BATCH NUMBER:

MWH Laboratories
750 Royal Oaks Drive, Suite 100
Monrovia, CA 91016-3629

Page

TOTAL SUSPENDED SOLIDS (TSS) MW SOP REVISION 1
TSS: SM 2540D SOP Revision #4

Analysis Date Start: ________ Time: ________
Analysis Date End: ________
Analyst: ________
Reviewed By: ________
LIMS Check By: ________

Oven Temp (104° ±1 °C) Start ____ C End ____ C

Dry time: ____ hours

LCS MW# ________
Exp Date: ________ 175 mg/L
LCS MW# ________
Exp Date: ________ 10 mg/L

Was QC Criteria Met? Y N
Was QIR Needed? Y N

Form: 00-04-02 Rev3

Run #	Sample ID	Client Name	Date Collected	Sample Volume (ml)	Filter ID	Filter Weight (g)	Filter + residue (g)	Residue (g)	TSS (mg/L)	pH	Comments
Blk	Blank	N/A	N/A	50						N/A	< 0.5 mg
MRL	MRL 1 - 10 mg/L	N/A	N/A	100						N/A	Rec. 50-150%
MRL	MRL 2 - 10 mg/L	N/A	N/A	100						N/A	Rec. 50-150%
LCS	LCS 1 - 175 mg/L	N/A	N/A	50						N/A	Rec. 80-120%
LCS	LCS 2 - 175 mg/L	N/A	N/A	50						N/A	Rec. 80-120%
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Dup											RPD < 10%
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
Dup											RPD < 10%

MRL 10 mg/L
Min/Max Residue 0.5mg - 200 mg

Holding time 7 day from sampling date

Drying Efficiency
< 1% or 0.5 mg

Sample ID: ________
Initial Wt (g) ________
Final Wt (g) ________
% change ________

% change = (Init-Fin) x 100 / Init

Calculation:
TSS (mg/L) = (C-A) * 1,000,000 / B

%RPD = (S1-S2) * 100 / (S1+S2)/2

A = Filter wt (g)
B = Sample Vol (ml)
C = Filter+residue (g)

S1 = TSS of sample
S2 = TSS of duplicate

Chromium, Hexavalent

✭Method 8023

1,5-Diphenylcarbohydrazide Method[1]

Powder Pillows or AccuVac® Ampuls

(0.010 to 0.700 mg/L Cr^{6+})

Scope and Application: For water and wastewater;
USEPA accepted for reporting for wastewater analysis[2]

[1] Adapted from *Standard Methods for the Examination of Water and Wastewater*.

[2] Procedure is equivalent to USGS method 1-1230-85 for wastewater.

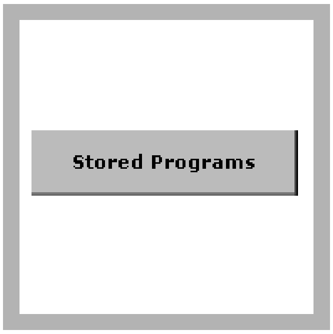
Test Preparation

Before starting the test:
For more accurate results, determine a reagent blank value for each new lot of reagent. Follow the procedure using deionized water instead of the sample.
At high chromium levels, a precipitate will form. Sample dilution may be necessary.
The final samples are highly acidic. Neutralize to pH 6–9 with Sodium Hydroxide Standard Solution and refer to reagent MSDS sheets for disposal information.

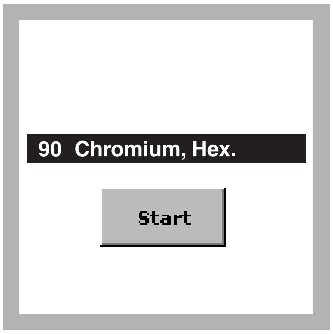
Collect the following items:	Quantity
Powder Pillow Test:	
ChromaVer® 3 Chromium Reagent Powder Pillows	1
Sample cells, 1-in. square, 10-mL	2
AccuVac Test:	
Collect at least 40 mL of sample in a 50-mL beaker	40 mL
ChromaVer® 3 AccuVac® Ampuls	1
Beaker, 50-mL (AccuVac test)	1
Sample cell, 10-mL round, with cap	1

***Note:** Reorder information for consumables and replacement items is on page 6.*

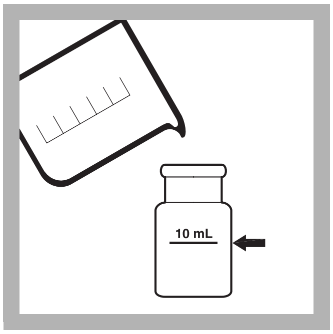
Powder Pillows Method 8023



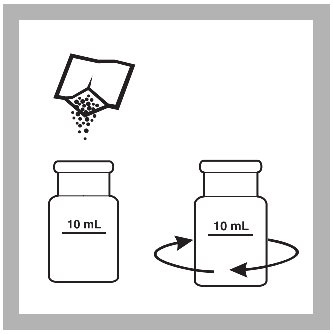
1. Press **STORED PROGRAMS**.



2. Select the test.



3. Fill a square sample cell with 10 mL of sample.

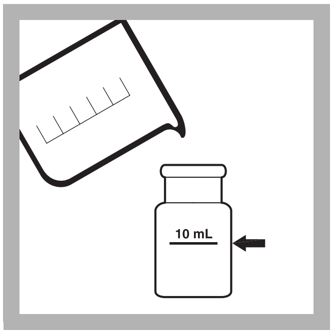


4. Prepared Sample: Add the contents of one ChromaVer® 3 Reagent Powder Pillow to the sample cell. Swirl to mix.

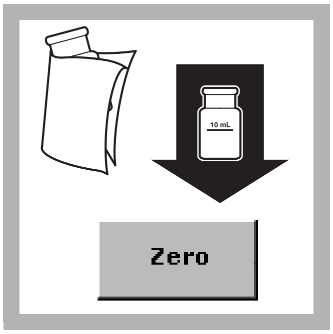
A purple color will form if hexavalent chromium is present.

5. Press **TIMER>OK**.

A five-minute reaction period will begin.



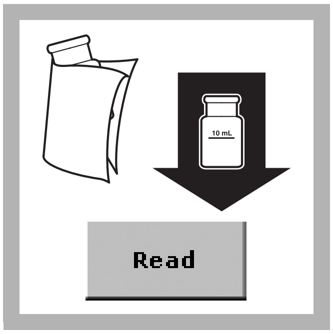
6. Blank Preparation: Fill a second square sample cell with 10 mL of sample.



7. When the timer expires, insert the blank into the cell holder with the fill line facing right.

Press **ZERO**. The display will show:

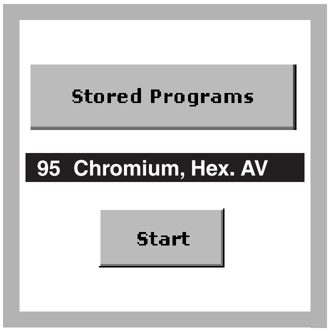
0.000 mg/L Cr^{6+}



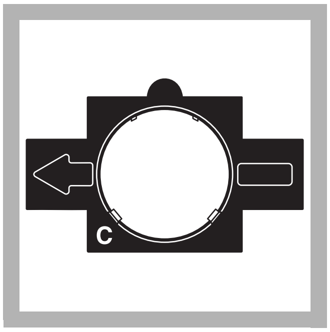
8. Insert the prepared sample into the cell holder with the fill line facing right.

Press **READ**. Results are in mg/L Cr^{6+}.

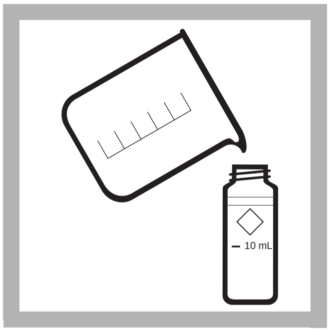
AccuVac Ampul® Method 8023



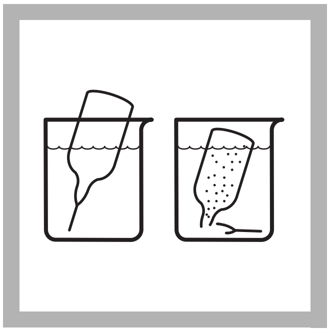
1. Select the test.



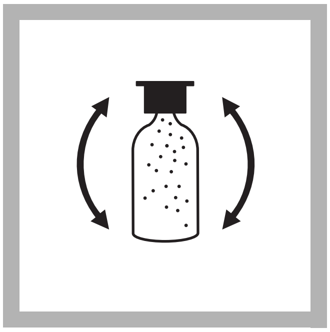
2. Insert Adapter C.



3. Blank Preparation: Fill a round sample cell with 10-mL of sample.



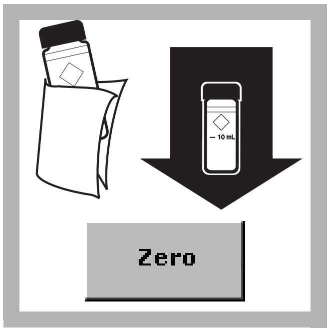
4. Prepared Sample: Fill a ChromaVer 3 Reagent AccuVac® Ampul with sample from the beaker. Keep the tip immersed while the Ampul fills completely.



5. Quickly invert the Ampul several times to mix. Wipe off any liquid or fingerprints.

6. Press **TIMER>OK**.

A five-minute reaction period will begin.



7. When the timer expires, insert the blank into the cell holder.

Press **ZERO**. The display will show:

0.000 mg/L Cr^{6+}

8. Insert the prepared sample into the cell holder.

Press **READ**. Results are in mg/L Cr^{6+}.

Interferences

Table 1 Interfering Substances and Levels

Interfering Substance	Interference Levels and Treatments
Iron	May interfere above 1 mg/L
Mercurous & Mercuric Ions	Interfere slightly
pH	Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment.
Vanadium	May interfere above 1 mg/L. Allow 10 minutes for the reaction period before reading.
Turbidity	For turbid samples, treat the blank with the contents of one Acid Reagent Powder Pillow[1]. This will ensure that any turbidity dissolved by the acid in the ChromaVer 3 Chromium Reagent will also be dissolved in the blank.

[1] See Optional Reagents and Apparatus on page 6

Sample Collection, Preservation, and Storage

Collect samples in a cleaned glass or plastic container. Store at 4 °C (39 °F) up to 24 hours. Samples must be analyzed within 24 hours.

Accuracy Check

Standard Additions Method (Sample Spike)

1. After reading test results, leave the sample cell, or AccuVac Ampul (unspiked sample) in the instrument. Verify the chemical form.
2. Press **OPTIONS>MORE**. Press **STANDARD ADDITIONS**. A summary of the standard additions procedure will appear.
3. Press **OK** to accept the default values for standard concentration, sample volume, and spike volumes. Press **EDIT** to change these values. After values are accepted, the unspiked sample reading will appear in the top row. See the user manual for more information.
4. Snap the neck off a Chromium Voluette® Ampule Standard, 12.5 mg/L Cr^{6+}.
5. For analysis using powder pillows, use the TenSette® Pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively to three 25-mL samples and mix thoroughly. Transfer 10 mL of each solution into a 10-mL sample cell and analyze as described above.

***Note:** For AccuVac Ampuls, fill three mixing cylinders* with 50-mL of sample and spike with 0.2 mL, 0.4 mL, and 0.6 mL of standard. Transfer 40 mL from each of the three mixing cylinders to three 50-mL beakers. Analyze each standard addition sample as described in the procedure above.*

6. Accept each standard additions reading by pressing **READ**. Each addition should reflect approximately 100% recovery.
7. After completing the sequence, press **GRAPH** to view the best-fit line through the standard additions data points, accounting for matrix interferences. Press **IDEAL LINE** to view relationships between the sample spikes and the “Ideal Line” of 100% recovery.

---

*See Optional Reagents and Apparatus on page 6.

Standard Solution Method

Prepare a 0.50-mg/L Cr^{6+} standard solution daily, as follows:

1. Using a 5.00 mL pipet transfer 5.00 mL of Hexavalent Chromium Standard Solution, 50 mg/L, into a Class A 500-mL volumetric flask.
2. Perform the hexavalent chromium procedure as described above.
3. Dilute to the mark with deionized water. Perform the test procedure as described above.
4. To adjust the calibration curve using the reading obtained with the standard solution, press **OPTIONS>MORE** on the current program menu. Press **STANDARD ADJUST**.
5. Press **ON**. Press **ADJUST** to accept the displayed concentration. If an alternate concentration is used, press the number in the box to enter the actual concentration, then press **OK**. Press **ADJUST**.

Summary of Method

Hexavalent chromium is determined by the 1,5-Diphenylcarbohydrazide method using a single dry powder formulation called ChromaVer 3 Chromium Reagent. This reagent contains an acidic buffer combined with 1,5-Diphenylcarbohydrazide, which reacts to give a purple color when hexavalent chromium is present. Test results are measured at 540 nm.

Consumables and Replacement Items

Required Reagents

Description	Quantity/Test	Unit	Cat. No.
ChromaVer® 3 Chromium Reagent Powder Pillows	1	100/pkg	12710-99
OR			
ChromaVer® 3 AccuVac® Ampuls	1	25/pkg	25050-25
Deionized Water	varies	4 L	272-56

Required Apparatus (Powder Pillows)

Description	Quantity/Test	Unit	Cat. No.
Sample Cells, 1-inch square, 10 mL, matched pair	2	2/pkg	24954-02

Required Apparatus (AccuVac)

Description	Quantity/Test	Unit	Cat. No.
Adapter, 1-inch round, for AccuVac Ampuls	1	each	LZV584
Beaker, 50-mL	1	each	500-41H
Sample Cell, 10-mL, with cap	1	each	21228-00

Recommended Standards

Description	Unit	Cat. No.
Chromium, Hexavalent Standard Solution, 10-mL Voluette® Ampules, 12.5-mg/L Cr^{6+}	16/pkg	14256-10
Chromium, Hexavalent Standard Solution, Chromium, Standard Solution, 50.0-mg/L Cr^{6+}	100 mL	810-42H

Optional Reagents and Apparatus

Description	Cat. No.
Acid Reagent Powder Pillow	2126-99
Flask, volumetric, Class A, 500-mL	14574-49
Pipet, 5.00 mL	14515-37
Sodium Hydroxide Standard Solution	2450-26

FOR TECHNICAL ASSISTANCE, PRICE INFORMATION AND ORDERING:
In the U.S.A. – **Call toll-free 800-227-4224**
Outside the U.S.A. – **Contact the HACH office or distributor serving you.**
On the Worldwide Web – **www.hach.com**; E-mail – **techhelp@hach.com**

HACH COMPANY
WORLD HEADQUARTERS
Telephone: (970) 669-3050
FAX: (970) 669-2932

Updated November 2005 Edition 1

Iron, Total

✭Method 8008

Powder Pillows or AccuVac® Ampuls

FerroVer® Method[1]

(0.02 to 3.00 mg/L)

Scope and Application: For water, wastewater, and seawater; digestion is required for determining total iron; USEPA approved for reporting wastewater analysis[2]

[1] Adapted from *Standard Methods for the Examination of Water and Wastewater*

[2] *Federal Register*, June 27, 1980; 45 (126:43459)

Test Preparation

Before starting the test:

Digestion is required for determining total iron for EPA reporting purposes.
For more accurate results, determine a reagent blank value for each new lot of reagent. Follow the procedure using deionized water in place of the sample. Subtract the reagent blank value from the final results or perform a reagent blank adjust. See the user manual for more information.

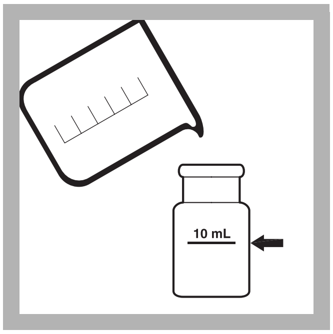
Collect the following items:	Quantity
Powder Pillow Test:	
FerroVer® Iron Reagent Powder Pillow	1
Sample Cells,1-inch square, 10 mL	2
Beaker, 50-mL	1
FerroVer® Iron Reagent AccuVac® Ampul	
Beaker, 50-mL	1
Sample Cells, 10-mL, with cap	1

Note: *Reorder information for consumables and replacement items is on page 6.*

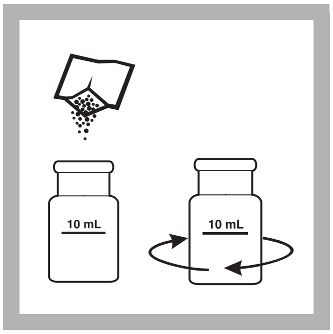
Powder Pillows — Method 8008

1. Press **STORED PROGRAMS**.

2. Select the test.



3. **Prepared Sample:** Fill a clean square sample cell with 10 mL of sample.



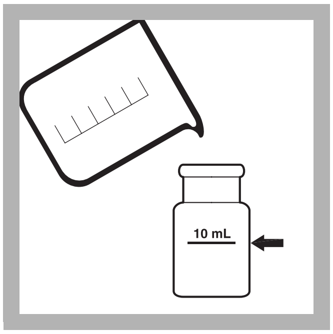
4. Add the contents of one FerroVer Iron Reagent Powder Pillow to the sample cell. Swirl to mix.

An orange color will form, if iron is present

5. Press **TIMER**>**OK**.

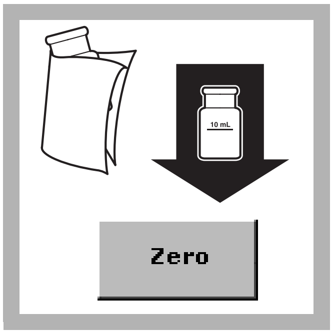
A three-minute reaction period will begin.

(Allow samples that contain rust to react for at least 5 minutes.)



6. Blank Preparation:

Fill a second square sample cell with 10 mL of sample.

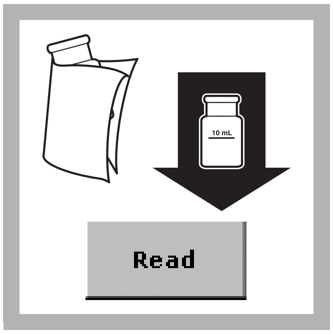


7. When the timer expires, insert the blank into the cell holder with the fill line facing right.

Press **ZERO**.

The display will show:

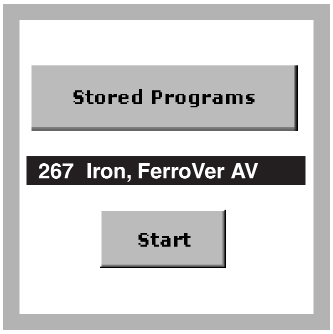
0.00 mg/L Fe



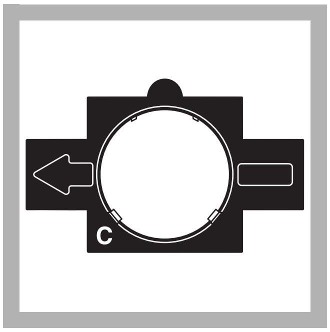
8. Place the prepared sample into the cell holder with the fill line facing right.

Press **READ**. Results are in mg/L Fe.

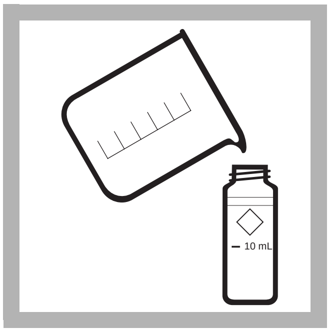
AccuVac Ampul — Method 8008



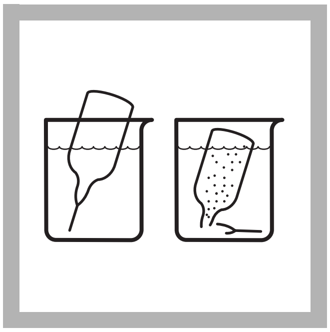
1. Select the test.



2. Insert Adapter C.



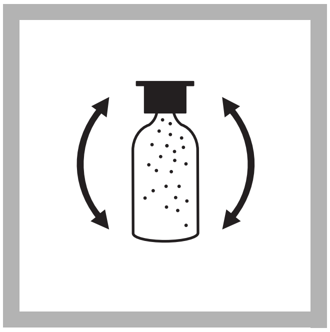
3. Blank Preparation: Fill a round sample cell with 10 mL of sample.



4. Prepared Sample: Collect at least 40 mL of sample in a 50-mL beaker.

Fill a FerroVer Iron AccuVac® Ampul with sample.

Keep the tip immersed while the Ampul fills completely.



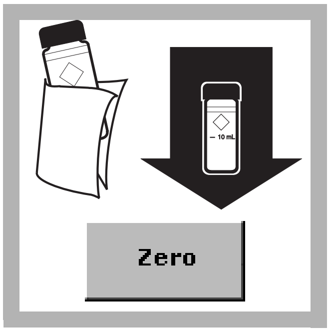
5. Quickly invert the Ampul several times to mix.

Wipe off all liquid and fingerprints.

6. Press **TIMER**>**OK**.

A three-minute reaction period will begin.

(Allow samples that contain rust to react for at least 5 minutes.)



7. When the timer expires, insert the blank into the cell holder.

Press **ZERO**.

The display will show:

0.00 mg/L Fe

8. Insert the AccuVac Ampul into the cell holder.

Press **READ**. Results are in mg/L Fe.

Interferences

Table 1 Interfering Substances and Levels

Interfering Substance	**Interference Levels and Treatments**
Calcium, Ca^{2+}	No effect at less than 10,000 mg/L as $CaCO_3$.
Chloride, Cl^{-}	No effect at less than 185,000 mg/L.
Copper, Cu^{2+}	No effect. Masking agent is contained in FerroVer Reagent.
High Iron Levels	Inhibit color development. Dilute sample and re-test to verify results.
Iron Oxide	Requires mild, vigorous or Digesdahl digestion. After digestion, adjust sample to pH 3–5 with sodium hydroxide, then analyze.
Magnesium	No effect at 100,000 mg/L as calcium carbonate.
Molybdate Molybdenum	No effect at 50 mg/L as Mo.
High Sulfide Levels, S^{2-}	**1.** Treat in fume hood or well-ventilated area. Add 5 mL hydrochloric acid[1], ACS to 100 mL sample in a 250-mL Erlenmeyer flask. Boil 20 minutes. **2.** Cool. Adjust pH to 3–5 with Sodium Hydroxide[1]. Readjust volume to 100 mL with deionized water. **3.** Analyze.
Turbidity	**1.** Add 0.1 g scoop of RoVer® Rust Remover to the blank. Swirl to mix. **2.** Zero the instrument with this blank. **3.** If sample remains turbid, add three 0.2 g scoops of RoVer to a 75-mL sample. Let stand 5 minutes. **4.** Filter through a Glass Membrane Filter and Filter Holder[1]. **5.** Use filtered sample in steps 6 and 3.
Extreme Sample pH	Adjust pH to 3–5.
Highly Buffered Samples	Adjust pH to 3–5.

[1] See Optional Reagents and Apparatus on page 6.

Sample Collection, Storage, and Preservation

Collect samples in acid-cleaned glass or plastic containers. No acid addition is necessary if analyzing the sample immediately. To preserve samples, adjust the pH to 2 or less with concentrated nitric acid (about 2 mL per liter). Preserved samples may be stored up to six months at room temperature. Before analysis, adjust the pH to between 3 and 5 with 5.0 N Sodium Hydroxide Standard Solution. Correct the test result for volume additions.

If only dissolved iron is to be determined, filter the sample before acid addition.

Accuracy Check

Standard Additions Method (Sample Spike)

1. After reading test results, leave the sample cell (unspiked sample) in the instrument.
2. Press **OPTIONS>MORE**. Press **STANDARD ADDITIONS**. A summary of the standard additions procedure will appear.
3. Press **OK** to accept the default values for standard concentration, sample volume, and spike volumes. Press **EDIT** to change these values. After values are accepted, the unspiked sample reading will appear in the top row. See the user manual for more information.
4. Snap the neck off an Iron Voluette Ampule Standard, 25-mg/L.
5. Prepare a 0.1 mL sample spike by adding 0.1 mL of standard to the unspiked sample. Press the timer icon. After the timer expires, read the result.
6. Prepare a 0.2 mL sample spike by adding 0.1 mL of standard to the 0.1 mL sample spike. Press the timer icon. After the timer expires, read the result.
7. Prepare a 0.3 mL sample spike by adding 0.1 mL of standard to the 0.2 mL sample spike. Press the timer icon. After the timer expires, read the result. Each addition should reflect approximately 100% recovery.

***Note:** For AccuVac® Ampuls, fill three mixing cylinders* with 50-mL of sample and spike with 0.2 mL, 0.4 mL, and 0.6 mL of standard. Transfer 40 mL from each of the three mixing cylinders to three 50-mL beakers*. Analyze each standard addition sample as described in the procedure above. Accept each standard additions reading by pressing **READ**. Each addition should reflect approximately 100% recovery.*

8. After completing the sequence, press **GRAPH** to view the best-fit line through the standard additions data points, accounting for matrix interferences. Press **IDEAL LINE** to view relationships between the sample spikes and the “Ideal Line” of 100% recovery.

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* See Optional Reagents and Apparatus on page 6.

Standard Solution Method

1. Prepare a 2.00-mg/L Fe standard solution by pipetting 2.00 mL of Iron Standard Solution, 100-mg/L, into a 100-mL volumetric flask. Dilute to the mark with deionized water. Stopper and invert to mix. Prepare this solution daily. Perform the iron procedure as described above.
2. To adjust the calibration curve using the reading obtained with the standard solution, press **OPTIONS>MORE** on the current program menu. Press **STANDARD ADJUST**.
3. Press **ON**. Press **ADJUST** to accept the displayed concentration. If an alternate concentration is used, press the number in the box to enter the actual concentration, then press **OK**. Press **ADJUST**.

Summary of Method

FerroVer Iron Reagent converts all soluble iron and most insoluble forms of iron in the sample to soluble ferrous iron. The ferrous iron reacts with the 1,10 phenanthroline indicator in the reagent to form an orange color in proportion to the iron concentration. Test results are measured at 510 nm.

Consumables and Replacement Items

Required Reagents

Description	Quantity/Test	Unit	Cat. No.
FerroVer® Iron Reagent Powder Pillows (for 10-mL sample)	1	100/pkg	21057-69
OR			
FerroVer® Iron Reagent AccuVac® Ampuls	1	25/pkg	25070-25

Required Apparatus (Powder Pillows)

Description	Quantity/Test	Unit	Cat. No.
Sample Cells, 1-inch square, 10 mL, matched pair	2	2/pkg	24954-02

Required Apparatus (AccuVacs)

Description	Quantity/Test	Unit	Cat. No.
Adapter, 1-inch round, for AccuVac Ampuls	1	each	LZV584
Beaker, 50-mL	1	each	500-41H
Sample Cells, 10-mL, with cap	1	each	21228-00

Recommended Standards and Apparatus

Description	Unit	Cat. No.
Iron Standard Solution, 100-mg/L	100 mL	14175-42
Iron Standard Solution, 10-mL Voluette® Ampule, 25-mg/L as Fe	16/pkg	14253-10
Metals Drinking Water Standard, LR for Cu, Fe, Mn	500 mL	28337-49
Metals Drinking Water Standard, HR for Cu, Fe, Mn	500 mL	28336-49
Water, deionized	4 L	272-56
Pipet, TenSette, 0.1–1.0 mL	each	19700-01
Pipet Tips, for TenSette Pipet 19700-01	50/pkg	21856-96
Pipet Tips, for TenSette Pipet 19700-01	1000/pkg	21856-28
Flask, volumetric, Class A, 100 mL	each	14574-42
Pipet, volumetric, Class A, 2.00 mL	each	14515-36
Pipet Filler, safety bulb	each	14651-00

Optional Reagents and Apparatus

Description	Cat. No.
Beaker, 50-mL	500-41H
Cylinder, mixing	1896-41
Hydrochloric Acid, concentrated	134-49
Nitric Acid, concentrated	152-49
Sodium Hydroxide Standard Solution, 5.0 N	2450-32
Glass Membrane Filter	2530-00
Glass Membrane Filter Holder	2340-00

Updated November 2005 Edition 1

Iron, Ferrous

Method 8146

1, 10 Phenanthroline Method[1]

Powder Pillows or AccuVac® Ampuls

(0.02 to 3.00 mg/L)

Scope and Application: For water, wastewater, and seawater

[1] Adapted from *Standard Methods for the Examination of Water and Wastewater*, 15th ed. 201 (1980)

Test Preparation

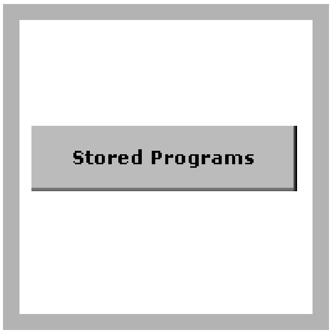
Before starting the test:

For more accurate results, determine a reagent blank value for each new lot of reagent. Follow the procedure using deionized water instead of the sample. Subtract the reagent blank value from the final results or perform a reagent blank adjust.
Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric iron, which is not determined.
If ferrous iron is present, an orange color will form after adding the reagent.

Collect the following items:	**Quantity**
Powder Pillow Test:	
Ferrous Iron Reagent Powder Pillows	1
Sample Cells, 1-inch square, 10-mL	2
AccuVac Test:	
Ferrous Iron Reagent AccuVac® Ampuls	1
Beaker, 50-mL (AccuVac test)	1
Sample Cell, 10-mL	1

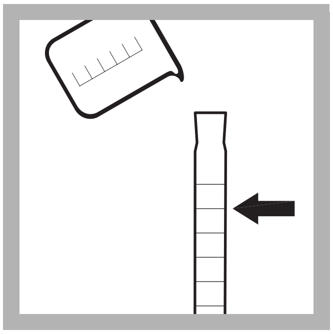
***Note:** Reorder information for consumables and replacement items is on page 5.*

Powder Pillows Method 8146

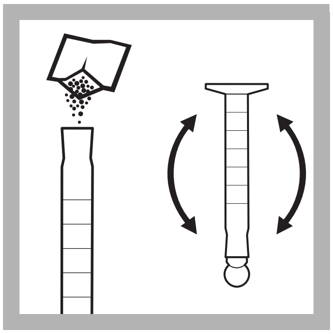


1. Press **STORED PROGRAMS**.

2. Select the test.



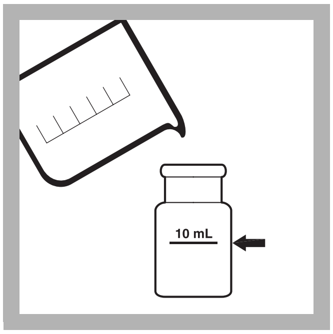
3. Fill a clean, mixed graduated cylinder with 25 mL of sample.



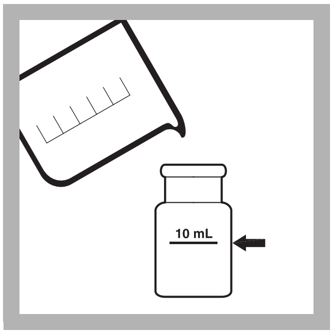
4. Prepared Sample: Add the contents of one Ferrous Iron Reagent Powder Pillow to the cylinder. Stopper and invert to mix.

5. Press **TIMER>OK**.

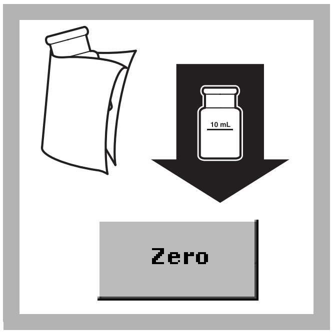
A three-minute reaction period will begin.



6. Blank Preparation: Fill a square cell with 10 mL of sample.



7. Fill a second square sample cell with the prepared sample from the mixing cylinder.

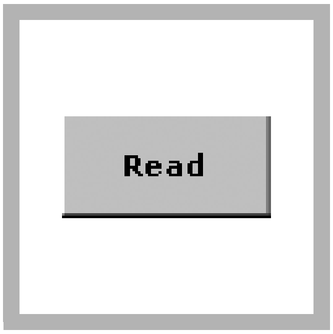


8. When the timer expires, insert the blank into the cell holder with the fill line facing right.

Press **ZERO**. The display will show:

0.00 mg/L Fe^{2+}

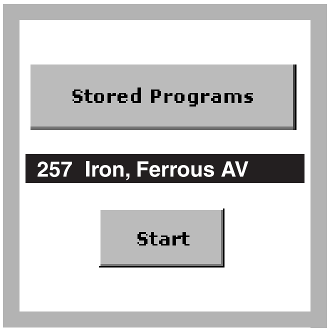
9. Insert the prepared sample into the cell holder with the fill line facing right.



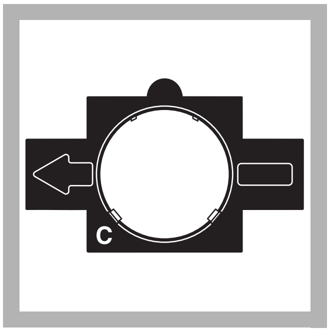
10. Press **READ**.

Results are in mg/L Fe^{2+}.

AccuVac Ampul Method 8146

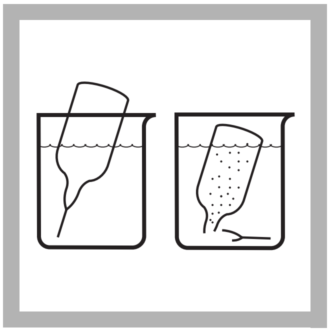


1. Select the test.



2. Insert Adapter C.

3. Blank Preparation: Fill a round sample cell with 10 mL of sample.

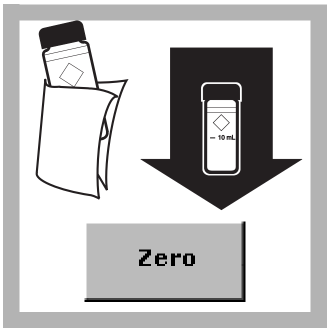


4. Prepared Sample: Collect at least 40 mL of sample in a 50-mL beaker. Fill a Ferrous Iron AccuVac® Ampul with sample. Keep the tip immersed while the Ampul fills completely.

5. Quickly invert the Ampul several times to mix.

6. Press **TIMER>OK**.

A three-minute reaction period will begin.



7. When the timer expires, insert the blank into the cell holder.

Press **ZERO**.

The display will show:

0.00 mg/L Fe^{2+}

8. Insert the AccuVac Ampul into the cell holder.

Press **READ**. Results are in mg/L Fe^{2+}.

Sample Collection, Storage, and Preservation

Collect samples in plastic or glass bottles. Analyze samples as soon as possible after collection.

Accuracy Check

Standard Solution Method

1. Prepare a ferrous iron stock solution (100-mg/L Fe^{2+}) by dissolving 0.7022 grams of Ferrous Ammonium Sulfate, hexahydrate, in deionized water. Dilute to one liter in a Class A volumetric flask. In a 100-mL Class A volumetric flask, dilute 2.00 mL of this solution to 100 mL with deionized water to make a 2.0-mg/L standard solution. Prepare this solution immediately before use. Perform the iron procedure as described above.

2. To adjust the calibration curve using the reading obtained with the standard solution, press **OPTIONS>MORE** on the current program menu. Press **STANDARD ADJUST**.

3. Press **ON**. Press **ADJUST** to accept the displayed concentration. If an alternate concentration is used, press the number in the box to enter the actual concentration, then press **OK**. Press **ADJUST**.

Summary of Method

The 1,10 phenanthroline indicator in the Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not react. The ferric iron (Fe^{3+}) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test. Test results are measured at 510 nm.

Consumables and Replacement Items

Required Reagents

Description	Quantity/Test	Unit	Cat. No.
Ferrous Iron Reagent Powder Pillows	1	100/pkg	1037-69
OR			
Ferrous Iron Reagent AccuVac® Ampuls	1	25/pkg	25140-25

Required Apparatus (Powder Pillows)

Description	Quantity/Test	Unit	Cat. No.
Sample Cells, 1-inch square, 10 mL, matched pair	2	2/pkg	24954-02

Required Apparatus (AccuVac)

Description	Quantity/Test	Unit	Cat. No.
Adapter, 1-inch round, for AccuVac Ampuls	1	each	LZV584
Beaker, 50-mL	1	each	500-41H
Sample Cell, 10-mL, with cap	1	each	21228-00

Recommended Standards

Description	Unit	Cat. No.
Balance, analytical	each	28014-01
Ferrous Ammonium Sulfate, hexahydrate, ACS	113 g	11256-14
Flask, volumetric, 1000 mL	each	14574-53
Pipet Bulb	each	14651-00
Pipet, volumetric, 2.00 mL	each	14515-35
Water, deionized	4 L	272-56

FOR TECHNICAL ASSISTANCE, PRICE INFORMATION AND ORDERING:
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On the Worldwide Web – **www.hach.com**; E-mail – **techhelp@hach.com**

HACH COMPANY
WORLD HEADQUARTERS
Telephone: (970) 669-3050
FAX: (970) 669-2932

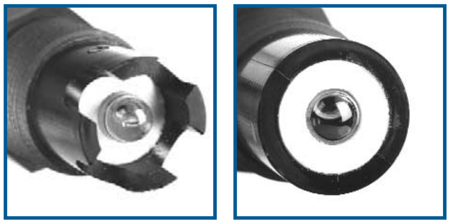
Updated November 2005 Edition 1

DATA SHEET

3/4-inch Combination pH and ORP Sensor Kits

pH/ORP

Use the Digital Gateway to make any Hach analog combination pH or ORP sensor compatible with the Hach sc100 Controller.



Digital combination pH and ORP sensors are available in convertible, insertion, and sanitary mounting styles. Choose from rugged dome electrodes or "easy-to-clean" flat glass electrodes.

DW
WW
PW
IW

Features and Benefits

Low Price—High Performance

These combination sensors are designed for specialty applications for immersion or in-line mounting. The reference cell features a double-junction design for extended service life, and a built-in solution ground. The body is molded from chemically-resistant Ryton® or PVDF, and the reference junction is coaxial porous Teflon®. All sensors are rated 0 to 105°C up to 100 psig, and have integral 4.5 m (15 ft.) cables with tinned leads. The PC-series (for pH) and RC-series (for ORP) combination sensors are ideal for measuring mild and aggressive media.

Special Electrode Configurations

Sensors with rugged dome electrodes, "easy-to-clean" flat glass electrodes, and even HF (hydrofluoric acid) resistant glass electrodes are available for a wide variety of process solutions.

Temperature Compensation Element Option

The PC-series combination pH sensors are available with or without a Pt 1000 ohm RTD temperature element. The RC-series combination ORP sensors are supplied without a temperature element.

Versatile Mounting Styles

Sensors are available in three mounting styles—convertible, insertion, and sanitary. Please turn to page 3 for more information.

Full Featured "Plug and Play" sc100 Digital Controller

There's no complicated wiring or set up procedures with the Hach sc100 controller. Just plug in any Hach digital sensor and it's ready to use—it's "plug and play."

One or two sensors—Use the sc100 Digital Controller to receive data from up to two Hach digital sensors in any combination.

Communications—Multiple alarm/control schemes are available using three relays and two PID control outputs. Communications use analog 4-20 mA and digital MODBUS®/RS485, MODBUS®/RS232 protocols. (Other digital protocols are available. Contact your Hach representative for details.) Every sc100 controller is equipped with wireless communication through an infrared port.

Data logger—A built-in data logger collects measurement data, calibration, verification points, and alarm history for up to 6 months.

DW = drinking water WW = wastewater municipal PW = pure water / power
IW = industrial water E = environmental C = collections FB = food and beverage

HACH®

Be Right™

Specifications*

Most pH applications fall in the 2.5-12.5 pH range. General purpose pH glass electrodes perform well in this range. Some industrial applications require accurate measurements and control at pH values below 2 or above 12. Consult Hach Technical Support for details on these applications.

Combination pH Sensors

Measuring Range

0 to 14 pH

Accuracy

Less than 0.1 pH under reference conditions

Temperature Range

0 to 105°C (32 to 221°F)

Flow Rate

0 to 2 m/s (0 to 6.6 ft./s); non-abrasive

Pressure Range

0 to 6.9 bar at 100°C (0 to 100 psig at 212°F)

Signal Transmission Distance

100 m (328 ft.) when used with the Hach Digital Gateway and sc100 Controller.

1000 m (3280 ft.) when used with the Hach Digital Gateway, Termination Box, and sc100 Controller.

Sensor Cable

Integral coaxial cable (plus two conductors for temperature compensator option); 4.5 m (15 ft.) long

Wetted Materials

Convertible style: Ryton® body (glass filled)

Insertion style: PVDF body (Kynar®)

Sanitary style: 316 stainless steel sleeved PVDF body

Common materials for all sensor styles include PTFE Teflon double junction, glass process electrode, and Viton® O-rings

Combination ORP Sensors

Measuring Range

-2000 to +2000 millivolts

Accuracy

Limited to calibration solution accuracy (± 20 mV)

Temperature Range

0 to 105°C (32 to 221°F)

Flow Rate

0 to 2 m/s (0 to 6.6 ft./s); non-abrasive

Pressure Range

0 to 6.9 bar at 100°C (0 to 100 psig at 212°F)

Signal Transmission Distance

100 m (328 ft.) when used with the Hach Digital Gateway and sc100 Controller.

1000 m (3280 ft.) when used with the Hach Digital Gateway, Termination Box, and sc100 Controller.

Sensor Cable

Integral coaxial cable; 4.5 m (15 ft.) long; terminated with stripped and tinned wires

Wetted Materials

Convertible style: Ryton® body (glass filled)

Insertion style: PVDF body (Kynar®)

Common materials for all sensor styles include PTFE Teflon double junction, glass with platinum process electrode, and Viton® O-rings

**Specifications subject to change without notice.*

Ryton® is a registered trademark of Phillips 66 Co.; Viton® is a registered trademark of E.I. DuPont de Nemours + Co.; Kynar® is a registered trademark of Pennwalt Corp.

Engineering Specifications

1. The pH sensor shall be available in convertible, insertion or sanitary styles. The ORP sensor shall be available in only convertible or insertion styles.
2. The convertible style sensor shall have a Ryton® body. The insertion style sensor shall have a PVDF body. The sanitary style sensor shall have a 316 stainless steel sleeved PVDF body. Common materials for all sensor styles shall include a PTFE Teflon® double junction, and Viton® O-rings. The pH sensor shall have a glass pH electrode. The ORP sensor shall have a platinum ORP electrode.
3. The convertible style pH sensor shall be available with or without a built-in Pt 1000 ohm RTD temperature element. Insertion and sanitary style pH sensors shall have a built-in Pt 1000 ohm RTD temperature element. Convertible and insertion style ORP sensors shall not have a built-in temperature element.
4. The sensor shall communicate via MODBUS® RS-485 to a Hach Model sc100 Controller.
5. The sensor shall be Hach Company Model PC sc or PC-series for pH measurement or Model PC sc or RC-series for ORP measurement.

Dimensions

Convertible Style Sensor

The convertible style sensor has a Ryton® body that features 3/4-inch NPT threads on both ends. The sensor can be directly mounted into a standard 3/4-inch pipe tee for flow-through mounting or fastened onto the end of a pipe for immersion mounting. The convertible style sensor enables inventory consolidation, thereby reducing associated costs. Mounting tees and immersion mounting hardware are offered in a variety of materials to suit application requirements.

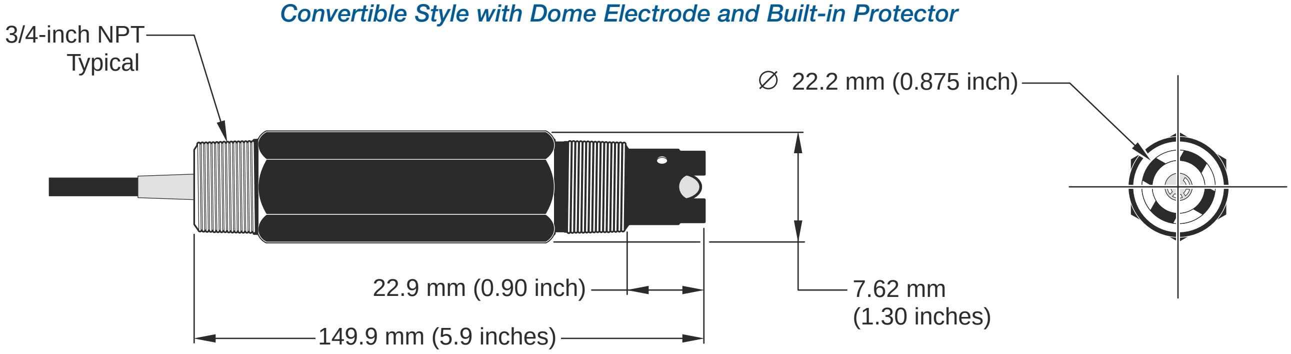
Insertion Style Sensor

Insertion style sensors feature a longer, non-threaded PVDF body with two Viton® O-rings, providing a seal when used with the optional Hach insertion mount hardware assembly. This ball valve hardware enables sensor insertion and retraction from a pipe or vessel without having to stop the process flow.

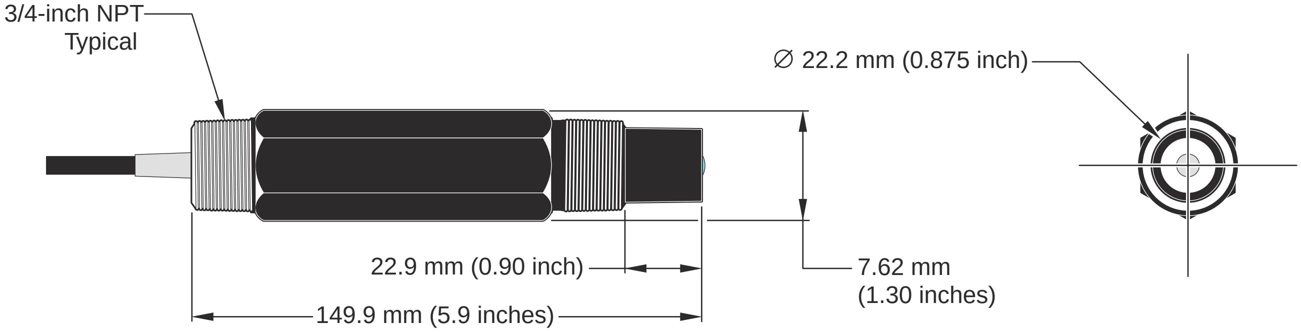
Sanitary Style Sensor

The sanitary style sensor, offered for pH measurement, has a 316 stainless steel-sleeved PVDF body with a 2-inch flange. The sensor mates to a standard 2-inch Tri-Clover fitting. The optional Hach sanitary mounting hardware includes a standard 2-inch sanitary tee, sanitary clamp, and Viton® sanitary gasket.

Convertible Style with Dome Electrode and Built-in Protector

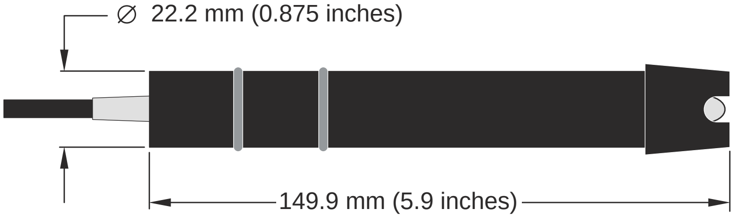


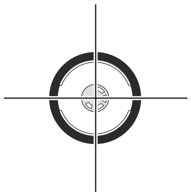
Convertible Style with Flat Electrode



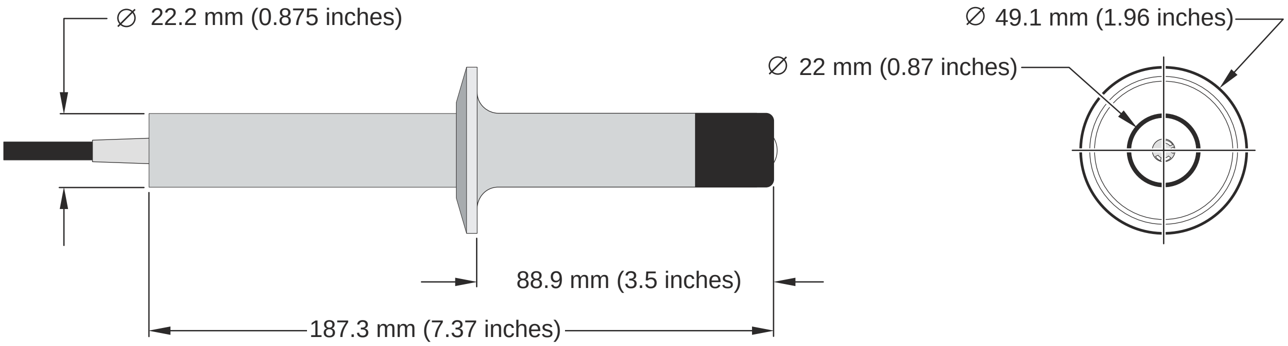
Dimensions *continued*

Insertion Style with Dome Electrode and Built-In Protector

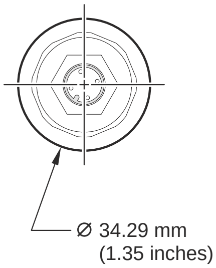


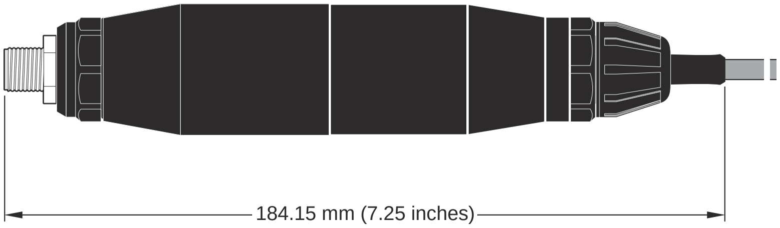


Sanitary Style



Digital Gateway





Ordering Information

Digital PC sc and RC sc 3/4-inch Combination pH/ORP Sensors

All PC sc and RC sc 3/4-inch combination sensors come complete with an integral 4.5 m (15 ft.) sensor cable, Digital Gateway, and 1 m (3.3 ft.) digital extension cable.

Product Number	*Measurement*	*Sensor Style*	*Body Material*	*Electrode Type*	*Temp. Comp.*
DPC1R1N	pH	Convertible	Ryton	General purpose glass	None
DPC1R1A	pH	Convertible	Ryton	General purpose glass	Pt 1000 ohm RTD
DPC1R2N	pH	Convertible	Ryton	Flat glass, general purpose	None
DPC1R2A	pH	Convertible	Ryton	Flat glass, general purpose	Pt 1000 ohm RTD
DPC1R3A	pH	Convertible	Ryton	HF-resistant glass (see Note)	Pt 1000 ohm RTD
DPC2K1A	pH	Insertion	PVDF	General purpose glass	Pt 1000 ohm RTD
DPC2K2A	pH	Insertion	PVDF	Flat Glass	Pt 1000 ohm RTD
DPC3K2A	pH	Sanitary	316 SS/PVDF	General purpose glass	Pt 1000 ohm RTD
DRC1R5N	ORP	Convertible	Ryton	Platinum	None
DRC2K5N	ORP	Insertion	PVDF	Platinum	None

NOTE

The HF (hydrofluoric acid) resistant glass electrode reduces the HF dissolution of the complete glass surface to extend the lifetime of the electrode in acid fluoride solutions. The electrode will last longer than conventional glass pH electrodes. How much longer depends on the HF concentration and temperature of the solution.

Replacement Digital Gateway

6120600 Use the Digital Gateway to connect analog PC and RC sensors to the Hach sc100 Controller.

Ordering Information continued

Analog PC and RC 3/4-inch Combination pH/ORP Sensors

All PC and RC 3/4-inch combination sensors come with an integral 4.5 m (15 ft.) standard length sensor cable.

Product Number	*Measurement*	*Sensor Style*	*Body Material*	*Electrode Type*	*Temp. Comp.*
PC1R1N	pH	Convertible	Ryton	General purpose glass	None
PC1R1A	pH	Convertible	Ryton	General purpose glass	Pt 1000 ohm RTD
PC1R2N	pH	Convertible	Ryton	Flat glass, general purpose	None
PC1R2A	pH	Convertible	Ryton	Flat glass, general purpose	Pt 1000 ohm RTD
PC1R3A	pH	Convertible	Ryton	HF-resistant glass	Pt 1000 ohm RTD
PC2K1A	pH	Insertion	PVDF	General purpose glass	Pt 1000 ohm RTD
PC2K2A	pH	Insertion	PVDF	Flat Glass	Pt 1000 ohm RTD
PC3K2A	pH	Sanitary	316 SS/PVDF	General purpose glass	Pt 1000 ohm RTD
RC1R5N	ORP	Convertible	Ryton	Platinum	None
RC2K5N	ORP	Insertion	PVDF	Platinum	None

Accessories for Digital and Analog 3/4-inch combination pH/ORP Sensors

Cables

Digital cables are used only with digital sensors or gateways when connecting to the sc100 digital controller.

6122400	Digital Extension Cable, 1 m (3.3 ft)
5796000	Digital Extension Cable, 7.7 m (25 ft)
5796100	Digital Extension Cable, 15 m (50 ft)
5796200	Digital Extension Cable, 31 m (100 ft)

Analog cables are used only with analog sensors, junction box, and controller.

1W1100	Analog Interconnect Cable (order per foot)

Digital Termination Box

Used with digital extension cables when the desired cable length between the digital sensor/digital gateway and sc100 controller is between 100 m (328 ft) and 1000 m (3280 ft).

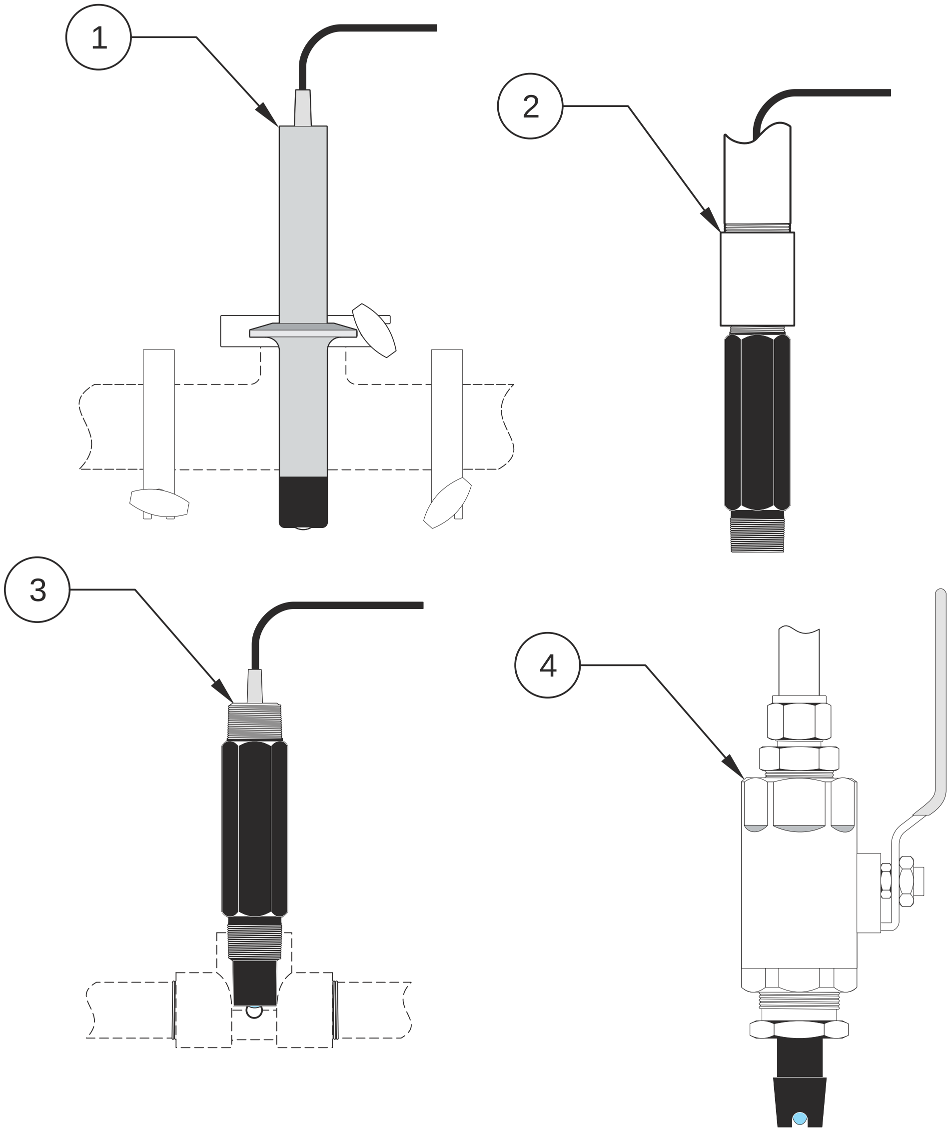
5867000	Digital Termination Box

Analog Junction Box

Used with analog interconnect cable when the desired cable length between analog sensor and analog controller is greater than the standard length of sensor cable. Each junction box includes terminal strip and gasket.

60A2053	Junction Box, Surface-mount, aluminum (includes mounting hardware)
60A9944	Junction Box, Pipe-mount, PVC, for 1/2-inch diameter pipe (includes mounting hardware)
60G2052	Junction Box, Pipe-mount, PVC, for 1-inch diameter pipe (includes mounting hardware)
76A4010-001	Junction Box, NEMA 4X (no mounting hardware included)

Ordering Information *continued*



1. Sanitary Mounting *2. Immersion Mounting* *3. Flow-through Mounting* *4. Insertion Mounting*

Mounting Hardware for PC sc and RC sc Combination Sensors

Sanitary Mount Hardware

9H1310	2-inch Sanitary Tee
9H1132	2-inch Sanitary Clamp
9H1384	2-inch Sanitary Viton Gasket

Immersion Mount Hardware

Each immersion hardware includes a 1/2-inch diameter x 4 foot long pipe, 1/2 x 3/4-inch NPT coupling, and plastic pipe-mount junction box with terminal strip.

MH432G	CPVC Pipe
MH462G	PVDF Pipe

Flow-through Mount Hardware

Each tee is a standard 3/4-inch tee with 3/4-inch NPT threads on all three openings.

MH313N3NZ	316 SS Tee
MH333N3NZ	CPVC Tee
MH363N3NZ	PVDF Tee
MH373N3NZ	PVC Tee

Insertion Mount Hardware

The insertion hardware includes a 1-1/2 inch ball valve, 1-1/2 inch NPT close nipple for process connection, sensor connection tube, stainless steel extension pipe, and stainless steel compression fitting with washer and lock nut.

MH116M3MZ	316 SS Hardware

To complete your pH and ORP measurement system, choose the sc100 or the sc1000 controller...

Model sc100 Controller

(see Lit. #2463)

LXV401.52.00002	sc100 Controller Standard
LXV401.52.01002	sc100 Controller with RS-232 MODBUS®
LXV401.52.02002	sc100 Controller with RS-485 MODBUS®

Model sc1000 Controller

(see Lit. #2403)

LXV402.99.00002	sc1000 Display Module
LXV400.99.1R572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, 110-230V
LXV400.99.1B572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, RS-485 (MODBUS), 110-230V
LXV400.99.1F572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, PROFIBUS DP, 110-230V
LXV400.99.1R582	sc1000 Probe Module, 6 sensors, 4 mA Out, 4 mA In, 4 Relays, 110-230V

Lit. No. 2470
B53 Printed in U.S.A.

In the interest of improving and updating its equipment, Hach Company reserves the right to alter specifications to equipment at any time.

At Hach, it's about learning from our customers and providing the right answers. It's more than ensuring the quality of water—it's about ensuring the quality of life. When it comes to the things that touch our lives...

Keep it pure.

Make it simple.

Be right.

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Portable pH Meter

Instruction Manual

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AccuVer™
AccuVial™
Add-A-Test™
AgriTrak™
AluVer®
AmVer™
APA 6000™
AquaChek™
AquaTrend®
BariVer®
BODTrak™
BoroTrace™
BoroVer®
C. Moore Green™
CA 610™
CalVer®
ChromaVer®
ColorQuik®
CoolTrak®
CuVer®
CyaniVer®
Digesdahl®
DithiVer®
Dr. F. Fluent™
Dr. H. Tueau™
DR/Check™
EC 310™
FerroMo®
FerroVer®
FerroZine®
FilterTrak™ 660
Formula 2533™
Formula 2589™
Gelex®
H_2O University™
H_2OU™
Hach Logo®
Hach One®
Hach Oval®
Hach.com™
HachLink™
Hawkeye The Hach Guy™
HexaVer®
HgEx™
HydraVer®
ICE-PIC™
IncuTrol®
Just Add Water™
LeadTrak®
m-ColiBlue24®
ManVer®
MolyVer®
Mug-O-Meter®
NetSketcher™
NitraVer®
NitriVer®
NTrak®
OASIS™
On Site Analysis. Results You Can Trust℠
OptiQuant™
OriFlow™
OxyVer™
PathoScreen™
PbEx®
PermaChem®
PhosVer®
Pocket Colorimeter™
Pocket Pal™
Pocket Turbidimeter™
Pond In Pillow™
PourRite™
PrepTab™
ProNetic™
Pump Colorimeter™
QuanTab®
Rapid Liquid™
RapidSilver™
Ratio™
RoVer®
*sens**ion***™
Simply Accurate℠
SINGLET™
SofChek™
SoilSYS™
SP 510™
Spec√™
StablCal®
StannaVer®
SteriChek™
StillVer®
SulfaVer®
Surface Scatter®
TanniVer®
TenSette®
Test 'N Tube™
TestYES!℠
TitraStir®
TitraVer®
ToxTrak™
UniVer®
VIScreen™
Voluette®
WasteAway™
ZincoVer®

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CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected, and found to meet its published specifications when it was shipped from the factory.

The *sension*™*1* Portable pH Meter has been tested and is certified as indicated to the following instrumentation standards:

EMI Immunity:

Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control, and laboratory use— EMC requirements) Supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:
IEC 1000-4-2:1995 (EN 61000-4-2) Electro-Static Discharge (Criteria B)

IEC 1000-4-3:1995 (EN 61000-4-3:1995) Radiated RF Electro-Magnetic Field Immunity (Criteria B)

ENV 50204:1996 Radiated Electro-Magnetic Field from Digital Telephones (Criteria B)

Radio Frequency Emissions:

Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control, and laboratory use— EMC requirements) Class B emission limits. Supporting test records by Criterion Technology O.A.T.S. (NVLAP #0369), certified compliance by Hach Company.

Additional Emissions Standard/s include:

EN 55011 (CISPR 11) Emissions, Class B Limits

CANADIAN INTERFERENCE-CAUSING EQUIPMENT REGULATION, IECS-003: Class A emission limits. Supporting test records by Criterion Technology O.A.T.S. (NVLAP #0369)**,** certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

FCC PART 15, Class “A” Limits:

Supporting test records by Criterion Technology O.A.T.S. (NVLAP #0369), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily:

1. Remove power from the *sens**ion1*** pH meter by removing one of its batteries to verify that it is or is not the source of the interference.
2. Move the meter away from the device receiving the interference.
3. Reposition the receiving antenna for the device receiving the interference.
4. Try combinations of the above.

SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE
Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

⚠ This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

⚠ ***Section 2.2 on page 19, Battery Installation***

SPECIFICATIONS

Specification subject to change without notice.

pH mode

Range	-2.00 to 19.99
Resolution (selectable)	0.001/0.01/0.1
Slope range	58 ±3 mV/decade

Millivolt mode

Range	-2000 to 2000 mV
Resolution	0.1 mV
Accuracy	0.2 mV or ±0.01% of reading, whichever is greater

Temperature mode

Range	-10.0 to 110 °C (can also display °F)
Resolution	0.1 °C
Accuracy	±0.3 from 0–70 °C; ±1.0 from >70–110 °C

Display: Custom LCD

Inputs: 1 BNC; 5-pin Hach pH/temperature or Hach temperature probe; 1 pin-tip

Power Requirements: 4 alkaline AA batteries

Input Impedance: $>10^{12}$ ohms

Instrument Drift: <40 µV/°C

Input Bias Current: <±1 picoamp at 25 °C; <±4 picoamp over full range

Environmental Requirements: 0 to 50 °C at 85% non-condensing relative humidity

Dimensions: 21.2 x 8.7 x 4.2 cm (8.35 x 3.43 x 1.65 in.)

Enclosure: Waterproof (meets IP67), chemical resistant, dust proof; meter will float.

OPERATION

DANGER

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

DANGER

La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.

PELIGRO

La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.

GEFAHR

Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

PERIGO

A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.

SECTION 1 INTRODUCTION

This manual describes the operation and use of the Hach *sension*™*1* Portable pH/mV/Temperature Meter (see *Figure 1*).

This meter features a custom digital LCD display which simultaneously shows temperature and measurement results. This meter has all the features of a simple pH meter plus a millivolt mode, IP67 waterproof design, electrode holder, ergonomic design, and automatic buffer recognition.

The electrode holder on the back of the instrument allows the user to store the electrode and meter in one convenient package when not in use. The electrode holder is designed so the user can slip a vinyl electrode cover over the electrode tip, creating a humid environment that allows the electrode membrane to remain hydrated when not in use (see *Figure 2 Electrode Holder*).

The meter is designed to be maintenance-free. If the meter gets dirty, wipe the surface with a damp cloth. Use a cotton-tipped applicator to clean or dry the connectors if they get wet.

1.1 Unpacking the Instrument

Remove the instrument and accessories from the shipping container and inspect each item for any damage that may have occurred during shipping. Verify that all items listed on the packing slip are included. If any items are missing or damaged, contact Hach Customer Service, Loveland, Colorado for instructions. Hach's toll free phone number for customers within the United States is 800-227-4224. For customers outside the United States, contact the Hach office or distributor serving you.

1.1.1 Standard Accessories

- Batteries - 4 alkaline AA (not rechargeable)
- Instrument Manual
- May include electrode and related accessories (covered in the electrode manual).

Figure 1 **Hach *sension1* Meter**

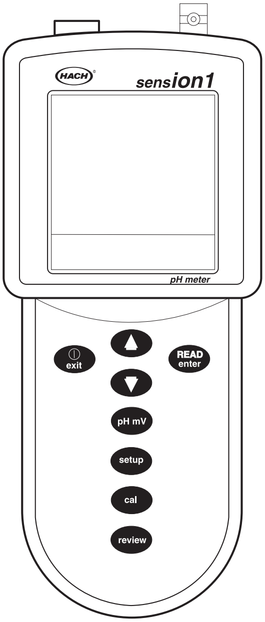
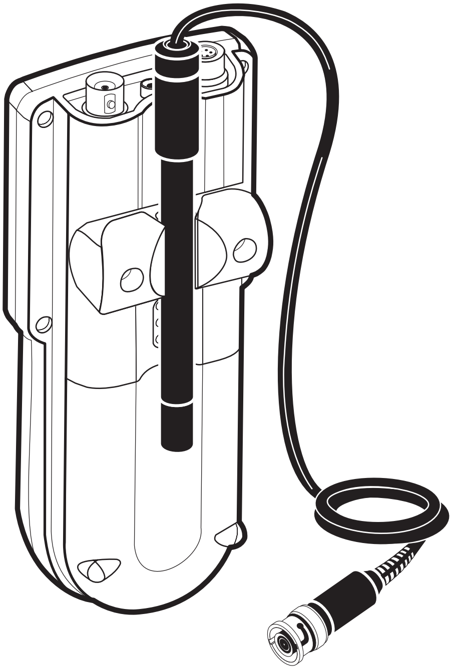


Figure 2 **Electrode Holder**



1.2 Keypad Description

Figure 3 illustrates the meter's keypad. The description and function of each key is given in *Table 1*.

Figure 3 *sension1* Meter Keypad

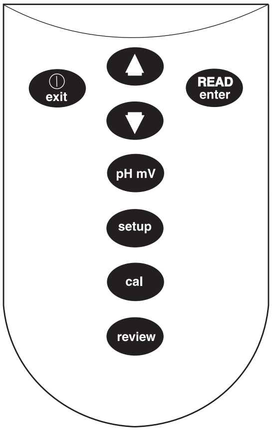


Table 1 Keys and Description

Key	Description
Exit/Power On-Off	Turns the instrument on; turns it off from the Reading mode. Acts as a NO or CANCEL key when the question mark icon is flashing. Performs the following and returns to the Reading mode: • Exits the Setup mode • Aborts a calibration • Exits a calibration review
Arrow Keys	Scroll between options in Setup mode. Change the default temperature when a temperature probe is not in use. In Setup mode, back up one step toward the Reading mode.
READ/ENTER Key	Acts as a YES key when the question mark is flashing. Allows user to edit a setup when the setup number is flashing. Initiates a new measurement when the meter has stabilized in the Display Lock Enabled mode.
pH/mV Key	Toggles between pH value and mV value in Reading, Calibration, and Cal Review modes.
Setup Key	Enters Setup mode (from Reading mode only).
Cal Key	Enters Calibration mode (from Reading mode only).
Review Key	Enters Calibration Review mode (from Reading mode only).

1.3 Display Fields and Icons

The display has two screens. The upper screen displays measurements or standard values, the operation mode in use, slope, sample/default temperature, pH or mV units, error codes, and indicates if the meter reading is stable. The lower screen displays the acrive keys.

Figure 4 shows the icons and screens displayed by the meter and *Table 2* describes each element. Several icons on the display are not used by the portable pH *sens**ion1*** meter (indicated by NA in the table), but will be displayed if the power key is held down for several seconds.

Figure 4 Display Elements

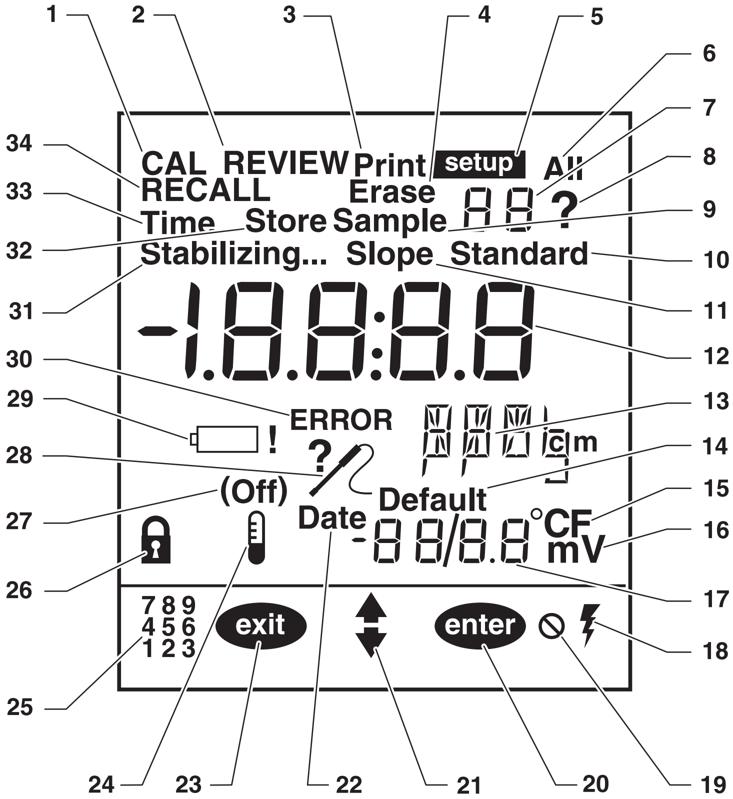


Table 2 Main Display Elements

Item No.	Description
1	Indicates meter is in Calibration mode. If the **?** is flashing, calibration is necessary.
2	Indicates meter is in Calibration Review mode.
3 (NA)	Indicates data is being sent to a printer/computer.
4 (NA)	Indicates recalled data that is currently displayed is being erased.
5	Indicates meter is in Setup mode.
6 (NA)	Indicates all data points are being printed or erased.
7	Numerical field that displays Setup, Sample, and Standard numbers when those words are displayed with the number. If **Standard** and **1** are displayed, the meter is measuring Standard 1.
8	Flashing **?** and **CAL** indicate calibration is necessary. Also a prompt to press the **ENTER** or **EXIT** key.
9	Indicates the meter is measuring a sample (sample number is displayed to the right).
10	Indicates the meter is measuring a standard (standard number is displayed above).
11	Indicates the displayed number is the electrode slope.
12	Numerical field that displays the slope and pH or mV values of standards and samples.
13	Indicates measurement units (pH or mV).
14	When **Default** is displayed, the meter is using the default temperature value to calculate the temperature correction for the pH value.
15	Temperature units (choice of °C or °F).
16	Indicates the value displayed in small numerical field (item 17) is in millivolts.
17	Numerical field that displays temperature value.
18 (NA)	Indicates meter is using AC power (only displayed when in the docking station).
19	Indicates an inactive key has been pressed and that function is not allowed.
20	Indicates **ENTER** key is active.
21	Indicates arrow keys are active.
22 (NA)	In Setup mode, it indicates the date is being set.
23	Indicates **EXIT** key is active.
24	Indicates temperature compensation is being used.
25 (NA)	Indicates numeric part of the keys is active.
26	Display Lock icon. Displayed with item 27.
27	Indicates whether Display Lock setting is **On** or **Off**.
28	Faulty probe connection or incorrect probe attached. May also indicate the calibration is questionable. Usually displayed with an error code.
29	Low battery icon. Change batteries as soon as possible.
30	Indicates a meter function problem.

Table 2 Main Display Elements (Continued)

Item No.	Description
31	When on or flashing, **Stabilizing...** indicates signal from sample is not yet stable. When it disappears, the reading is stable and may be recorded.
32	Used with **?** icon. Asks if user wants to store the displayed sample data or the calibration that has been just completed.
33 (NA)	Used with large display to indicate the time is being set.
34 (NA)	Indicates meter is in recall mode and the data displayed is stored data.

1.4 Audible Signals

The meter will beep under certain conditions:

- when a non-functional key press is made (one beep)
- when display lock is enabled and measurement stability is reached in reading mode (three beeps)
- any time measurement stability is reached during calibration mode, regardless of the Display Lock setting
- to signal an error condition.

SECTION 2 INSTRUMENT SETUP

2.1 Instrument Description

This durable portable *sension*™*1* pH/mV meter is designed for easy hand-held use when measuring samples in the field or laboratory. The meter operates on 4 alkaline batteries with an estimated battery life of at least 500 hours of continuous use.

The meter measures from -2.0 to 19.99 pH units and the sample temperature. Displayed pH values are temperature corrected using the measured sample temperature or a default temperature setting. The meter also measures and displays mV.

2.2 ⚠ Battery Installation

CAUTION
Use only alkaline batteries in this product. Other types of batteries can result in safety hazards.

PRUDENCE
Utiliser seulement des piles alcalines dans cet appareil. Les autres types de piles peuvent créer des risques pour la sécurité.

ATENCIÓN
Utilice solamente baterias alcalinas en este producto. El uso de otros tipos de baterias puede causar riesgos de seguridad.

VORSICHT
Verwenden Sie in diesem Produkt nur Alkali-Batterien. Die Verwendung anderer Batterien gefährdet die Betriebssicherheit.

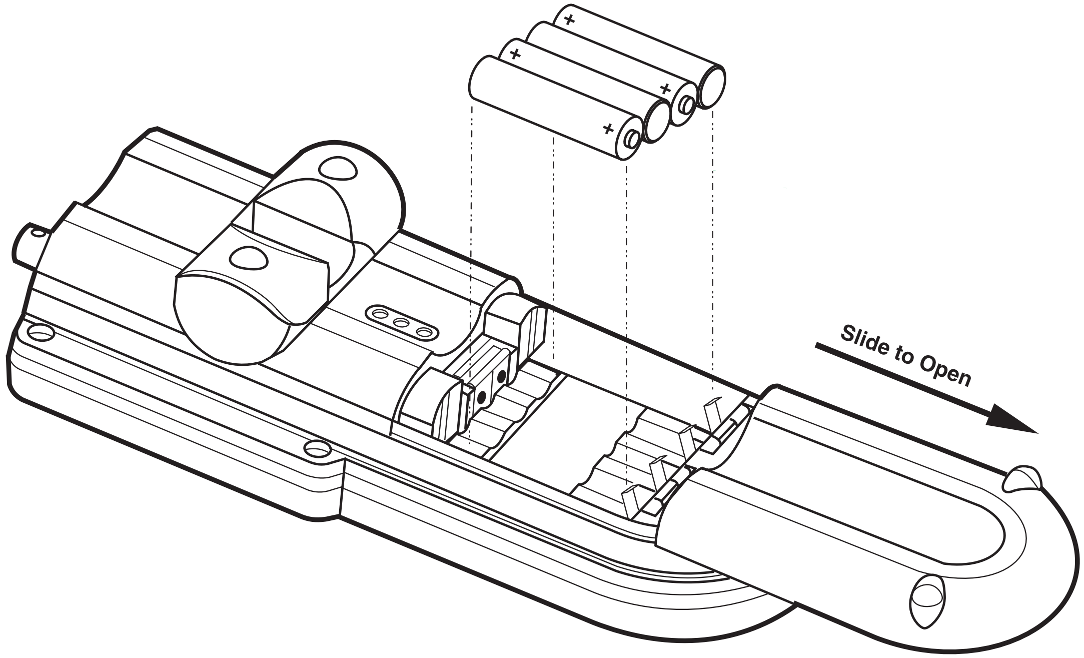
ATENÇÃO
Use somente baterias alcalinas neste produto. Outros tipos de baterias podem resultar em risco a segurança.

The *sension1* meter requires four alkaline AA batteries for portable operation. **Other types of batteries should not be used in the meter**. The battery compartment access panel is on the bottom of the instrument. To access the battery compartment, turn the instrument over and position the connectors away from you. Hold the instrument between your hands and use your thumbs to slide the panel towards you. See *Figure 5*.

When battery replacement is necessary, replace all four batteries. The position of the batteries in the instrument is important. Icons of the correct orientation are molded into the bottom of the battery compartment.

With the connectors pointing away from you, insert a battery in left-most position so the positive end faces you. Insert the other three batteries so the positive and negative ends alternate (i.e, +, -, +, -). Insertion is easiest if the battery is pushed against the spring connector first, then pressed into place.

Figure 5 Battery Replacement



2.3 Probe Connections

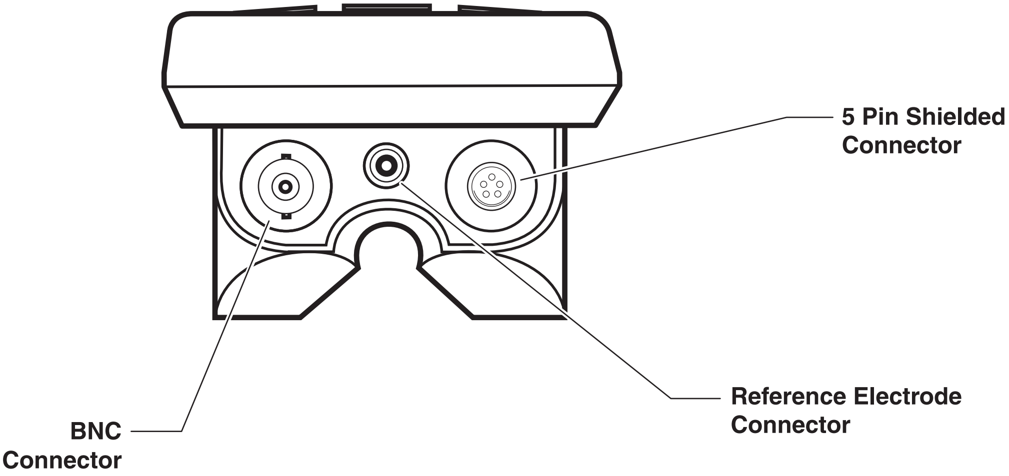
Attach electrodes with 5-pin connectors to the sensor input by lining the pins up with the holes in the meter port (see *Figure 6*). Push the electrode connector toward the instrument.

For probes with BNC connectors, slide the connector into the input. Push towards the instrument and turn clockwise to lock into position.

Electrodes may be attached to both the 5-pin and BNC connectors at the same time as long as they are **not** in contact with the same solution. To select either of the connectors for measurement, go to the **Setup 1** menu and select one.

When using half-cells, connect reference electrodes with pin tip connectors by pushing the connector straight into the center reference input. If using a combination electrode with a BNC or 5-pin connector, the reference pin-tip jack is not used.

Figure 6 Electrode Connectors



2.3.1 Temperature Probe Connection

Hach electrodes with the 5-pin connector have the temperature sensing unit included in the electrode probe. If using an electrode with BNC connector, connect a Hach Temperature Probe (Cat. No. 51980) to the 5-pin connector on the meter (see *Figure 6*). Or measure the temperature manually and enter the value as the default temperature using the arrow keys.

2.4 Turning the Meter On

After the batteries are installed, turn the instrument on using the **I/O/EXIT** key (located on the upper left side of the keypad). Press the key once to power the instrument up. The display will show the software version number, then move to the Reading mode.

2.5 Temperature Measurement

The meter displays temperature in the range of -10.0 to 110 °C simultaneously with sample results. If a temperature probe is properly connected, actual temperature measurements are displayed in the temperature/mV field.

The meter requires a temperature to calculate temperature-corrected pH readings. The meter uses temperature data from one of three sources:

- The temperature sensor in the sample
- The factory default setting (25 °C)
- A user-entered setting (which becomes the default)

If a temperature probe is connected properly, the meter will display the current sample temperature and will not allow the temperature to be manually set.

To manually set the temperature

When a temperature probe is not used to supply the temperature for pH temperature compensation, the temperature must be set manually or the factory default temperature (25 °C) will be used. In either case, **Default** will be displayed above the temperature.

To change the default temperature, first put the meter in Reading or Calibration mode. Press the arrow keys to increase or decrease the displayed default temperature value to the desired temperature. The value adjusts in 0.1 °C (0.1 to 0.2 °F) increments.

Note: *Acceptable temperatures range from -10 to 110 °C.*

To change the units of temperature measurement, see *Section 3.1.3* on page *26*.

2.6 Millivolt Measurements

The meter can be used to measure absolute millivolts (mV). To display a current millivolt reading, press the **pH/mV** key. The mV value is displayed with **mV** in the units field.

Absolute millivolts are displayed with 0.1 mV resolution in the range of -2000 to 2000. The millivolt mode is useful when measuring oxidation-reduction potential, performing potentiometric titrations, or preparing calibration curves. Detailed instructions for any Hach electrode are given in the electrode instruction manual. Titration instructions are included in the Hach ORP Electrode Instruction Manual, or in standard analytical chemistry texts.

2.7 Automatic Shut-off Function

The meter is equipped with an automatic shut-off feature to prolong battery life. The meter will automatically shut off 15 minutes after the last key press unless the meter is in Calibration mode. If it is in Calibration mode, automatic shutoff will occur four hours after the last key press.

Press the **I/O/EXIT** key after automatic shut-off to restore power to the instrument.

3.1 Setup Menu

The *sension*™*1* Portable pH meter has a setup menu that allows the analyst to choose options for connector choice, display lock, temperature units, automatic buffer recognition of pH 6.86 or 7.0, and the display resolution.

To access the Setup menu, press the **SETUP** key. The arrow icons will be displayed, indicating that additional options are available within the menu. Press the up or down arrow key to scroll to the desired option, then press **ENTER**. *Table 3* describes these options.

Table 3 Setup Options

Setup Number	Option Description
1	Use BNC or 5-pin connector
2	Display lock (On or Off)
3	Temperature units (°C or °F)
4	Measurement resolution (0.0, 0.00, or 0.000)
5	Automatic buffer recognition (pH 7.00 or 6.86)

3.1.1 Choosing the Probe Connector

This setup ensures the potential from the appropriate electrode is detected by the meter. Connect only one electrode to the meter.

1. From the reading mode, press **SETUP**.
2. The **Setup** icon and the number **1** (flashing) will be displayed. Change the connector choice by pressing **ENTER**; this toggles the selection between **BNC** and **5 pin**.
3. When the desired option is selected, press **EXIT** to return to the reading mode.

3.1.2 Turning Display Lock Off and On

Setup 2 is Display Lock option. This feature stops measurement reading fluctuation on the display once a stable reading is reached. The default setting is Off.

When this feature is not used, the measurement value may continue to fluctuate and **Stabilizing...** may be displayed.

1. From the reading mode, press **SETUP**.
2. The **Setup** icon and the number **1** (flashing) will be displayed. Press the up arrow once so the Setup number is **2**.
3. Change the display lock status by pressing **ENTER**; this toggles the display lock between off and on. When the display lock is disabled, the Display Lock icon and **Off** are displayed. When this feature is enabled, the Display Lock icon is displayed without **Off**. When this feature is enabled, the Display Lock icon is displayed when the stabilization criteria are met.
4. When the desired option is selected, press **EXIT** to return to the reading mode.

3.1.3 Selecting Temperature Units

1. From the reading mode, press **SETUP**.
2. The **Setup** icon and the number **1** (flashing) will be displayed. Press the up arrow until the Setup number is **3**.
3. Change the temperature unit by pressing **ENTER**; this key toggles the temperature units between °C and °F. The default is °C.
4. When the desired option is selected, press **EXIT** to return to the reading mode.

3.1.4 Selecting Measurement Resolution

The meter can display measurement values to tenths (0.0), hundredths (0.00) or thousandths (0.000). The default is hundredths.

1. From the reading mode, press **SETUP**.
2. The **Setup** icon and the number **1** (flashing) will be displayed. Press the up arrow three times so the Setup number is **4**.
3. Change the resolution by pressing **ENTER**; this toggles between the three resolution options.
4. When the desired option is selected, press **EXIT** to return to the reading mode.

3.1.5 Selecting Auto Buffer Recognition

The *sens***ion1** Portable pH Meter is designed to auto-recognize and calibrate on 4.01, 6.86 or 7.00, and 10.01 pH buffers. Buffers with pH values other than these cannot be used to calibrate the *sens***ion1** meter.

The only selection option for pH buffer auto recognition is 6.86 or 7.00. The default is pH 7.00. To change this option:

1. From the reading mode, press **SETUP**.
2. The **Setup** icon and the number **1** (flashing) will be displayed. Press the up arrow until the Setup number is **5**.
3. Change the buffer value by pressing **ENTER**; this toggles the between the choices 6.86 and 7.00.
4. When the desired option is selected, press **EXIT** to return to the reading mode.

3.2 Calibrating the Meter

Hach recommends a daily two- or three-point calibration using buffers that bracket the sample pH. This will verify the electrode is working properly and allow the slope value to be stored.

3.2.1 Performing a Calibration Using pH 4, 6.86, 7, and 10 Buffers

1. If using a probe without a temperature sensor, see *Section 2.3.1* on page *22* and *Section 2.5* on page *22* for information about obtaining and using a default temperature.

2. Prepare two pH buffers, either 4.01 and 7.00 (or 6.86), or 7.00 (or 6.86) and 10.01, according to the electrode instruction manual.

Note: *Use a 6.86 or 7.0 pH buffer for the mid-range buffer. To view or change the setting for the mid-range buffer see Section 3.1.5.*

Note: *The pH values for the buffers are given for 25 °C. If the sample temperature is not 25 °C, the pH values displayed for the buffers will reflect the correct pH value for the sample temperature.*

3. Press **I/O/EXIT** to turn the instrument on. From the Reading mode, press **CAL**. **CAL** and flashing **?** will appear in the upper display area, along with **Standard** and **1**.

4. Press **READ/ENTER**. The temperature and pH values will be updated until a stable reading is reached.

Note: *If the meter is measuring in pH mode, it automatically moves to the next calibration step when stabilization is reached (indicated by three beeps). If measuring in mV mode, the three beeps will still sound when the stabilization occurs, but* **ENTER** *must be pressed to accept the reading. This lets the operator control the acceptance point of the buffer.*

5. When the reading has stabilized or been accepted, the standard number will change to **2**.

6. Remove the probe from the first buffer and rinse with deionized water. Place the probe in the second buffer.

7. Repeat *steps 5* and *6* for the third buffer and press **EXIT**.

8. Press **READ/ENTER**. The temperature and pH values will be updated until a stable reading is reached.

9. When the reading has stabilized or been accepted, the slope value and the **Store** and **?** icons will appear. Verify the slope value is within the ranges specified in the electrode manual.

10. To save the calibration and return to the Reading mode, press **ENTER**. To exit the calibration without saving it and return to the reading mode, press **EXIT**.

3.3 Reviewing the Calibration

1. From the pH Reading mode, press the **REVIEW** key.
2. The display will show the standard number, standard pH, and temperature (view mV value by pressing **pH/mV**). Press the up arrow once.
3. The meter will continue to scroll through the standard information with each press of the up arrow key. When all the standards have been displayed, press the up arrow key again.
4. The meter will display the slope and offset of the calibration curve.
5. To exit Cal Review mode, press **EXIT**. To review any standard or slope information again, press the down arrow.

3.4 Measuring Samples

After successful calibration, the meter is ready to measure samples. See instructions in the electrode manual for more information and specific steps for using the electrode.

1. Place the electrode in the sample. Press **READ/ENTER**. **Stabilizing...** will appear, along with the sample temperature and the pH or mV reading. These values may fluctuate until the system is stable.
2. When the reading is stable **Stabilizing...** will disappear. If the Display Lock is enabled, the display will “lock in” on the pH or mV and sample temperature. If the Display Lock is off, the display will show the current reading and temperature, but the values may fluctuate.
3. Record the pH or mV value.
4. Remove the electrode from the sample, rinse with deionized water and place the electrode in the next sample. Repeat Steps 1-3 for each sample.
5. When measurements are complete, press the **I/O/EXIT** key to turn the meter off. Rinse the electrode with deionized water and blot dry. Replace the protective cap on the electrode and put the electrode in the electrode holder. To store the electrode for more than 30 days, see the electrode manual for specific instructions.

SECTION 4 TROUBLESHOOTING

4.1 Introduction

Correcting problem conditions with the *sension*™ electrochemical meters is limited to responding to the error message displayed. Other problems must be handled by a Hach technician at a service center. Refer to *REPAIR SERVICE* on page *38*. **Do not** attempt to service the meter as there are no field-serviceable parts. Opening the meter case will void the warranty.

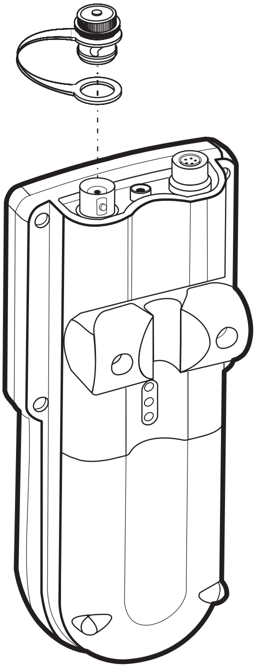
4.2 Shorting Test

This test detects the meter offset.

1. Turn the meter on. Connect the shorting cap to the BNC connector (see *Figure 7*). Unplug any electrodes from the 5-pin connector. Select the BNC connector from Setup 1.

2. Change the output to display in mV (press **pH/mV** to toggle between pH and mV readings). After the meter has stabilized, simultaneously press **CAL** and **ENTER**. The display should show **0.0 mV**. If it does not, contact Hach Service.

Figure 7 Attaching Shorting Cap to The BNC Connector



4.3 Error Codes

Error codes indicate a functional problem with the meter and/or the electrode. Error code numbers will appear in the temperature field along with other icons. *Table 4* describes the possible error codes and some possible solutions to eliminate the cause.

Table 4 Error Codes

Error Code	Error Name & Display Icons	Description
2	Cal slope error. **ERROR** and **SLOPE** will be displayed.	Calibration slope is too high or low. Ensure correct pH buffers are used. Be sure a pH probe is connected to the meter. Disconnect any probe connected to the BNC connector.
3	Cal Std Error. **ERROR, ENTER, CAL** and **Standard** will be displayed.	The value read will not work in the calibration algorithm. Ensure one buffer was not measured twice and that the correct buffers were used. If not, repeat calibration with new buffers.

4.4 Meter Service Request Questionnaire

1. What is the complete lot code of the meter and electrode?
2. On what date was the meter purchased?
3. How long has the meter been in use?
4. What types of samples are being tested?
5. What is the temperature of the samples being tested?
6. How often is the meter being used?
7. How is the meter being stored between uses?
8. If the meter has been in use for a while, what maintenance has been performed?
9. Describe the suspected problem or failure of the meter.
10. Please have your meter, electrode, buffers/standards, and this completed questionnaire near the phone before calling technical support.

GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

REPLACEMENT PARTS

REQUIRED REAGENTS

Description	Quantity Required Per Test	Unit	Cat. No.
Buffer, Powder Pillows			
pH 4.01, color-coded red	1	15/pkg	22269-95
pH 7.00, color-coded yellow	1	15/pkg	22270-95
pH 10.00, color-coded blue	1	15/pkg	22271-95
Buffer Solutions			
pH 4.01, color-coded red	20 mL	500 mL	22834-49
pH 7.00, color-coded yellow	20 mL	500 mL	22835-49
pH 10.01, color-coded blue	20 mL	500 mL	22836-49
pH Electrode Storage Powder Pillows		20/pkg	26573-64
pH Electrode Storage Solution		475 mL	50301-49

REQUIRED APPARATUS

Beaker, poly, 50 mL	1	each	1080-41
Electrode, pH combination, w/temp, 5-pin connector	1	each	51910-00
sension™*1* Portable pH Meter	1	each	51700-00
Shorting Cap, BNC	1	each	50071-00
Temperature Probe, 5-pin	1	each	51980-00

OPTIONAL APPARATUS

Demineralizer Bottle, 177 mL		each	14299-00
Electrode, pH, gel-filled, w/temp, 5-pin connector		each	51935-00
Electrode, pH combination, flat end, 5-pin		each	51915-00
Electrode, reference, single junction		each	50220-00
Electrode, reference, double junction		each	50225-00
Electrode Stand		each	45300-00
Electrode Stand with Electromagnetic Stirrer, 115 VAC		each	45300-01
Electrode Stand with Electromagnetic Stirrer, 230 VAC		each	45300-02
Electrode Washer		each	27047-00
sension™*2* Portable pH/ISE Meter		each	51725-11
sension™*3* Benchtop pH Meter, 115 V, with electrode		each	51750-10
sension™*3* Benchtop pH Meter, 220 V, with electrode		each	51750-11
sension™*4* Benchtop pH/ISE Meter, 115 V, No. American style Plug		each	51775-10
sension™*4* Benchtop pH/ISE Meter, 230 V, European Style Plug		each	51775-11
Stir Bar, 7/16 x 3/16 in.		each	45315-00
Thermometer, mercury, -20 to 110 °C		each	20959-11

HOW TO ORDER

By Telephone:
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
By FAX:
(970) 669-2932

By Mail:
Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389
U.S.A.
Ordering information by E-mail:
orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you. Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or call (970) 669-3050.

In Canada:
Hach Sales & Service Canada Ltd.; Manitoba, Canada
Telephone: (204) 632-5598; FAX: (204) 694-5134

REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Service Center serving your location.

In the United States:
Hach Company
100 Dayton Ave.
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

Other locations:
Hach Company World Headquarters,
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932

WARRANTY

Hach warrants most products against defective materials or workmanship for at least one year from the date of shipment; longer warranties may apply to some items.

HACH WARRANTS TO THE ORIGINAL BUYER THAT HACH PRODUCTS WILL CONFORM TO ANY EXPRESS WRITTEN WARRANTY GIVEN BY HACH TO THE BUYER. EXCEPT AS EXPRESSLY SET FORTH IN THE PRECEDING SENTENCE, HACH MAKES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO ANY PRODUCTS. HACH EXPRESSLY DISCLAIMS ANY WARRANTIES IMPLIED BY LAW, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION OF REMEDIES: Hach shall, at its option, replace or repair nonconforming products or refund all amounts paid by the buyer. **THIS IS THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.**

LIMITATION OF DAMAGES: IN NO EVENT SHALL HACH BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND FOR BREACH OF ANY WARRANTY, NEGLIGENCE, ON THE BASIS OF STRICT LIABILITY, OR OTHERWISE.

This warranty applies only to Hach products purchased and delivered in the United States.

Catalog descriptions, pictures and specifications, although accurate to the best of our knowledge, are not a guarantee or warranty.

For a complete description of Hach Company’s warranty policy, request a copy of our Terms and Conditions of Sale for U.S. Sales from our Customer Service Department.

Hach warrants the meter against defective materials or workmanship for three years from the date of shipment. The Docking station has a one year warranty from the date of shipment.

HACH COMPANY
WORLD HEADQUARTERS
P.O. Box 389
Loveland, Colorado 80539-0389
Telephone: (970) 669-3050
FAX: (970) 669-2932

FOR TECHNICAL ASSISTANCE, PRICE INFORMATION AND ORDERING:
In the U.S.A. - **Call toll-free 800-227-4224**
Outside the U.S.A. - **Contact the HACH office or distributor serving you.**
On the Worldwide Web - **www.hach.com**; E-mail - **techhelp@hach.com**

quickly because wet samples tend to lose weight by evaporation. After drying or ignition, residues often are very hygroscopic and rapidly absorb moisture from the air. Highly alkaline residues may react with silica in the samples or silica-containing crucibles.

2. Apparatus

All the apparatus listed in Section 2540B.2 is required except that a magnetic stirrer and pipets are not used and a balance capable of weighing to 10 mg may be used.

3. Procedure

a. Total solids:

1) Preparation of evaporating dish—If volatile solids are to be measured, ignite a clean evaporating dish at 550°C for 1 h in a muffle furnace. If only total solids are to be measured, heat dish at 103 to 105°C for 1 h in an oven. Cool in desiccator, weigh, and store in desiccator until ready for use.

2) Sample analysis

a) Fluid samples—If the sample contains enough moisture to flow more or less readily, stir to homogenize, place 25 to 50 g in a prepared evaporating dish, and weigh. Evaporate to dryness on a water bath, dry at 103 to 105°C for 1 h, cool to balance temperature in an individual desiccator containing fresh desiccant, and weigh. Repeat heating, cooling, desiccating, and weighing procedure until the weight change is less than 4% or 50 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight.

b) Solid samples—If the sample consists of discrete pieces of solid material (dewatered sludge, for example), take cores from each piece with a No. 7 cork borer or pulverize the entire sample coarsely on a clean surface by hand, using rubber gloves. Place 25 to 50 g in a prepared evaporating dish and weigh. Place in an oven at 103 to 105°C overnight. Cool to balance temperature in a desiccator and weigh. Repeat drying (1 h), cooling, weighing, and desiccating steps until weight change is less than 4% or 50 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight.

b. Fixed and volatile solids: Transfer the dried residue from 2)a) above to a cool muffle furnace, heat furnace to 550°C, and ignite for 1 h. (If the residue contains large amounts of organic matter, first ignite it over a gas burner and under an exhaust hood in the presence of adequate air to lessen losses due to reducing conditions and to avoid odors in the laboratory.) Cool in desiccator to balance temperature and weigh. Repeat igniting (30 min), cooling, desiccating and weighing steps until the weight change is less than 4% or 50 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight.

4. Calculation

$$\%\ \text{total solids} = \frac{(A - B) \times 100}{C - B}$$

$$\%\ \text{volatile solids} = \frac{(A - D) \times 100}{A - B}$$

$$\%\ \text{fixed solids} = \frac{(D - B) \times 100}{A - B}$$

where:

A = weight of dried residue + dish, mg,
B = weight of dish,
C = weight of wet sample + dish, mg, and
D = weight of residue + dish after ignition, mg.

5. Precision and Bias

Precision and bias data are not now available.

6. Bibliography

GOODMAN, B.L. 1964. Processing thickened sludge with chemical conditioners. Pages 78 et seq. *in* Sludge Concentration, Filtration and Incineration. Univ. Michigan Continued Education Ser. No. 113, Ann Arbor.

GRATTEAU, J.C. & R.I. DICK. 1968. Activated sludge suspended solids determinations. *Water Sewage Works* 115:468.

n 2550 A+B

2550 TEMPERATURE*

2550 A. Introduction

Temperature readings are used in the calculation of various forms of alkalinity, in studies of saturation and stability with respect to calcium carbonate, in the calculation of salinity, and in general laboratory operations. In limnological studies, water temperatures as a function of depth often are required. Elevated temperatures resulting from discharges of heated water may have significant ecological impact. Identification of source of water supply, such as deep wells, often is possible by temperature measurements alone. Industrial plants often require data on water temperature for process use or heat-transmission calculations.

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* Approved by Standard Methods Committee, 1993.

2550 B. Laboratory and Field Methods

1. Laboratory and Other Non-Depth Temperature Measurements

Normally, temperature measurements may be made with any good mercury-filled Celsius thermometer. As a minimum, the thermometer should have a scale marked for every 0.1°C, with markings etched on the capillary glass. The thermometer should have a minimal thermal capacity to permit rapid equilibration. Periodically check the thermometer against a precision thermometer certified by the National Institute of Standards and Technology (NIST, formerly National Bureau of Standards)* that is used with its certificate and correction chart. For field operations use a thermometer having a metal case to prevent breakage.

Thermometers are calibrated for total immersion or partial immersion. One calibrated for total immersion must be completely immersed to the depth of the etched circle around the stem just below the scale level.

2. Depth Temperature Measurements

Depth temperature required for limnological studies may be measured with a reversing thermometer, thermophone, or thermistor. The thermistor is most convenient and accurate; however, higher cost may preclude its use. Calibrate any temperature measurement devices with a NIST-certified thermometer before field use. Make readings with the thermometer or device immersed in water long enough to permit complete equilibration. Report results to the nearest 0.1 or 1.0°C, depending on need.

The thermometer commonly used for depth measurements is of the reversing type. It often is mounted on the sample collection apparatus so that a water sample may be obtained simultaneously. Correct readings of reversing thermometers for changes due to differences between temperature at reversal and temperature at time of reading. Calculate as follows:

$$\Delta T = \left[\frac{(T^1 - t)(T^1 + V_0)}{K}\right] \times \left[1 + \frac{(T^1 - t)(T^1 + V_0)}{K}\right] + L$$

where:

ΔT = correction to be added algebraically to uncorrected reading,
T^1 = uncorrected reading at reversal,
t = temperature at which thermometer is read,
V_0 = volume of small bulb end of capillary up to 0°C graduation,
K = constant depending on relative thermal expansion of mercury and glass (usual value of $K = 6100$), and
L = calibration correction of thermometer depending on T^1.

If series observations are made it is convenient to prepare graphs for a thermometer to obtain ΔT from any values of T^1 and t.

3. Bibliography

WARREN, H.F. & G.C. WHIPPLE. 1895. The thermophone—A new instrument for determining temperatures. *Mass. Inst. Technol. Quart.* 8:125.

SVERDRUP, H.V., M.W. JOHNSON & R.H. FLEMING. 1942. The Oceans. Prentice-Hall, Inc., Englewood Cliffs, N.J.

AMERICAN SOCIETY FOR TESTING AND MATERIALS. 1949. Standard Specifications for ASTM Thermometers. No. E1-58, ASTM, Philadelphia, Pa.

REE, W.R. 1953. Thermistors for depth thermometry. *J. Amer. Water Works Assoc.* 45:259.

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[*] Some commercial thermometers may be as much as 3°C in error.

2560 PARTICLE COUNTING AND SIZE DISTRIBUTION (PROPOSED)*

2560 A. Introduction

1. General Discussion

Particles are ubiquitous in natural waters and in water and wastewater treatment streams. Particle counting and size distribution analysis can help to determine the makeup of natural waters, treatment plant influent, process water, and finished water. Similarly, it can aid in designing treatment processes, making decisions about changes in operations, and/or determining process efficiency. Methods for measuring particle size distribution included herein depend on electronic measurement devices because manual methods are likely to be too slow for routine analysis. However, when particle size analysis is to include size distribution of large (>500-µm) aggregates, use direct microscopic counting and sizing. Principles of various types of instruments capable of producing both size and number concentration information on particulate dispersions are included. Unless explicitly stated otherwise, the term "size distribution" means an absolute size distribution, i.e., one that includes the number concentration or count.

In most particle-counting instruments, particles pass though a sensing zone where they are measured individually; the only exception included is the static type of light-scattering instrument. Instruments create an electronic pulse (voltage, current, or resistance) that is proportional to a characteristic size of the particle.

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[*] Approved by Standard Methods Committee, 1993.

Catalog Number 6010018

1720E Low Range Turbidimeter

USER MANUAL

May 2007, Edition 7

Table of Contents

Section 1 Specifications

Specifications are subject to change without notice.

Table 1 1720E Low Range Specifications

<table>
<tr><td>Range</td><td>0–100 nephelometric turbidity units (NTU)</td></tr>
<tr><td>Measurement Units</td><td>mg/L, NTU, TE/F, FTU, Degree</td></tr>
<tr><td>Accuracy[1]</td><td>± 2% of reading or ± 0.02 NTU (whichever is greater) from 0 to 40 NTU;
± 5% of reading from 40 to 100 NTU (when calibration is performed at 20.0 NTU with the offset turned off).</td></tr>
<tr><td>Linearity[1]</td><td>Better than 1% 0–40 NTU on formazin. Allows for accurate calibration at high turbidity values.</td></tr>
<tr><td>Resolution (Displayed)</td><td>0.0001 NTU up to 9.9999 NTU; 0.001 NTU from 10.000 to 99.999 NTU; 0.01 NTU at 100.00 NTU</td></tr>
<tr><td>Repeatability</td><td>Better than ±1.0% of reading or ±0.002 NTU, whichever is greater</td></tr>
<tr><td>Response Time</td><td>For a full-scale step change, initial response in 1 minute, 15 seconds. Varies with flow rate, see the table below. The response time is also dependent on the signal averaging time, which is user selectable.
<table>
<tr><th rowspan="2">% Step Change</th><th colspan="3">Flow Rate</th></tr>
<tr><th>750</th><th>500</th><th>250</th></tr>
<tr><td>10</td><td>1¼ minutes</td><td>1½ minutes</td><td>2½ minutes</td></tr>
<tr><td>50</td><td>2 minutes</td><td>2½ minutes</td><td>6 minutes</td></tr>
<tr><td>90</td><td>3½ minutes</td><td>3½ minutes</td><td>9 minutes</td></tr>
<tr><td>99</td><td>4 minutes</td><td>5 minutes</td><td>12 minutes</td></tr>
</table></td></tr>
<tr><td>Sample Flow Required</td><td>250 to 750 mL/minute</td></tr>
<tr><td>Storage Temperature</td><td>–20 to 60 °C (–4 to 140 °F)</td></tr>
<tr><td>Operating Temperature</td><td>0 to 50 °C (32–122 °F) for single sensor system, 0 to 40 °C (32–104 °F) for two sensor system</td></tr>
<tr><td>Sample Temperature Range</td><td>0 to 70 °C</td></tr>
<tr><td>Operating Humidity</td><td>5 to 95% non-condensing</td></tr>
<tr><td>Power Requirements</td><td>12 VDC ± 5%, 12.5 Watts maximum</td></tr>
<tr><td>Sample Inlet Fitting</td><td>⅛ barb fitting to ¼-inch NPT male adapter</td></tr>
<tr><td>Signal Average Time</td><td>no averaging, 6, 30, 60, and 90 seconds, user selectable. Default is 30 seconds.</td></tr>
<tr><td>Dimensions</td><td>Turbidimeter body and cap: 25.4 x 30.5 x 40.6 cm (10 x 12 x 16 inches)</td></tr>
<tr><td>Sensor Cable Length</td><td>2 m (6.6 ft); Optional 7.62 m (25 ft)</td></tr>
<tr><td>Mounting Options</td><td>Turbidimeter Body and Head Assembly: Wall; floor stand</td></tr>
<tr><td>Shipping Weight</td><td>1720E Series 2 Turbidimeter and Controller: 6.31 kg (13.5 lb); 1720E Turbidimeter only: 4.71 kg (10 lb)</td></tr>
<tr><td>Calibration Methods</td><td>1. StablCal® (stabilized formazin) – primary or wet calibration of the instrument. Recommended at 20.0 NTU.
2. Formazin – user-prepared primary or wet calibration of the instrument. Recommended at 20.0 NTU.
3. Multi-sensor calibration – Performed with a specialized calibration procedure for up to eight sensors on a single set of fresh StablCal® standards.</td></tr>
</table>

Table 1 1720E Low Range Specifications (continued)

Verification (Wet) Method	**1.** StablCal® (stabilized formazin) – recommended for verification in the appropriate application range of measurement. For regulatory verification, standards of 0.1 to 50 NTU. **2.** Formazin – fresh user-prepared standard
Verification (Dry) Method	**1.** ICE-PIC™ Verification Module with factory-set values of 20.0 or 1.0 ±25%. Unique value is assigned when dry verification is done immediately after calibration and is used as pass/fail criteria for subsequent verifications.
Recommended Maintenance	**1.** Lamp replacement: once per year. **2.** Cleaning: mandatory before calibration, optional before calibration, and mandatory upon verification failure.
Installation Environment	Indoor
Primary Compliance Method	USEPA 180.1; Hach Method 8195; ASTM D 6698; Standard Methods 2130B
Limit of Detection[1]	0.0032 NTU (according to criteria specified by ISO 15839)

[1] All specifications are based on a calibration with 20.0 NTU formazin and with the offset turned off.

2.1 Safety Information

Please read this entire manual before unpacking, setting up, or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure that the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that specified in this manual.

2.1.1 Use of Hazard Information

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

Important Note: *Information the requires special emphasis.*

Note: *Information that supplements points in the main text.*

2.1.2 Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists.
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground).

2.1.3 General Product Information

The 1720E Turbidimeter is a continuous-reading nephelometric turbidimeter designed for low-range turbidity monitoring. This process turbidimeter is capable of measuring turbidity from 0.001 to 100.0 NTU. Calibration is based on formazin, the primary turbidity reference standard adopted by the APHA *Standard Methods for the Examination of Water and Wastewater* and the U.S. Environmental Protection Agency (EPA) and on StablCal® which is also recognized as a primary standard.

The 1720E Turbidimeter can be operated using an sc controller. Refer to the Operation section (Section 5 on page 15) for more information.

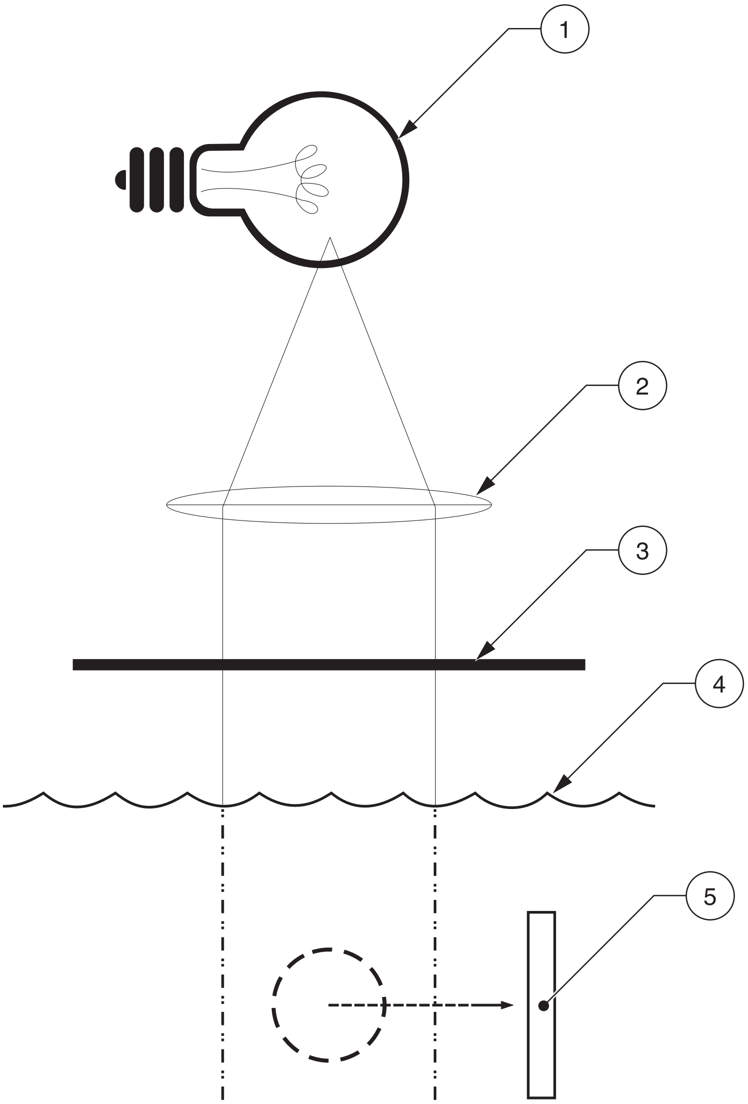
2.2 Theory of Operation

The 1720E Turbidimeter measures turbidity by directing a strong beam of collimated light from the sensor head assembly down into the sample in the turbidimeter body. Light scattered at 90° relative to the center line of incident light by suspended particles in the sample is detected by the submerged photocell (Figure 1).

The amount of light scattered is proportional to the turbidity of the sample. If the turbidity of the sample is negligible, little light will be scattered and detected by the photocell and the turbidity reading will be low. High turbidity, on the other hand, will cause a high level of light scattering and result in a high reading.

Sample enters the turbidimeter body and flows through the baffle network of the bubble trap. The flow allows bubbles to either cling to surfaces of the baffle system or rise to the surface and vent to atmosphere. After traveling through the bubble trap, sample enters the center column of the turbidimeter body, rises into the measuring chamber and spills over the weir into the drain port. A reading is taken once per second.

Figure 1 **90 Degree Detector**



1. Lamp	**3.** Aperture	**5.** 90° Detector
2. Lens	**4.** Water Level	

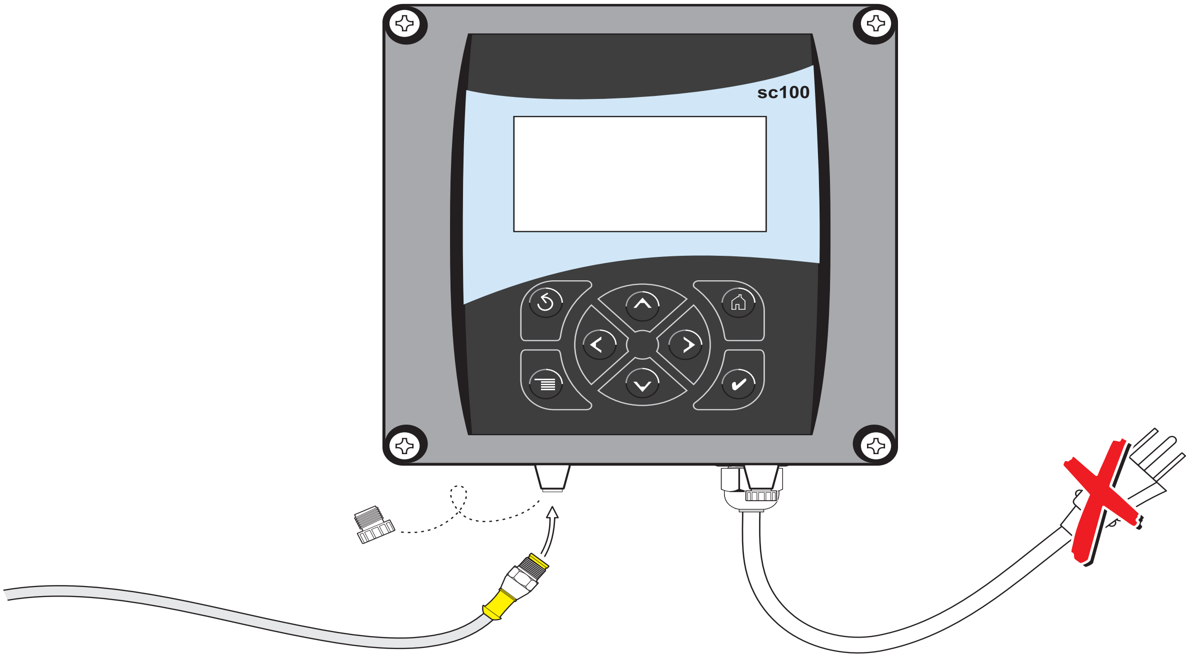
DANGER
Only qualified personnel should conduct the tasks described in this section of the manual. The 1720E/sc100 product configuration is not intended for installation in hazardous locations.

3.1 Connecting/Wiring the Sensor to the sc100 Controller

3.1.1 Attaching a sc Sensor with a Quick-connect Fitting

The sensor cable is supplied with a keyed quick-connect fitting for easy attachment to the controller, see Figure 2. Retain the connector cap to seal the connector opening in case the sensor must be removed. The 1720E sensor cable may be extended by a maximum of 7.62 m (25 ft), see Replacement Parts and Accessories on page 31.

Figure 2 Attaching the Sensor using the Quick-connect Fitting



3.1.2 Hard-wiring a sc Sensor to the sc100 Controller

1. Disconnect power to the controller if powered.

2. Open the controller cover.

3. Disconnect and remove the existing wires between the quick-connect and terminal strip J5, see Figure 3.

4. Remove the quick-connect fitting and wires and install the threaded plug on the opening to maintain the environmental rating.

5. Cut the connector from the sensor cable.

6. Strip the insulation on the cable back 1-inch. Strip ¼-inch of each individual wire end.

7. Pass the cable through conduit and a conduit hub or a strain relief fitting (Cat. No. 16664) and an available access hole in the controller enclosure. Tighten the fitting.

***Note:** Use of strain relief fitting other than Cat. No. 16664 may result in a hazard. Use only the recommended strain relief fitting.*

8. Reinstall the plug on the sensor access opening to maintain the environmental rating.

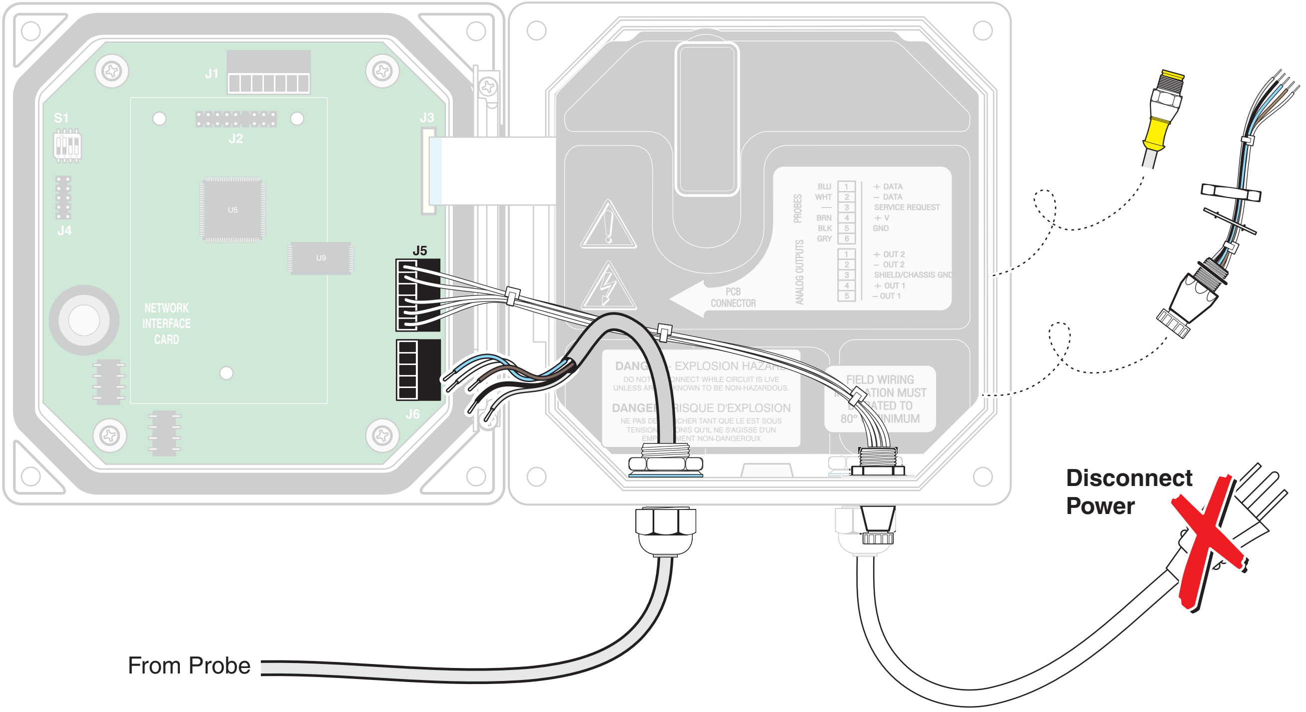
9. Wire as shown in Table 2 and Figure 3.

10. Close and secure the cover.

Table 2 Wiring the Sensor at Terminal Block J5

Terminal Number	Terminal Designation	Wire Color
1	Data (+)	Blue
2	Data (–)	White
3	Service Request	No Connection
4	+12 V dc	Brown
5	Circuit Common	Black
6	Shield	Shield (grey wire in existing quick disconnect fitting)

Figure 3 Hard-wiring the Sensor



3.2 Connecting the Sensor to the sc1000 Controller

3.2.1 Connecting the Sensor using the Quick-connect Fittings

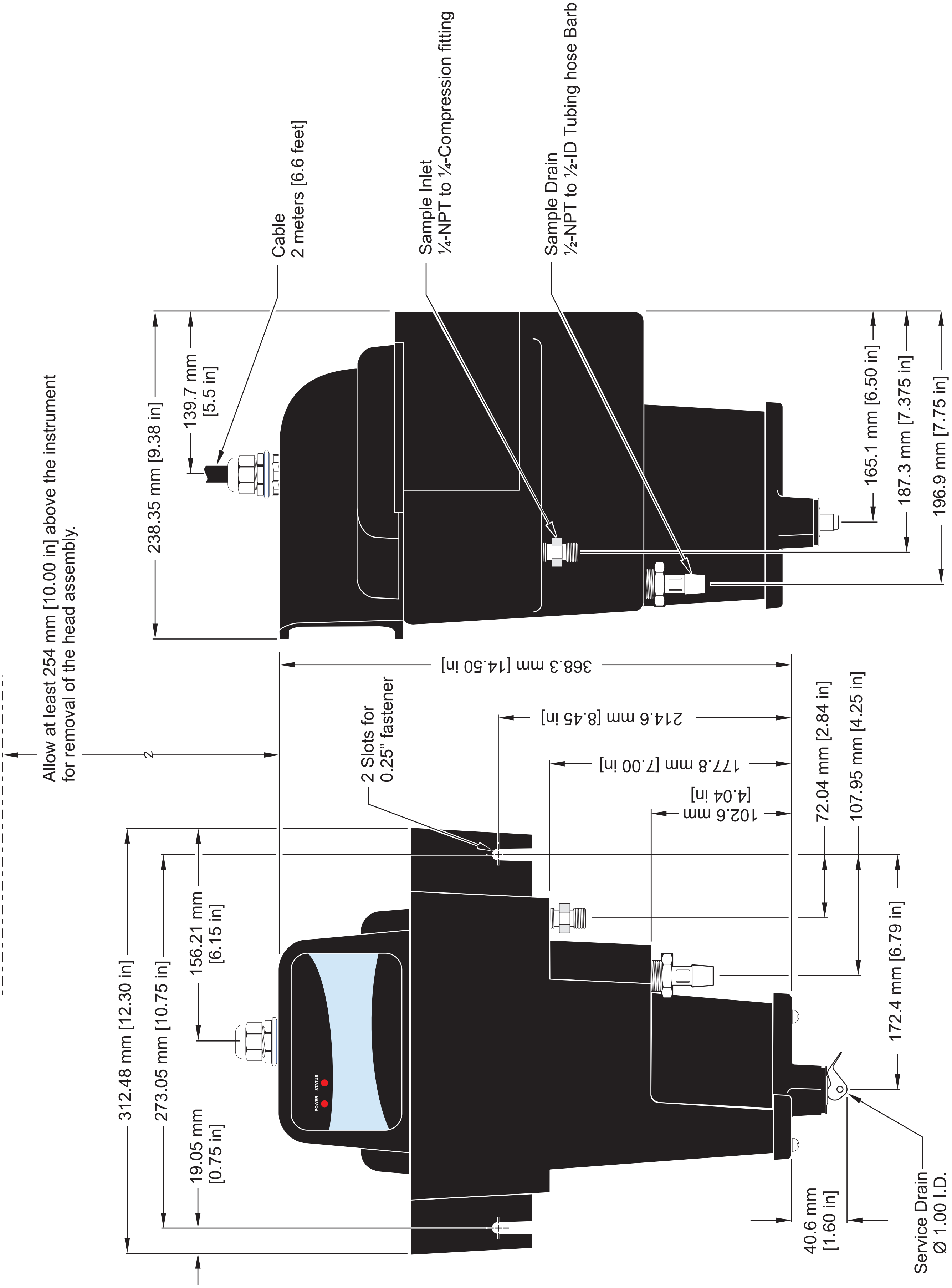
1. Unscrew the connector cap from the controller. Retain the connector cap to seal the connector opening in case the sensor must be removed.
2. Push the connector into the socket.
3. Hand-tighten the union nut.

Note: *Do not use the middle connection for the sensors as this is reserved for the display module.*

3.3 Turbidimeter Installation Information

The turbidimeter body is designed for wall-mounting (although it may be mounted on the optional floor stand). The turbidimeter sensor must be mounted within six feet of the controller unless an extension cable is used. Maximum cable length is 9.6 m (31 feet).

Figure 4 1720E Dimensions



3.3.1 Mounting the Turbidimeter Body

Locate the turbidimeter as close to the sampling point as possible. A shorter distance for the sample to travel results in a faster response time.

Clean the turbidimeter body and bubble trap before installation using the instructions supplied in section 6.4.2 on page 24. Slotted mounting brackets are integral parts of the turbidimeter body. Install customer-supplied hardware appropriate for the installation environment using the criteria detailed below:

- Install in a location that is isolated from vibration.
- Allow at least 22 cm (approximately 10 inches) clearance for removal of the head assembly and bubble trap cover from the top of the turbidimeter body.
- Leave enough room below the turbidimeter body to remove the bottom plug and to place a container under the drain when calibrating or cleaning.

Note: *Make sure the top of the turbidimeter body is level.*

- Install two ¼-20 bolts 10-3/4 inches apart (on center). Leave at least ¼-inch of the bolt head exposed.
- Make sure the bolts are installed level.

Slide the slotted mounting brackets of the turbidimeter body onto the bolts.

3.3.2 Installing the Head Assembly

After the turbidimeter body has been mounted, install the bubble trap cover, then place the head assembly on the turbidimeter body with the label facing the front. Move the head assembly back and forth slightly to ensure it is properly seated on the body of the instrument. Failure to properly seat the head will result in light leakage and erroneous readings.

The rear portion of the head assembly has a molded “lip” which may be used to hang the head assembly on the turbidimeter body edge for routine maintenance.

3.4 Installing a Sample Line

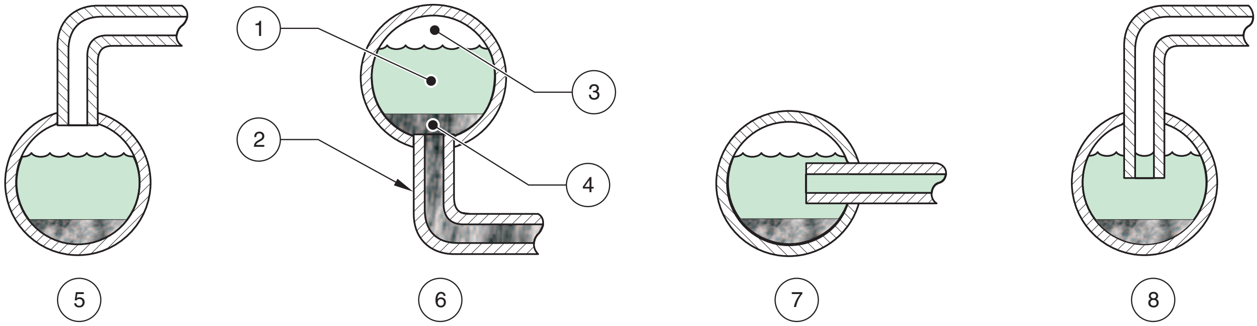
DANGER
This turbidimeter is not designed for use in hazardous locations or with samples that are flammable or explosive in nature. If any sample solution other than water is used in this product, test the sample/product compatibility to ensure user safety and proper product performance.

One-fourth inch OD rigid or semi-rigid tubing is recommended for sample lines. Run them as directly as possible between the turbidimeter body and the sampling point to minimize sample flow lag time.

Install sample line taps into larger process pipes to minimize interference from air bubbles or pipeline bottom sediment. A tap projecting into the center of the pipe is ideal. Figure 5 shows examples of sample tap installations.

Note: *When setting the flow rate, take care to avoid sweeping air “micro-bubbles” through the internal bubble trap. Observe the sample flow inside the turbidimeter body. If small air bubbles can be seen flowing up through the center, reduce the flow rate.*

Figure 5 Sampling Techniques



1. Sample Flow	**4.** Sediment (Typical)	**7.** Good
2. Sampling Line to Sensor	**5.** Poor	**8.** Best
3. Air (Typical)	**6.** Poor	

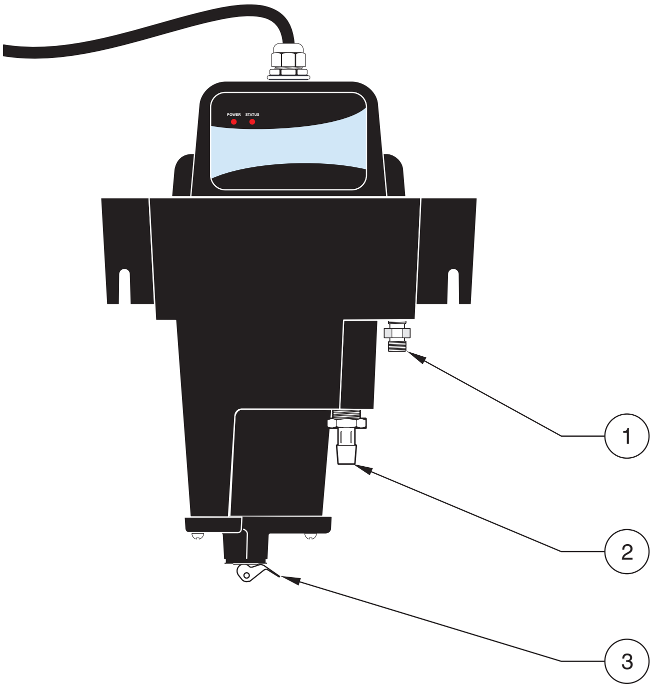
3.5 Sample Connections

Sample inlet and drain connections are made on the turbidimeter body. The sample inlet fitting installed in the body is a ¼-inch NPT x ¼-inch compression fitting. One additional fitting supplied with the instrument is a ½-inch NPT-to-hose fitting for use with ½-inch ID flexible plastic tubing on the drain.

Note: *For samples with high solids content (high turbidity), operate at the highest flow rate possible. For samples with low solids content (low expected turbidity), operate at a low flow rate (200–300 mL/min).*

The required flow rate is 200 to 750 mL/min (4.0 to 11.9 gal/hour). Flow rate into the turbidimeter may be controlled with a flow restriction device on the inlet line. Flow rates below 200 mL/min will reduce response time and cause inaccurate readings. Flow rates above 750 mL/min will cause the turbidimeter to overflow, indicating flow rate is too high.

Figure 6 Sample Connections



1. Sample Inlet, ¼-28 NPT x ¼-inch Compression fitting	**2.** Drain, ½-inch NPT fitting	**3.** Service Drain

Section 4 System Startup

4.1 General Operation

Plug the sensor into the unpowered controller by aligning the orientation tab on the cable connector with the channel in the controller connector. Push in and turn to secure the connection. Tug gently to check the connection.

After all plumbing and electrical connections have been completed and checked, place the head on the body and supply power to the system. Ensure the head is seated on the body when power is applied, since dark readings are measured at this time. If power is applied while the sensor head is off the turbidimeter body, cycle the power with the sensor head on the body.

The first time a controller is powered up, a language selection menu will appear. The user must select the correct language from the displayed options.

Following language selection and upon power-up, the controller will search for connected sensors. The display will show the main measurement screen.

4.2 Starting Sample Flow

Start sample flow through the instrument by opening the sample supply valve. Allow the turbidimeter to run long enough for the tubing and body to become completely wetted and the reading on the display to stabilize. One to two hours or longer may be required initially for complete stabilization. Allow measurements to become stable through adequate conditioning before completing instrument settings or performing calibrations.

Section 5 Operation

5.1 Sensor Setup

When a sensor is initially installed, the serial number of the sensor will be displayed as the sensor name. To change the sensor name refer to the following instructions:

1. Select Main Menu.
2. From the Main Menu, select SENSOR SETUP and confirm.
3. Highlight the appropriate sensor if more than one sensor is attached and confirm.
4. Select CONFIGURE and confirm.
5. Select EDIT NAME and edit the name. Confirm or cancel to return to the Sensor Setup menu.

5.2 Sensor Data Logging

The sc100 provides two data logs (one for each sensor) and two event logs (one for each sensor). The data logs store the measurement data at selected intervals. The event log stores a variety of events that occur on the devices such as configuration changes, alarms, and warning conditions. The data logs are stored in a packed binary format and the event logs are stored in a CSV format. The logs can be downloaded through the digital network port, service port, or the IrDA port. DataCom is needed for downloading logs to a computer. If the datalogging frequency is set to 15 minute intervals, the instrument can continue to store data for approximately six months.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select CONFIGURE and confirm.
3. Select the datalog interval (30 seconds, 1 minute, 5 minutes, 10 minutes or 15 minutes). Confirm.

5.3 Sensor Diagnostics Menu

SELECT SENSOR	
ERROR LIST	See section 7.1 on page 27.
WARNING LIST	See section 7.2 on page 27.

5.4 Sensor Setup Menu

SELECT SENSOR (if more than one sensor is attached)	
CALIBRATE	
USER PREPD CAL	Calibration using 4000 NTU stock solution diluted to 20.00 NTU formazin.
STABLCAL CAL	Calibration using 20 NTU StablCal Stabilized Formazin Standard
VERIFICATION	Perform a verification, set the pass/fail criteria, and view the verification history.
0 ELECTRONICS	Zero electronics
CAL HISTORY	View the last 12 entered calibrations. Confirm to move to the next history entry. See section 5.6 on page 20 for more information.
CONFIGURE	
BUBBLE REJECT	Choose Yes or No to enable/disable bubble reject. Default: Yes
SIGNAL AVG	Choose no averaging or specify the amount of time for signal averaging. Available options are: no averaging, 6 sec., 30 sec., 60 sec., or 90 sec. Default is 30 seconds.
MEAS UNITS	Select the appropriate measurement units to display. Choose from mg/L, NTU, TE/F, FTU and Degree. Default: NTU
EDIT NAME	Enter up to a 12-digit name in any combination of symbols and alpha or numeric characters. Confirm when the entry is complete. The name will be displayed on the status line above the measurement value on the main display.
SET RESOLUTION	Set the number of significant digits to display. Default is three significant digits.
DATALOG INTRVL	Choose the amount of time between saving data points to the data log. Default: 15 min.; Options: 30 sec., 1 minute, 5 minutes, 10 minutes, or 15 minutes.
OFFSET	Enter an offset between –0.05 to 0.05 NTU. Values outside this range are not accepted.
DIAG/TEST	
SOFTWARE VERS.	Displays the software version number.
SERIAL NUMBER	Displays the serial number of the sensor.
INT TEMP	Displays the internal temperature of the sensor electronics in °C.
DEFAULT SETUP	Restores the sensor's factory default settings and invalidates the current calibration.
POWER CHECK	Displays the electrical statistics for the sensor.
SERVICE MODE	Choose On or Off to enable/disable service mode. Default: Off
SERVICE DIAGS	Passcode protected. Menu options only available to service personnel.

5.5 Sensor Calibration and Verification

The manufacturer offers two EPA-approved calibration methods one using user-prepared formazin and the other using StablCal® Stabilized Formazin. Two verification methods (wet and dry) are also offered.

The 1720E Turbidimeter is factory-calibrated using StablCal Stabilized Formazin before shipment. **The instrument must be recalibrated before use to meet published accuracy specifications.** In addition, recalibration is recommended after any significant maintenance or repair and at least once every three months during normal operation. **The turbidimeter body and bubble trap must be thoroughly cleaned and rinsed before initial use and prior to each calibration.**

Tips to achieve the most accurate calibrations:

- Optimum performance is achieved when calibration is performed in the turbidimeter body. Accurately prepare the standard then add it to the turbidimeter body at the appropriate step in the procedure. Do not prepare the standard in the body.

- Stop sample flow, drain, and clean the turbidimeter body before beginning the calibration procedure.
- Always clean the photocell window per the instructions in section 6.4.1 on page 24. Rinse the photocell with deionized water and dry with a soft, lint-free cloth before calibrating.
- Always clean the turbidimeter body or calibration cylinder per the instructions in section 6.4.2 on page 24. Rinse with deionized water before calibrating.
- Store the calibration cylinder upside-down to minimize contamination between calibrations.
- Pour the calibration standard into the turbidimeter body at the inflow end (left side when facing the instrument).
- Gently invert StablCal standards for 1 minute before opening. Do not shake. This ensures a consistent turbidity of the standard.
- If the 20.0 NTU StablCal standard is allowed to sit in the calibration cylinder or turbidimeter body for more than 15 minutes, it must be remixed (gently swirled in the calibration cylinder) before use to ensure a consistent turbidity.
- Discard all standards after use per the instructions on the container. Never transfer the standard back into its original container. Contamination will result.
- Always recalibrate after restoring default settings.

5.5.1 User-prepared Calibration

The user-prepared calibration is a two-step calibration in which the difference between the DI water and the standard value is used to determine the gain of the instrument. The water used for the standard solution must be from the same source as that which the DI water measurement is made. Variation in dilution of the water source could negatively impact the accuracy of the calibration. **The manufacturer does not recommend calibrating below 1.0 NTU, and instrument specifications are based on the calibration point at 20 NTU.** Before starting the calibration, read and apply the tips in section 5.5 on page 16.

Follow the procedure as written (using 1 L of deionized water and 5.0 mL of 4000 NTU formazin) **if using a calibration cylinder** for calibration.

If using the turbidimeter body for the user-prepared calibration follow the procedure below using 20.0 NTU formazin in step 12. Follow the steps below for proper calibration:

1. Stop the sample flow, then drain and clean the body.
2. Prepare a 20.0 NTU standard by adding 5.0 mL of 4000 NTU formazin to a 1-L flask. Dilute to the mark with deionized water and invert gently to mix.
3. Drain the deionized water and pour the prepared 20.0 NTU standard into the turbidimeter body at step 12. Do not add additional 4000 NTU formazin.
4. From the Main Menu, select SENSOR SETUP and confirm.
5. Select the appropriate sensor if more than one is connected and confirm.
6. Select CALIBRATE and confirm.
7. Select USER PREPD CAL and confirm.
8. Select the available Output Mode (Active, Hold, or Transfer) from the list and confirm.

9. Stop the sample flow. Drain and clean the body and bubble trap. Fill the cylinder with 1 L deionized water. Replace the head and confirm.

Important Note: *Carefully pour the DI water in such a way that minimizes any bubble formation that would result in a false, high reading.*

10. The measured reading (based on a gain of 1.0) is displayed. Confirm.

11. Enter the standard turbidity value of the user prepared standard and confirm.

12. Drain the cylinder. Pour the prepared standard into the cylinder and confirm.

13. The measured reading (based on a gain of 1.0) is displayed. Confirm.

14. The display will read GOOD CAL! GAIN: X.XX ENTER TO CONT. Confirm. (If the calibration was unsuccessful, the display will read BAD CAL! Confirm to redo or exit.)

15. The display will read VERIFY CAL? Confirm to verify or exit without verification.

Note: *If a dry verification is performed directly after a calibration, the measured value is assigned as the expected value for future verifications (when using the dry verification device with the same serial number). As long as the verification exists within the verification history, the expected value will be retained. Otherwise, the expected value will be the nominal labeled value associated with the dry verification device.*

16. Select the verification type (begin at step 5 in section 5.5.3.1 on page 19 for dry verification or section 5.5.3.2 on page 19 for wet verification) or enter initials to complete calibration.

17. Return the sensor to measure mode and confirm.

5.5.2 Calibration with StablCal®

Before starting the calibration, read and apply the tips in section 5.5 on page 16.

1. From the Main Menu, select SENSOR SETUP and confirm.

2. Select the appropriate sensor if more than one is connected and confirm.

3. Select CALIBRATE and confirm.

4. Select STABLCAL CAL and confirm. Select the available Output Mode (Active, Hold, or Transfer) from the list and confirm.

5. Enter the standard turbidity value of the user prepared standard and confirm.

6. Drain/clean/rinse the turbidimeter body or cal cylinder. Pour the 20 NTU standard into the cylinder body. Replace the head and confirm.

7. The measured reading (based on a gain of 1.0) is displayed. Confirm.

8. The display will read GOOD CAL! GAIN: X.XX ENTER TO CONT. Confirm. (If the calibration was unsuccessful, the display will read BAD CAL! Confirm to redo or exit.)

9. The display will read VERIFY CAL? Confirm to verify or exit without verification.

Note: *If a dry verification is performed directly after a calibration, the measured value is assigned as the expected value for future verifications (when using the dry verification device with the same* *serial number). As long as the verification exists within the verification history, the expected value will be retained. Otherwise, the expected value will be the nominal value associated with the dry verification device.*

10. Select the VERIFICATION type (begin at step 5 in section 5.5.3.1 on page 19 for dry verification or section 5.5.3.2 on page 19 for wet verification) or enter initials to complete calibration.

11. Return the sensor to measure mode and confirm.

5.5.3 Instrument Verification

Instrument verification is intended as a simple check to ensure Turbidimeter functionality between calibrations. Two types of verifications are offered. The dry verification is performed using a “dry” calibration device such as the ICEPIC™. A wet verification is performed using a standard with a predetermined value such as StablCal® Stabilized Formazin.

A dry verification directly after calibration is used to establish the baseline. Any verification afterwards, until the next calibration, that uses the same dry verification standard will reference the recorded value from the baseline verification as the “expected” value. In order for the verification to pass, the measured value should be within the limits set by the Pass/Fail Criteria of the baseline value.

5.5.3.1 Dry Verification

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select CALIBRATE and confirm.
3. Select VERIFICATION and confirm.
4. Select PERFORM VER and confirm. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.
5. Select DRY for the verification type and confirm.
6. Select 1 NTU STD or 20 NTU STD or verify SN of previously used calibration device and confirm.
7. Set the Head to Standard and confirm. Confirm again to accept the reading.
8. The display will read GOOD VER!. Confirm.
9. Enter initials and confirm.
10. Return the sensor to measure mode and confirm.

5.5.3.2 Wet Verification

Before starting the verification, read and apply the appropriate tips in section 5.6. For wet verification values at or below 1.0 NTU, only use the cleaned turbidimeter body.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select CALIBRATE and confirm.
3. Select VERIFICATION and confirm.

4. Select PERFORM TEST and confirm. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.
5. Select WET for the verification type and confirm.
6. Enter the Std Turbidity and confirm.
7. Drain and clean the sensor body and confirm.
8. Pour the standard into cylinder. Replace the head and confirm.
9. The reading will be displayed. Confirm to accept the verification.
10. Return the sensor to measure mode and confirm.

5.6 Calibration and Verification History

The calibration and verification history logs contain information on the last 12 calibrations and the last 12 verifications. The calibration history log shows the gain value, the time and date of the calibration, and the initials of the operator performing verification.

Note: *Restoring default settings from the DIAG/TEST menu will return the turbidimeter to its non calibration state (gain = 1.0) but it will not remove the previous calibration history from memory.*

The calibration history log is accessed from the Calibrate menu. The verification history log is accessed from the Verification menu (a submenu of the Calibrate menu).

Each verification history entry shows the serial number of the verification device (dry verification) or the value of the verification standard (wet verification), the time and date of the verification, and the initials of the operator performing the verification.

Scroll through the entries by pressing the **ENTER** key. After scrolling through all 12 histories, the display will return to the calibration menu level.

When the instrument is received from the factory, default values or blank spaces will be shown for the calibration and verification history information. Those values will be replaced with real data as the history log is filled.

The data is retained as first in, first out. When the log is full, the newest entry is stored and the oldest entry in the log is deleted.

5.7 Offset Feature

The offset or clean water offset (CWO) feature will allow a ± 0.05 NTU offset to the measured value. The offset value denoted as CWO will be subtracted from the value displayed on the sc Interface. The 0.05 NTU offset can be entered after a calibration is complete and is based on an independent determination of the water used in the preparation of the turbidity standards.

Note: *The offset is a limited value. An offset outside the range of ± 0.05 mg/L, ± 0.05 NTU, ± 0.05 TE/F, ± 0.05 FTU or ± 0.05 Degree will not be accepted.*

For example, if a standard is prepared with a value of 0.8 NTU, the 0.05 NTU offset would result in a displayed value of 0.75 NTU. See the Setting the Offset section to change the offset value. When the offset is used, the letters CWO are displayed after the turbidity value in the upper-right corner.

5.7.1 Setting the Offset

Follow the steps below to enter an offset:

Note: *The data log for this channel will be erased if the offset is changed to anything other than zero.*

1. From the Main Menu select SENSOR SETUP and confirm.
2. Select 1720E and confirm.
3. Select CONFIGURE and confirm.

Note: *Offset is not used during calibration. During calibration the offset is zero.*

4. Move the pointer to OFFSET and confirm.
5. The display will show an Offset screen. Use the arrow keys to enter the offset. The value entered must be between –0.05 to 0.05 NTU, values outside this range are not accepted.
6. Confirm to accept the offset reading.

Section 6 Maintenance

DANGER
Only qualified personnel should conduct the tasks described in this section of the manual.

6.1 Maintenance Schedule

Maintenance Task	**Frequency**
Clean the sensor	Before each calibration and as needed. Depends on sample characteristics.
Calibrate Sensor (as required by regulatory agency)	Per agency-dictated schedule.

Scheduled periodic maintenance requirements of the 1720E are minimal and include calibration and cleaning of the photocell window, bubble trap, and body. Check and clean the bubble trap and turbidimeter body (as described in section 6.4.2) if visual inspection shows that it is necessary. Perform other maintenance on a regular basis; experience will dictate scheduling and may depend on the installation, sample type, and season.

It is very important to maintain the cleanliness of the interior and exterior of the turbidimeter body, head assembly, the integral bubble trap, and the surrounding area. Doing so will ensure accurate, low-level turbidity measurements.

Clean the turbidimeter body before performing any calibration or wet verification (especially when measurements are being made at 1.0 NTU or lower).

Check and/or perform a calibration periodically (as experience dictates) using one of the methods described in section 5.5 on page 16*.* A calibration history menu option is available under Sensor Setup/Calibrate.

6.2 Removing a Sensor from the System

Prior to physically removing a sensor from the system, record all user defined settings such as relays, signal averaging, etc. Disconnect the sensor connector at the controller.

6.3 Reinstalling a Sensor on the System

To return the system to normal operation following a software upgrade or sensor repair perform the following procedure:

1. Detach all sensors from the sc100 controller.
2. From the main menu, press the down arrow key to highlight TEST/MAINT. Press **ENTER**.
3. Use the down arrow key to scroll to SCAN SENSORS and press **ENTER**.
4. Remove attached sensors by selecting the corresponding serial number or select “All”.
5. **Power down the sc100 then attach the 1720E.**

Note: *Clean sensors before reinstallation on the system.*

6. Supply power to the sc100. The system will initialize automatically.

6.4 Cleaning

6.4.1 Cleaning the Photocell Window

Occasional cleaning of the photocell window is required. The frequency will depend on the nature and concentration of dissolved and suspended solids in the sample. Biological activity is a primary factor in mineral scale deposit on the window and the amount differs with sample temperature. In general, more growth will occur in warm temperatures and less in cold.

Note: *Do not disassemble the photocell assembly. It contains liquid.*

Note: *Take care to not scratch the photocell window.*

Inspect the photocell window often to determine cleaning needs. Remove any organic growth or film on the photocell window before standardization or calibration. Use a cotton swab and isopropyl alcohol or a mild detergent (such as Liqui-nox®) to remove most sediment and dirt. Mineral scale buildup may require cleaning with a mild acid applied with a cotton swab followed by a detergent wash. **Do not use abrasive cleaners.**

6.4.2 Cleaning the Turbidimeter Body and Bubble Trap

Sediment may collect in the turbidimeter body after extended use. Noise (fluctuation) in the reading could indicate the need to clean the body and/or bubble trap. The 1720E bubble trap and bottom plate may be removed to make cleaning easier. Drain and clean the turbidimeter body before each calibration. Establish a regular schedule or perform cleaning as determined by visual inspection.

Cleaning the Turbidimeter Body

Note: *The turbidimeter body, bubble trap, and detector must be cleaned before each calibration.*

1. Turn off sample flow to the turbidimeter body.
2. Remove the head assembly and bubble trap cover from the body. Remove the bubble trap by lifting it vertically. Set it aside to be cleaned separately.
3. Drain the body by removing the plug from the bottom of the body.
4. Replace the drain plug and fill the body to the weir with cleaning solution. This cleaning solution can consist of dilute chlorine solution (25 mL of household bleach in 3.78 liters of water) or a laboratory detergent such as Liqui-nox (1 mL detergent in 1 liter of water).
5. Use a soft brush to clean the inside surfaces of the body.
6. Remove the drain plug again and thoroughly flush the turbidimeter body with ultra-filtered deionized water. Clean and replace the plug.

Cleaning the Bubble Trap

1. Prepare a cleaning solution (as in step 4 above) in a container large enough to submerge the entire bubble trap.
2. Using a test tube brush such as Cat. No. 690-00, clean each surface.
3. Rinse the bubble trap thoroughly with ultra-filtered deionized water and reinstall it in the turbidimeter body.

4. Replace the bubble trap cover and head assembly on the top of the body.
5. Restore sample flow to the instrument.
6. Calibrate the instrument using one of the methods in section 5.5 on page 16.

If the above cleaning procedures have been performed and the turbidimeter readings are still noisy, the bottom plate and gasket may need to be removed and cleaned. Carefully perform the following procedure to ensure the turbidimeter body integrity is maintained.

1. Turn off sample flow to the turbidimeter body.
2. Remove the head assembly, bubble trap cover, and bubble trap (by lifting it vertically) from the body.
3. Drain the body by removing the plug from the bottom of the body.
4. Lift the body off of its mounting screws.
5. With the body turned upside-down, remove the two Phillips-head screws holding the bottom plate.
6. Lift the bottom plate off the body; set the gasket aside for use in reassembly.
7. Use a soft brush and a dilute cleaning solution (as prepared above) to clean the bottom plate and inside surfaces of the turbidimeter body. Rinse the entire body and bottom plate with ultra-filtered deionized water.
8. Reassemble by inserting the gasket into the molded channel in the bottom plate.
9. Fit the bottom plate onto the turbidimeter body.
10. Reinstall both screws and carefully tighten to 15 inch-lb maximum.
11. Reinstall the turbidimeter onto the wall mounting screws.
12. Replace the bubble trap, bubble trap cover, and head assembly on the top of the body.
13. Restore sample flow to the instrument.

6.4.3 Replacing the Lamp Assembly

The Lamp Assembly is located on the head assembly. Under normal use, Hach recommends replacing the lamp once a year to maintain peak performance. Replacement bulbs have been “burned-in” at the factory and are ready for installation and use.

To change the lamp, refer to Figure 7 on page 26 and perform the following steps:

1. Disconnect power to the controller to remove all power to the turbidimeter.
2. Disconnect the lamp leads by unplugging the connector.

3. After the bulb has cooled, remove as follows:

   a. Wear cotton gloves to protect your hands and to avoid fingerprints on the bulb.

   b. Grasp the bulb.

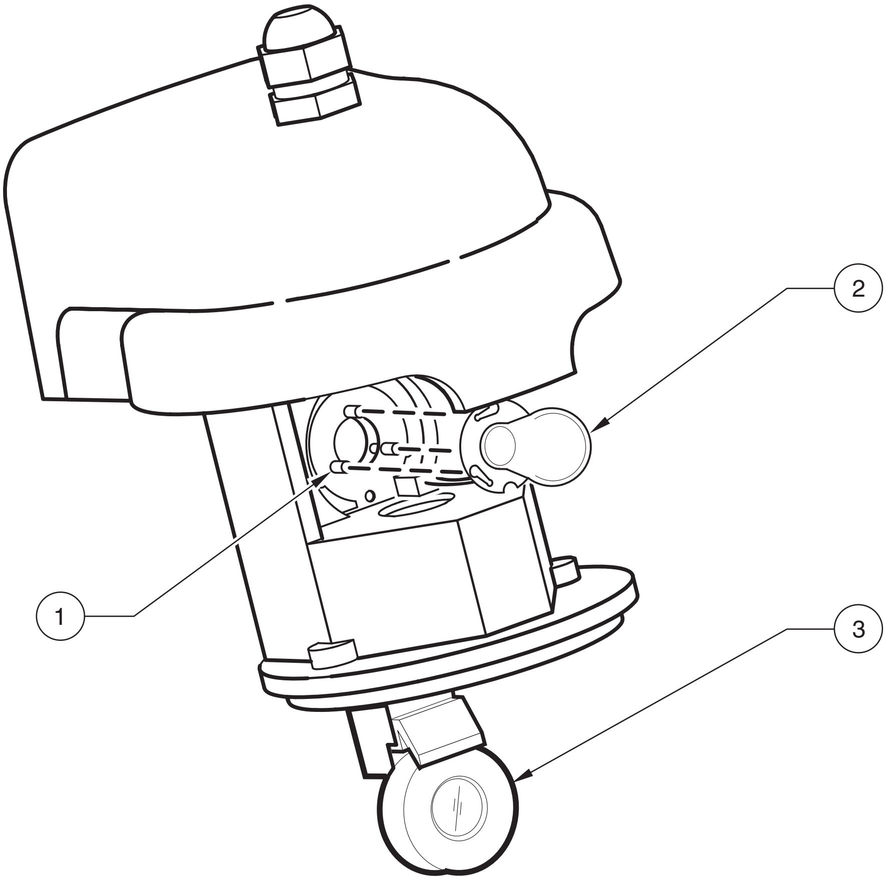
   c. Twist the bulb in a counterclockwise direction, pulling out slightly, until it is released from the housing.

   d. Pull the lamp leads and connector through the hole in the lamp housing.

Do not touch the new bulb with bare hands. Etched glass and reduced lamp life will result. Wear cotton gloves or grasp the lamp assembly with a tissue to avoid contamination. If contamination occurs, clean the glass bulb portion with isopropyl alcohol.

Replace the bulb by reversing the above instructions. The bulb base only fits one way; align the notch in the metal bulb flange with the hole in the lamp holder.

Figure 7 **Lamp Replacement**



1. Lamp Housing	**2.** Lamp Assembly	**3.** Photo Detector

Section 7 Troubleshooting

7.1 Error Codes

When a sensor is experiencing an error condition, the sensor reading on the measurement screen will flash and all relays and analog outputs associated with the sensor will be held.

Highlight the Probe Diag menu and press **ENTER**. Highlight Errors and press **ENTER** to determine the case of the error. Errors are defined in Table 3.

Table 3 Error Codes

Displayed Error	Definition
A/D Fail	Failed A/D converter. Call the Service Department.
Lamp Fail	The light source has failed. See section 6.4.3 on page 25 for instructions for replacing it.
Flash Fail	Datalog and event log will not work.

7.2 Warnings

A sensor warning will leave all menus, relays, and outputs functioning normally, but will cause a warning icon to flash on the right side of the display. Highlight the Probe Diag menu and press **ENTER** to determine the cause of the error. Warnings are defined in Table 4.

A warning may be used to trigger a relay and users with the sc100 controller can set warning levels to define the severity of the warning (see the sc100 controller user manual for more information about warning levels). Errors are defined in Table 4.

Table 4 Warning Codes

Warning Number	Displayed Warning	Definition/Resolution
1	Dark Reading Warning	Dark reading detects too much light. (> 0.05 NTU)
2	Temp Warning	Sensor head internal temperature is higher than specified. Contact the Service Department. (> 70 °C)
3	Data Log Full	Sensor data log is full. No additional data will be logged until sensor log is downloaded into controller memory.
4	Event Log Full	Sensor data log is full. No additional data will be logged until sensor log is downloaded into controller memory.
5	5 Volt Warn	Monitored voltage is outside the range of 4.5–5.5 V.
6	Inp V Warn	Monitored voltage is outside the range of 9.08–14.13 V.
7	Lamp Volt Warn	Monitored voltage is outside the range of 3.96–4.48 V.
8	Lamp Curr Warn	Monitored current is outside the range of 1.67–2.75 Amps.
9	Output Mode Warn	Activated when the sensor is not in normal measurement mode (such as when in calibration or verification mode).

Table 5 presents sensor warnings displayed in the Event Log, possible causes, and corrective actions.

Table 5 General Troubleshooting

Sensor Warning	Possible Cause	Corrective Action
Bad Lamp	Lamp burned out	Replace the lamp. See section 6.4.3 on page 25.
	Lamp unplugged	Restore connection
	+12 V connection loose at controller	Restore connection
	Dislodged lamp	Reinstall lamp
	Bad circuit board in turbidimeter head	Contact the Customer Service Department.
Low Signal	Photocell coated/dirty	See section 6.4.1 on page 24. Contact the Customer Service Department.
	Photocell wires disconnected	Reconnect wires
	Photocell broken/cracked	Replace photocell Contact the Customer Service Department.
	Lens coated/dirty	Clean the lens using isopropyl alcohol and a cotton swab.
	Obstructed light path	Remove obstruction
	See Bad Lamp causes above	See Bad Lamp corrective actions above
Bad System Voltage	Improper wiring at controller	Refer to section 3.1 on page 7.
	Turbidimeter head cable shortened to improper length	Contact the Customer Service Department.
	Fluctuation in voltage	Turn instrument power off and back on.
	Bad circuit board in turbidimeter head	Contact the Service Department
A/D Converter Timeout	Fluctuation in voltage	Turn instrument power off and back on.
	Bad circuit board in turbidimeter head	Contact the Customer Service Department.
High Dark Counts	Light Leak—Turbidimeter head not on turbidimeter body or calibration cylinder during Power Up or Zero Electronics	Make sure the turbidimeter head is on the turbidimeter body and properly aligned and repower instrument or perform ZERO ELECTRONICS in the CALIBRATION MENU.
	Light Leak—Turbidimeter head not properly aligned on the turbidimeter body or calibration cylinder during Power Up or Zero Electronics	Make sure the turbidimeter head is properly aligned and repower instrument or perform ZERO ELECTRONICS in the CALIBRATION MENU.
	Photocell broken/cracked	Contact the Customer Service Department.

Table 6 presents additional malfunctions which may not be recorded in the Event Log.

Table 6 Additional Malfunctions Not Recorded in the Event Log

Symptom	Possible Cause	Corrective Action
Continuous Underrange	The calibration standard was either improperly prepared or was unstable at the time the calibration was accepted.	Verify the accuracy of calibration standards and recalibrate the instrument. See Low Signal in Table 5.
Continuous Overrange (100 NTU)	The calibration standard was either improperly prepared or was unstable at the time the calibration was accepted.	Verify the accuracy of calibration standards and recalibrate the instrument.
Erratic Readings	Inadequate bubble removal from sample	Verify the accuracy of calibration standards and recalibrate the instrument. Increase the signal averaging time to a longer interval. Make sure the Bubble Reject feature is turned on. Slow the flow of sample into the instrument.

Table 6 Additional Malfunctions Not Recorded in the Event Log (continued)

Symptom	Possible Cause	Corrective Action
High Readings	Deionized water turbidity is greater than 0.5 NTU	Clean the instrument. Access Calibration History for turbidity value of ultra-filtered water. Verify the flow is between 200–750 mL/min. Recalibrate the instrument.

7.3 Event Codes

Event codes are not displayed on controller and must be downloaded from the event log to be viewed. Troubleshooting actions are provided in Table 5 on page 28.

Table 7 Event Log List

Event	Event #	Data1	Data2	Data3
Bubble Reject Change	0	0 = OFF 1= ON	—	—
Filter Size Change	1	0 = No avg, 1 = 6 sec 2 = 30 sec, 3 = 60 sec 4 = 90 sec	—	—
Data Log Interval Change	2	0 = 30 sec, 1 = 1min 2 = 5 min, 3 = 10 min 4 = 15 min	—	—
Power On	3	1	—	—
Calibration	4	Cal Gain	Initials	—
Verification	5	Expected Value	Meas Value	Initials
Dark Reading Warning	6	Measured Value	—	—
Temperature Warning	7	Temperature Value	—	—
Voltage Warning	8	16 = +5V high 32 = +5V low 64 = V in high 128 = V in low	—	—
Lamp Warning	9	1 = lamp V high 2 = lamp V low 4 = lamp I high 8 = lamp I low	—	—
A/D Fail	10	1	—	—
Lamp Fail	11	2	—	—
Flash Fail	12	4	—	—
Output Mode Change	13	0 = Active, 1 = Hold 2 = Transfer, 4 = Normal	—	—

8.1 Replacement Items

Description	QTY	Catalog Number
Lamp Assembly	each	18950-00
Instruction Manual, 1720E Turbidimeter System, English	each	60100-18

8.2 Optional Accessories

Description	QTY	Catalog Number
Cable, sensor extension, 7.7 m (25 ft)	each	57960-00
Cap, Connector Receptacle	each	52100-00
Deionized (demineralized) water	1 L	272-56
Drain plug for the 1720E body	each	44116-00
Filter, 0.45 µm, to produce ultra-filtered water for cleaning and calibration	each	26705-00
Filter, 0.2 µm, to produce ultra-filtered water for calibration standard preparation	each	23238-10
Formazin Calibration Kit includes: Calibration Cylinder, TenSette® Pipet, 4000 NTU Formazin Primary Standard (500 mL)	each	44156-00
Floor Stand	each	57432-00
Flow meter, 500–700 mL/min	each	40282-00
ICE-PIC Module for Calibration and Calibration Verification, 20 NTU	each	52250-00
ICE-PIC Module for Calibration and Calibration Verification, 1 NTU	each	52215-00
Lid, Bubble Trap, 1720E	each	52012-00
LonWorks Card	each	59200-02
Photocell Replacement Kit for the 1720E	each	52180-00
Pipet tips for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet tips for 19700-10 TenSette Pipet	50/pkg	21997-96
StablCal Calibration Set for the 1720 Series Turbidimeter		
Includes: StablCal Standards, < 0.1 NTU, 20.0 NTU	1 L/each	26596-00
StablCal Standard, 0.1 NTU	1 L	27233-53
StablCal Standard, 0.3 NTU	1 L	26979-53
StablCal Standard, 0.5 NTU	1 L	26980-53
StablCal Standard, 1.0 NTU	1 L	26598-53
Strain relief, Heyco	each	16664
Swabs, Cotton, presterilized for cleaning the photodetector	100/pkg	25543-00
TenSette Pipet, 0.1 to 1.0 mL	each	19700-01
TenSette Pipet, 1.0 to 10.0 mL	each	19700-10
Tubing, Inlet, ¼-inch OD, Polyethylene	per foot	51322-00
Tubing, Outlet, ½-inch ID, ¾ inch OD, Tygon R3603	per foot	51263-00

8.3 Calibration and Verification Standards and Accessories

Description	QTY	Catalog Number
Calibration Cylinder	each	44153-00
Formazin Calibration Standards, Formazin, 4000 NTU Stock Solution	500 mL	2461-49
Calibration/Verification Modules		
ICE-PIC™ Module, 1 NTU	1 each	52215-00
ICE-PIC™ Module, 20 NTU	1 each	52250-00
StablCal® Calibration Standards		
StablCal® Stabilized Formazin Standard, 1 NTU	1 L	26598-53
StablCal® Stabilized Formazin Standard, 20 NTU	1 L	26601-53
StablCal® Stabilized Formazin Standard, <0.1 NTU	1 L	26597-53
StablCal® Stabilized Formazin Set, four 1-L bottles 20-NTU and four 1-L bottles <0.1 NTU	1 L each	26596-00
StablCal® Stabilized Formazin Standard, 40 NTU	1 gallon (3.78 L)	27463-56
StablCal® Stabilized Formazin Standard, 0.1 NTU	1 gallon (3.78 L)	27233-56

Section 9 Compliance Information

Hach Co. certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The **Model sc100/sc1000 with 1720E Sensor** has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

UL 61010A-1 (ETL Listing # 65454)
CSA C22.2 No. 1010.1 (ETLc Certification # 65454)
Certified by Hach Co. to EN 61010-1 Amds. 1 & 2 (IEC1010-1) per 73/23/EEC, supporting test records by Intertek Testing Services.

Immunity

This equipment was tested for Industrial level EMC per:

EN 61326 (EMC Requirements for Electrical Equipment for Measurement, Control and Laboratory Use) **per 89/336/EEC EMC:** Supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:

IEC 1000-4-2:1995 (EN 61000-4-2:1995) Electro-Static Discharge Immunity (Criteria B)
IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electro-Magnetic Field Immunity (Criteria A)
IEC 1000-4-4:1995 (EN 61000-4-4:1995) Electrical Fast Transients/Burst (Criteria B)
IEC 1000-4-5:1995 (EN 61000-4-5:1995) Surge (Criteria B)
IEC 1000-4-6:1996 (EN 61000-4-6:1996) Conducted Disturbances Induced by RF Fields (Criteria A)
IEC 1000-4-11:1994 (EN 61000-4-11:1994) Voltage Dip/Short Interruptions (Criteria B)

Additional immunity Standard/s include:

ENV 50204:1996 Radiated Electro-Magnetic Field from Digital Telephones (Criteria A)

Emissions

This equipment was tested for Radio Frequency Emissions as follows:

Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use—EMC requirements) Class “A” emission limits. Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

Standards include:

EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment
EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

Additional Emissions Standard/s include:

EN 55011 (CISPR 11) Class “A” emission limits

Canadian Interference-causing Equipment Regulation, IECS-003, Class A

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numÈrique de la classe A respecte toutes les exigences du RËglement sur le matÈriel brouilleur du Canada.

FCC PART 15, Class “A” Limits

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Disconnect the Controller from its power source to verify that it is or is not the source of the interference.
2. If the Controller is connected into the same outlet as the device with which it is interfering, try another outlet.
3. Move the Controller and 1720E sensor away from the device receiving the interference.
4. Reposition the device receiving the interference.
5. Try combinations of the above.

Appendix A Modbus Register Information

Table 8 Sensor Modbus Registers

Group Name	Tag Name	Register #	Data Type	Length	R/W	Units (U)	Range
Measurements	Cal Gain	40013	float	2	R	none	0.5 to 2.0
Verification	PF Criteria	40062	Integer	1	R/W	%	5 to 10
Measurements	Turbidity	40001	Float	2	R	NTU	0/100
Diagnostics	Temperature	40005	Float	2	R	Deg C	—
Diagnostics	Dark Reading	40009	Float	2	R	NTU	0/100
Diagnostics	Raw Turbidity	40011	Float	2	R	NTU	0/100
Diagnostics	Lamp Voltage	40018	Float	2	R	Volts	0/5
Diagnostics	Lamp Current	40020	Float	2	R	Amps	0/2.75
Diagnostics	Plus 5V	40022	Float	2	R	Volts	0/5.5
Diagnostics	Voltage In	40024	Float	2	R	Volts	0/1443
Setup	Software Version	40015	Float	2	R	—	—
Setup	Bubble Rej	40017	Integer	1	R/W	—	On/Off
Setup	DataLog Interval	40026	Integer	1	R/W	Sec or Min	30 sec, 1 min, 5 min, 10 min, 15 min
Setup	Sensor Name	40027	String	6	R/W	—	—
Setup	Filter Size	40033	Integer	1	R/W	sec	no averaging, 6, 30, 60, 90
Setup	Sensor Ser Num	40036	String	6	R	—	12 digits
Setup	Output Mode	40042	Integer	1	R	—	0, 1, 2, 4
Setup	Set Resolution	40061	Integer	1	R/W	decimal places	4, 3, or 2

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CAT. NO. 46500-88

PORTABLE TURBIDIMETER

Model 2100P

Instrument and Procedure Manual

te/dk 3/04 8ed

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CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The Model 2100P Portable Turbidimeter has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

Battery/Eliminator Power Supply Only:
120 Vac, 60 Hz, UL Listed & CSA Certified, Class 2
230 Vac, 50 Hz, VDE Approved, GS & CE marked

Immunity

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50082-1 (European Generic Immunity Standard) **per 89/336/EEC EMC:** Supporting test records with Dash Straus and Goodhue, Inc. (now Intertek Testing Services), certified compliance by Hach Company.

Standards include:
IEC 801-2 Electro-Static Discharge
IEC 801-3 Radiated RF Electro-Magnetic Fields
IEC 801-4 Electrical Fast Transients/Burst

Emissions

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50081-1 (Emissions) **per 89/336/EEC EMC:** Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

Standards include:
EN 55022 (CISPR 22) Emissions, Class B Limits

Canadian Radio Interference-Causing Regulation, Chapter 1374, Class A: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

FCC Part 15, Class "A" Limits: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at his own expense.

The following techniques of reducing interference problems are applied easily:

1. Disconnect the battery eliminator from it's power source and from the 2100P Portable Turbidimeter to verify if it is the source of the interference
2. If the battery eliminator for the 2100P Portable Turbidimeter is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the 2100P Portable Turbidimeter away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE
Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

⚠ This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

SPECIFICATIONS

Specifications subject to change without notice.
Operating specifications applicable at 25 °C unless noted.
Program software copyrighted by Hach Company, 1991.

Measurement Method: Ratio Nephelometric signal (90°) scatter light ratio to transmitted light

Range: 0-1000 NTU with automatic decimal point placement or manual range selection of 0-9.99, 0-99.9 and 0-1000 NTU

Accuracy: ± 2% of reading plus stray light from 0-1000 NTU

Resolution: 0.01 NTU on lowest range

Repeatability: ±1% of reading or 0.01 NTU, whichever is greater (with Gelex standards)

Response Time: 6 seconds for full step change without signal averaging in constant reading mode

Stray Light: <0.02 NTU

Standardization: StablCal® Stabilized Formazin primary standards or Formazin primary standards

Secondary Standards: Gelex® Secondary Standards

Display: Four-digit liquid crystal; 10.16 mm (0.4 in) high digits with custom icons

Light Source: Tungsten filament lamp; lamp life typically greater than 100,000 readings

Detectors: Silicon photovoltaic

Signal Averaging: Operator selectable on or off

Sample Cells: (Height X width) 60.0 X 25 mm (2.36 X 1 in)
Borosilicate glass with screw caps, marking band and fill line

Sample Required: 15 mL (0.5 oz.)

Storage Temperature: -40 to 60 °C (-40 to 140 °F) (instrument only)

Operating Temperature: 0 to 50 °C (32 to 122 °F) (instrument only)

Operating Humidity Range: 0 to 90% RH noncondensing at 30 °C;
0 to 80% RH noncondensing at 40 °C;
0 to 70% RH noncondensing at 50 °C

Power Requirements: Four AA Alkaline cells or optional battery eliminator

Battery Life: Typically 300 tests with signal average mode off; 180 tests with signal average mode on

Battery Eliminator (optional):

For 120 V eliminator: CSA and UL approved for 120 VAC ±10%, 60 Hz, 6 V at 800 mA DC output

For 230 V eliminator: CE (VDE) approval pending for 230 VAC ±10%, 50 Hz, 6 V at 900 mA DC output

Enclosure: High impact ABS plastic

Dimensions: 22.2 X 9.5 X 7.9 cm (8.75 X 3.75 X 3.12 in)

Instrument Weight: 520 kg (1 lb 2.5 oz)

Shipping Weight: 3.1 kg (6 lbs 8.5 oz)

OPERATION

DANGER

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

DANGER

La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.

PELIGRO

La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.

GEFAHR

Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

PERIGO

A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.

PERICOLO

La manipolazione di campioni, standard e reattivi chimici può essere pericolosa. La preghiamo di prendere conoscenza delle Schede Techniche necessarie legate alla Sicurezza dei Materiali e di abituarsi con tutte le procedure di sicurezza prima di manipolare ogni prodotto chimico.

SECTION 1 DESCRIPTION

1.1 General Description

The Hach Model 2100P Portable Turbidimeter (*Figure 1*) measures turbidity from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The manual range mode measures turbidity in three ranges: 0.01 to 9.99, 10 to 99.9 and 100 to 1000 NTU. Designed primarily for field use, the microprocessor-based Model 2100P has the range, accuracy, and resolution of many laboratory instruments. The instrument operates on four AA batteries or with an optional battery eliminator. Rechargeable nickel-cadmium cells may be used, but cannot be recharged in the instrument. The instrument automatically shuts off after 5.5 minutes if no keystrokes occur (does not influence operation). If this occurs, simply turn the instrument on – the 2100P will resume operation as if the power had not been interrupted. The instrument, all standard accessories, and the optional battery eliminator may be conveniently stored in the carrying case.

Figure 1 2100P Turbidimeter and Accessories

Note: *Avoid prolonged exposure to ultraviolet light and sunlight.*

Note: *Do not hold the instrument during measurements; place the instrument on a flat, steady surface.*

1.2 Accessories

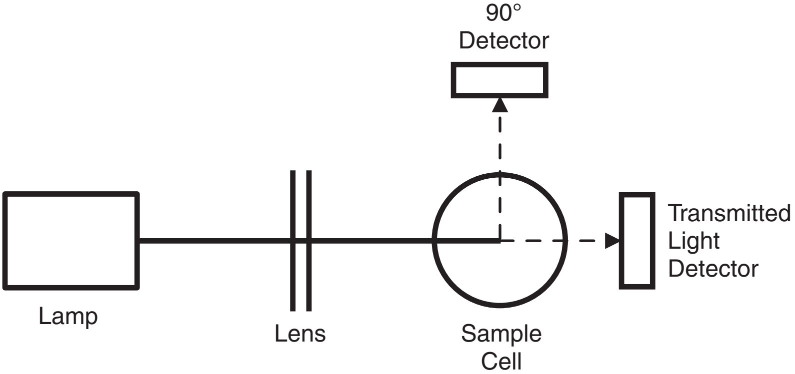
Accessories supplied with the turbidimeter include nine sample cells; three Gelex® Secondary Standards; one sealed vial each of: <0.1-NTU, 20-NTU, 100-NTU, and 800-NTU StablCal® Stabilized Formazin Standards; 4 AA alkaline batteries; 15 mL of silicone oil; oiling cloth; carrying case; instrument manual; and quick reference card.

1.3 Principle of Operation

The Model 2100P Portable Turbidimeter operates on the nephelometric principle of turbidity measurement. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1.

The optical system* (*Figure 2*) includes a tungsten-filament lamp, a 90° detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90° and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

Figure 2 Ratio Optical System



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* Patent number 4,198,161; other patents pending.

1.4 Preparation for Use

1.4.1 Unpacking

Remove the instrument and accessories from the shipping box and inspect them for damage that may have occurred due to rough handling or extreme weather conditions. Verify the following are present:

- Model 2100P Portable Turbidimeter
- Instrument Manual (with quick reference card)
- Set of StablCal Primary Standards in sealed vials, one each of:
  <0.1 NTU*
  20 NTU
  100 NTU
  800 NTU
- Standardization Kit containing Gelex Secondary Standards (0-10, 0-100 and 0-1000 ranges) plus nine sample cells with caps.
- Silicone Oil, 15-mL (0.5 oz) dropping bottle
- Oiling Cloth
- Carrying Case
- Four AA alkaline batteries

If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. The toll-free number in the United States is 800-227-4224. International customers should contact the Hach office or authorized distributor serving your area. Refer to *REPAIR SERVICE* on page *77*. **Please do not return the instrument without prior authorization from Hach.**

1.4.2 Battery Installation

The instrument is shipped completely assembled without the batteries installed. Before use, install the four AA alkaline batteries or connect

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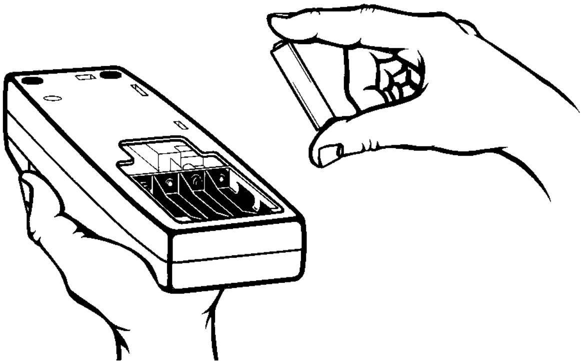
* Used in place of the dilution water standard when performing a calibration.

the battery eliminator (*Figure 3*). For battery operation, remove the battery compartment cover on the instrument bottom and install the batteries. Correct battery polarity is shown on the battery holder. The instrument will not function if the batteries are not installed correctly. Reinstall the battery compartment cover.

Figure 3 Battery Installation



⚠ 1.4.3 Using the Battery Eliminator and Rechargeable Batteries

For operation with the optional battery eliminator, plug the eliminator jack into the connector on the turbidimeter side. The battery eliminator may be used with or without the batteries installed. **The eliminator will not charge batteries.** Rechargeable batteries may be used in the instrument, but must be removed for recharging. See *HOW TO ORDER* on page *76* for ordering information. To prolong battery life, the instrument lamp turns on temporarily when the **READ** key is depressed. Batteries are not necessary for battery eliminator operation.

1.4.4 Calibration

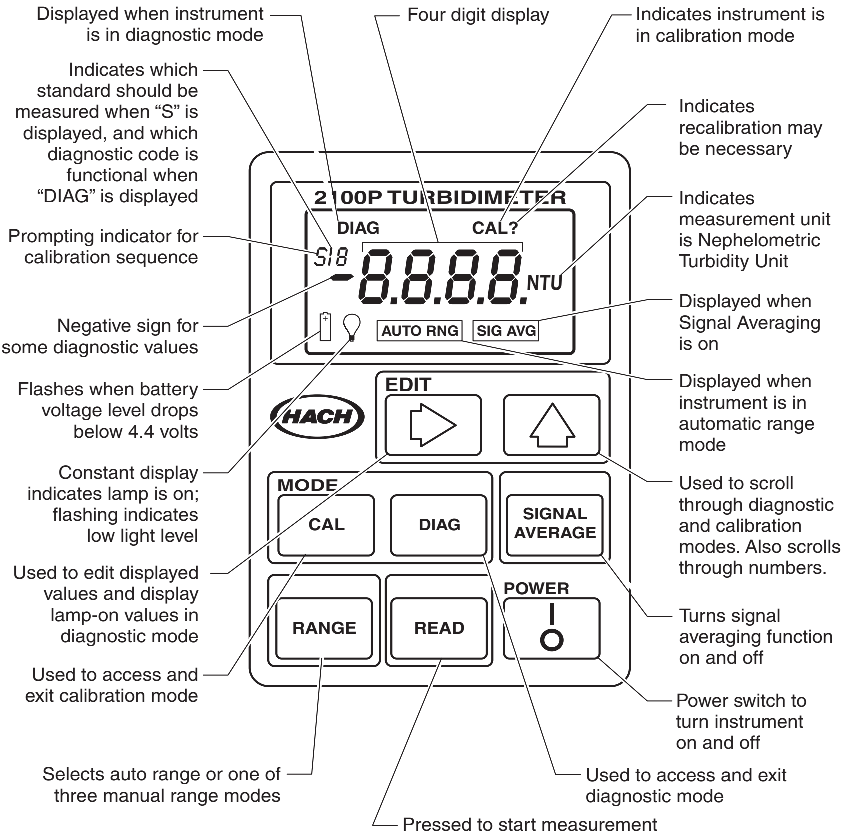
The 2100P Portable Turbidimeter is calibrated with Formazin Primary Standard at the factory and **does not require recalibration before use.** Hach recommends recalibration with formazin once every three months, or more often as experience dictates. The Gelex Secondary Standards supplied with the instrument are labelled with general ranges for application, but must be assigned values before use from formazin calibration. See *Section 3.6* on page *37* for calibration instructions.

SECTION 2 TURBIDITY MEASUREMENT

2.1 Operating Controls and Indicators

Figure 4 shows the 2100P controls and indicators. Refer to *SECTION 3* for a detailed description of each control and indicator.

Figure 4 Keyboard and Display with Descriptions



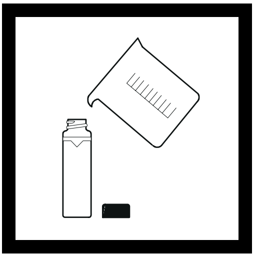
2.2 Turbidity Measurement

Measurements may be made with the signal average mode on or off and in manual or automatic range selection mode. Using automatic range selection is recommended. Signal averaging uses more power and should be used only when the sample causes an unstable reading. Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 20 seconds). After this, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When not in signal average mode, the final value is displayed after about 13 seconds.

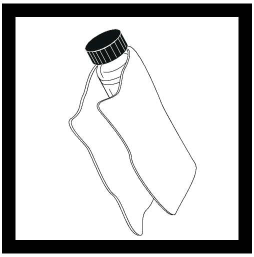
Accurate turbidity measurement depends on good measurement technique by the analyst, such as using clean sample cells in good condition and removing air bubbles (degassing). Refer to *Section 2.3* on page *22* for a detailed discussion of measurement techniques.

2.2.1 Turbidity Measurement Procedure

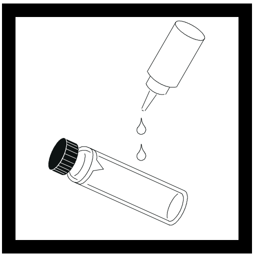


1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page *22* for more information about collecting a representative sample).

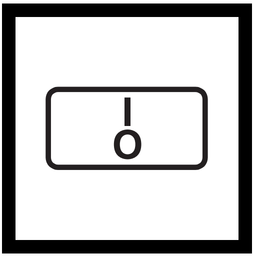
***Note:** The instrument automatically shuts off after 5.5 minutes if no keystrokes occur. To resume operation, press* **I/O**.



2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

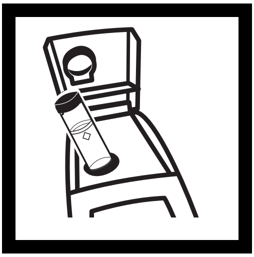


3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.



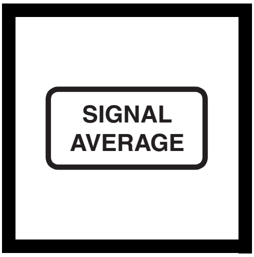
4. Press: **I/O**.

The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.

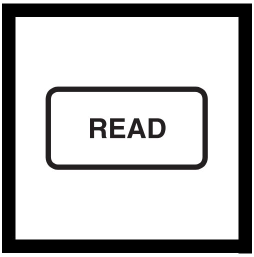


5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.
Close the lid.

6. Select manual or automatic range selection by pressing the **RANGE** key. The display will show **AUTO RNG** when the instrument is in automatic range selection.



7. Select signal averaging mode by pressing the **SIGNAL AVERAGE** key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).



8. Press: **READ**

The display will show **- - - - NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Note: *The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.*

2.2.2 Measurement Notes

- Always cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Dirty, scratched, or damaged cells can cause inaccurate readings.
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.
- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Avoid operating in direct sunlight.
- Make certain cold samples do not “fog” the sample cell.
- Avoid settling of sample prior to measurement.
- Keep sample compartment lid closed to prevent dust and dirt from entering.

2.3 Measurement Techniques

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Regardless of the instrument used, measurements are more accurate, precise and repeatable if the analyst pays close attention to proper measurement techniques.

Measure samples immediately to prevent temperature changes and settling. Avoid sample dilution when possible. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes or when the sample is diluted, resulting in a non-representative sample measurement.

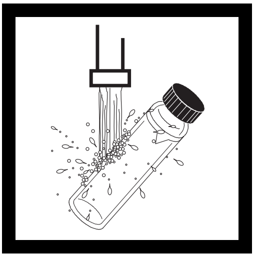
2.3.1 Cleaning Sample Cells

Cells must be extremely clean and free from significant scratches. The glass used to make cells is easily scratched – manufacturing cells free of minor scratches and other imperfections is difficult. However, minor imperfections are effectively masked by applying silicone oil as outlined in *Section 2.3.2*.

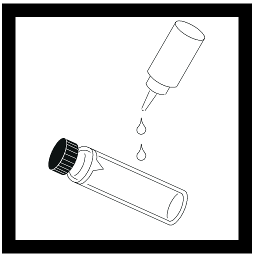
Clean the inside and outside of the cells by washing with laboratory detergent. Follow with multiple rinses of distilled or deionized water. Allow cells to air dry. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.

2.3.2 Oiling the Sample Cell

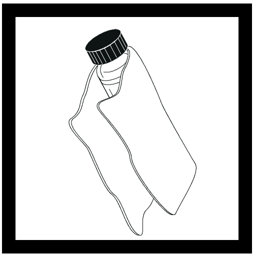
Applying a thin coat of silicone oil will mask minor imperfections and scratches which may contribute to turbidity or stray light. Use silicone oil equivalent to Hach Cat. No. 1269-36. This silicone oil has the same refractive index as glass. When applied in a thin, uniform coat, the oil fills in and masks minor scratches and other imperfections in the glass. Apply the oil uniformly by wiping with a soft, lint-free cloth. **Avoid application of excess oil.** Applying excess oil may retain dirt and contaminate the instrument's cell compartment.



1. Thoroughly clean the sample cell.



2. Apply a small bead of silicone oil from the top to the bottom of the cell-- just enough to coat the cell with a thin layer of oil.



3. Using a soft, lint-free cloth, spread the oil uniformly, then wipe off the excess so that only a thin coat of oil is left. The cell should appear nearly dry with little or no visible oil.

Note: *Soft, lint-free cloth (velvet) works well for oiling. Store the oiling cloth with the sample cells and keep it free of dirt. After a few applications of oil, the cloth will contain enough residual oil that simply wiping the cell with the oiled cloth will provide a sufficient oil coat on the sample cell. Periodically, add a small amount of oil to the sample cell surface to replenish the oil in the cloth.*

Note: *Only a thin coat of oil on the sample cells is necessary.* ***Avoid using excessive amounts of oil.***

2.3.3 Orienting Sample Cells

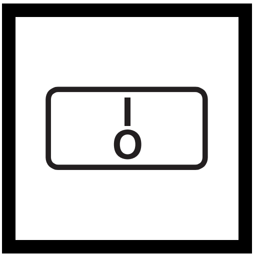
Note: *When orienting and matching cells, it may be more efficient to use the continuous reading mode. The instrument performs continuous readings if the* **READ** *key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds. The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.*

Precise measurements for very low turbidity samples require using a single cell for all measurements or optically matching the cells. Using one cell provides the best precision and repeatability. When one cell is used, an orientation mark (other than the factory-placed diamond) can be placed on the cell so it’s inserted into the instrument with the same orientation each time.

2.3.3.1 Orienting a single cell

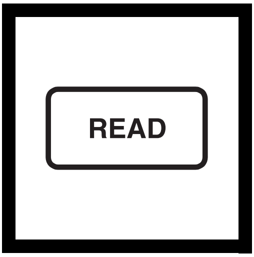
When using a single cell, make an index or orientation mark on the cell as follows:

1. Fill the clean sample cell to the line with high quality water (< 0.5 NTU). Cap and wipe with lint-free cloth. Apply silicone oil. See *Section 3.6.2.2* on page *40* for more information about high quality water.



2. Press: **I/O** to turn the instrument on.

3. Insert the sample cell into the sample compartment. Close the cover.



4. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

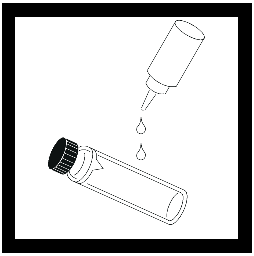
Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*

5. Remove the cell, rotate it slightly and reinsert it into the cell compartment. Close the cover, then press **READ**. Record the cell's position and the displayed reading.

6. Repeat *step 5* until the lowest reading is displayed. Place an orientation mark on the cell's marking band near the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading. When using the cell, always place it in the instrument so the orientation mark aligns with the raised mark on the instrument.

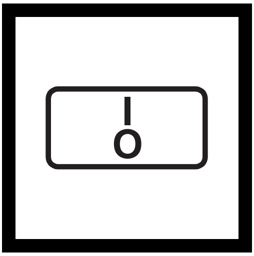
2.3.4 Matching multiple sample cells

Precise measurements of very low turbidity samples require the cells be optically matched or a single cell be used for all measurements. If more than one cell is used, follow this procedure to match (index) the cells:



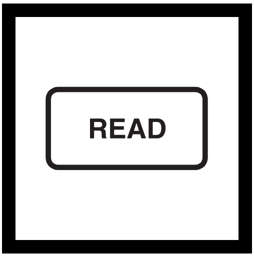
1. Clean and oil the sample cells as instructed in *Section 2.3.1* on page *23* and *Section 2.3.2* on page *23*.

2. Fill the clean sample cells to the line with the same sample.



3. Press: **I/O** to turn the instrument on.

4. Insert the **first** sample cell into the sample compartment and close the cover.

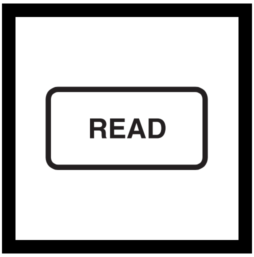


5. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading. Place an orientation mark on the cell’s marking band.

Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*

6. Insert the **second** sample cell into the cell compartment and close the cover.



7. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

8. Remove the cell, rotate it slightly and reinsert into the cell compartment. Close the cover, then press **READ** again. Record the cell's position and the displayed reading.

9. Repeat *step 8* until the value displayed for the second cell is within 0.01 NTU (or 1%) of the value obtained for the first cell. Place an orientation mark on the second cell's marking band so it is consistently inserted in this position.

Note: *Due to variability in glass, it may not be possible to match all cells.*

10. Repeat *step 6* through *step 9* if matching other sample cells.

2.3.5 Removing Bubbles (Degassing)

Before measurement, removing air and other trapped gasses from the sample is strongly recommended, even if bubbles are not visible. Four degassing methods are commonly used:

1. applying a partial vacuum
2. adding a surfactant
3. using an ultrasonic bath
4. heating the sample

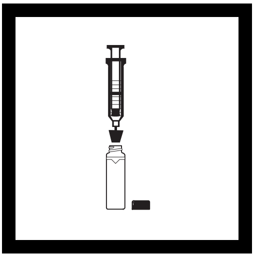
In some cases, more than one method may be necessary for effective bubble removal. For example, use of both a surfactant and ultrasonic bath may be necessary for some severe conditions. Use care with these techniques. If misused, sample turbidity can be altered.

Removing air bubbles by letting the sample stand for a period of time is not recommended. Particulates that cause turbidity may settle and the sample temperature may change. Both conditions may alter sample turbidity, resulting in measurements not representative of the original turbidity.

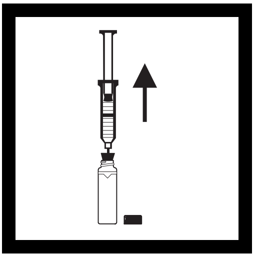
2.3.5.1 Application of vacuum

Apply a vacuum with any convenient, clean, oil-free vacuum source. The vacuum lowers the atmospheric pressure, allowing trapped bubbles to escape into the air above the sample. Vacuum works well with non-viscous samples (such as water) that don't contain volatile components. Applying vacuum to viscous, volatile-containing samples (paint resins) may cause the volatile components to come out of solution and aggravate the bubble problem.

To apply a vacuum, use a sample degassing kit equivalent to Cat No. 43975-00 (Degassing Kit) or 43975-10 (Degassing and Filtration Kit). These kits contain a syringe and rubber stopper for vacuum degassing. An electric or hand-operated pump equivalent to Cat No. 14283-00 or 14697-00, respectively, may also be used.



1. Fill a sample cell to the mark with sample. Insert a #2 single-hole rubber stopper and syringe into the cell. If using a pump, insert a piece of glass tubing into the stopper.



2. **Slowly** apply the vacuum by carefully pulling the plunger upward, then holding it. If using a hand or electric pump, connect the tubing to the vacuum pump with vacuum hose. Apply vacuum until visible gas bubbles disappear. **Slowly** release the vacuum. Remove the vacuum apparatus and cap the cell.

2.3.5.2 Adding a surfactant

Surfactants should be limited to severe problems when other degassing methods are ineffective. Surfactants change the surface tension of the water, which releases trapped gases. Hach recommends a surfactant such as Triton X-100 or the equivalent, Hach Cat No. 14096-37. Put one drop of Triton X-100 in the sample cell before adding sample.

Note: *Any turbidity contributed by surfactant addition is negligible.*

This technique is very effective when the water is super-saturated with air. However, changing the surface tension may accelerate settling of turbidity-causing particles. Mix the sample gently, but thoroughly, and analyze as soon as possible after adding the surfactant. Avoid vigorous mixing as the surfactant may foam. Rinse the sample cells thoroughly between samples to prevent surfactant accumulation.

2.3.5.3 Using an ultrasonic bath

Note: *The time necessary to expel bubbles may vary from a few seconds to a minute or more. To avoid excessive application of ultrasound, a simple procedure can be followed. First, apply ultrasound until all visible bubbles are absent. Then measure the sample turbidity. Apply ultrasound for a short time period and again measure turbidity. Continue for several repetitions, noting the treatment time and turbidity readings. If turbidity begins to increase instead of decrease, the ultrasound waves have probably started to alter the suspended particles. Note the time it takes for this to occur and record it as the maximum time limit for ultrasonic treatment.*

Ultrasonic baths effectively remove gas bubbles from most samples, especially viscous liquids. However, the ultrasonic waves which cause degassing may also alter the characteristics of the particles causing the turbidity. Turbidity depends on the size, shape, composition and refractive index of the suspended particles. Excessive ultrasound application may alter particle size and shape, thus changing sample turbidity. In some cases, ultrasound may aggravate air bubble removal by fracturing the bubbles, making degassing more difficult.

1. Fill a clean sample cell to the line with sample. Leave uncapped.
2. Immerse the cell (1/2 to 2/3 immersed) in an ultrasonic bath and allow it to stand until visible bubbles are expelled.
3. Remove the cell, cap, then thoroughly dry the cell. Apply silicone oil as directed.

2.3.5.4 Application of heat

Whenever possible, avoid using heat to degas samples because heat may change the characteristics of the suspended particles and cause volatile components to come out of solution. Gentle heating may be helpful for degassing some very viscous samples when combined with application of vacuum or ultrasound. If heat is necessary, heat the sample only until degassing occurs. The simplest technique is to prepare a warm water bath and partially immerse the filled sample cell. Use the shortest time necessary for expelling visible bubbles. Cool sample to original sample temperature before taking measurements.

2.3.6 Measuring Overrange Samples

Nephelometric turbidity measurement depends on detection of light scattered from particles suspended in the liquid. If the turbidity is very high, a significant amount of light is blocked or absorbed by the particles and only a small amount of light reaches the detector. This results in a negative interference – the measured turbidity is lower than the actual turbidity. This condition is called "going blind". A multidetector ratioing instrument, such as the Hach 2100P Turbidimeter, minimizes this effect and extends the instrument range. Highly turbid samples may also be diluted, but this should be avoided when possible since it may alter the characteristics of the suspended particles and produce erroneous results.

Light absorbing particles such as activated carbon and highly colored samples may also cause an instrument to "go blind". Dilution may not correct for these interferences. A ratioing instrument will correct for the presence of light absorbing particles and color.

2.3.7 Condensation (fogging)

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at room temperature or immersing it in a warm bath for a short period. After warming, mix the sample thoroughly before measurement. Allowing samples to warm can alter sample turbidity, so it is best to avoid warming samples before measurement when possible.

2.3.8 Calibration

Turbidimeters must be properly calibrated with a primary standard. Hach recommends formazin or StablCal Stabilized Formazin for calibration. For U.S. Environmental Protection Agency (USEPA) reporting, calibrate at least as often as required by the appropriate regulatory agencies. The frequency of calibration depends on environmental conditions (humidity, temperature) and use. If necessary, calibrate more frequently.

Use secondary standards for periodic calibration checks. Please note that Gelex® standards must be assigned values after StablCal Stabilized Formazin calibration or formazin calibration and before use as secondary standards. Gelex standards must be recalibrated (values assigned) each time the instrument is calibrated with StablCal Stabilized Formazin or formazin. See *Section 3.6* on page *37* for detailed information on the use of StablCal Stabilized Formazin, formazin, and Gelex standards.

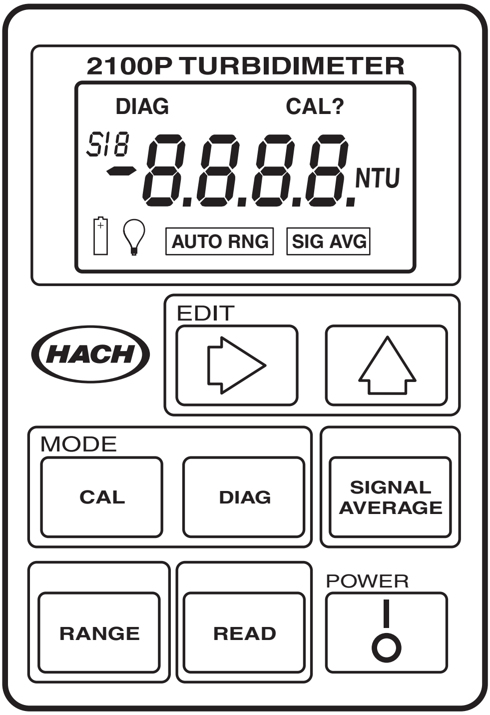
2.3.9 Representative Sampling

A representative sample accurately reflects the true condition of the water source from which the sample was taken. To ensure a representative sample, gently, but thoroughly, mix every sample before aliquots are taken. Do not allow the sample to settle.

When sampling from a tap in a distribution system or treatment plant, allow the water to run for at least five minutes before sampling. When sampling from a stream, reservoir, clarifier, or storage tank, collect at least one liter (l quart) and thoroughly mix before measurement. If the water source is not uniform, it may be necessary to sample several locations at varying depths and combine the samples into a single, well-mixed composite sample before measurement.

SECTION 3 OPERATION

3.1 Operational Controls and Indicators



Key	Description
I O	Power key to turn instrument on and off. If no keys are pressed for 5.5 minutes, the instrument turns off automatically.
READ	Depressed to perform a measurement. To conserve battery power, the lamp turns on only when **READ** is depressed. A reading is displayed about 12 seconds after the key is depressed. During the delay, a flashing **NTU** is displayed. After the reading is displayed, the lamp turns off and the reading continues to be displayed. Continuous readings may be done by holding this key if **not** in the Signal Averaging mode. After the initial delay, the reading is updated every 1.2 seconds.
CAL	Used to perform a calibration or review calibration data. Also terminates a calibration or calibration review and returns to the 2100P measurement mode.

Key	Description
⇧	Edits a flashing digit in the calibration mode or sequences through the calibration standards (S0,S1, S2, S3) or diagnostic menu.
⇨	Used to move the editing cursor to the digits being edited in the calibration mode or initiate editing of a standard value.
SIGNAL AVERAGE	Turns the signal averaging function on or off.
DIAG	Selects the diagnostic mode.
RANGE	Selects Auto Range or Manual Range (one of three manual modes).

Display Icon	Description
DIAG	Turns on after the **DIAG** is pressed to access the diagnostic mode. A number displayed under the **DIAG** icon (1-9) indicates which diagnostic function is active. See *Section 5.1* on page *67* for more information on diagnostic codes.
CAL	Turns on after the **CAL** key is pressed to access the calibration mode and remains on during the calibration.
CAL?	Appears after calibration if a value entered during calibration is outside an acceptable range. May indicate an operator error or possible instrument malfunction. Flashing **CAL?** indicates the default calibration coefficients are being used (even after a user-calibration has been done) or that no calibration data is currently stored.
S__	Displayed during calibration. The S is followed by a number to indicate which standard value is currently being edited or displayed. Flashing number is prompting user for measurement of **S0**, **S1**, **S2** or **S3** to establish a calibration. Steady number identifies which standard's value is being displayed.
🔋	Flashes when the battery voltage drops to 4.4 volts as an indication to change batteries. At <4.0 volts, the instrument automatically shuts off.
💡	The lamp symbol is constantly on when the lamp is on and flashes after a reading if a marginal light level reaches the transmitted light detector. A flashing icon indicates the sample may be too turbid (not within measurement range) and needs dilution or the lamp needs replacing.

Display Icon	Description
SIGNAL AVERAGE	Indicates the signal averaging mode is on. The icon turns off if signal averaging is not selected.
AUTO RNG	Indicates instrument is in automatic range mode. The icon turns off when manual range mode is selected.
8888	The 4-digit display is active when the instrument is on (measurements are displayed to three digits). After the **READ** key is pressed **- - - -** is displayed during wait periods.
NTU	Identifies the measurement units- Nephelometric Turbidity Units. This icon is active during measurements and in the calibration mode.

3.2 Using the Read Key

To preserve battery power and prolong lamp life, the lamp turns on only after the **READ** key is pressed. Pressing the key turns the instrument lamp on; after about 12 seconds, the lamp turns off, but the measurement value continues to be displayed. After the first measurement, a four-second recovery time occurs before another measurement can be started. If **READ** is pressed during the recovery time, the display will begin flashing, but the lamp will not turn on until the full four seconds have passed. If no other key strokes occur within 5.5 minutes, the instrument turns off.

3.2.1 Continuous Reading

The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.

The instrument will perform continuous readings if the **READ** key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds.

3.3 Using the Signal Averaging Key

The signal averaging mode compensates for reading fluctuations caused by drifting of sample particles through the light path. Signal averaging is turned on or off by pressing the **SIGNAL AVERAGE** key. The **SIG AVG** icon is displayed when signal averaging is on.

Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about

11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 22 seconds). After 22 seconds, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When signal averaging is off, the instrument takes three measurements, the microprocessor averages them, then displays the average. If the **READ** key is held during measurement, the initial value is displayed in 12 seconds and is updated every 1.2 seconds as long as the **READ** key is held.

When the instrument is turned on, the instrument defaults to the signal averaging mode which was used during the last measurement.

3.4 Using the Range Selection Key

As shipped, the instrument defaults to automatic range mode. The first time the **RANGE** key is pressed, the instrument goes into manual range mode. The second, third, and fourth key strokes put the instrument in the 0.00-9.99, 10 to 99.9 or 100-1000 NTU range, respectively. Another key stroke brings the selection back to automatic range mode. When the automatic range mode is selected, the **AUTO RNG** icon is displayed. Range selection can be done any time except when a measurement or calibration is in progress.

When the instrument is turned on, the instrument defaults to the range mode and measurement range which was used during the last measurement.

3.5 Restoring the Default Calibration

To restore and use the default calibration, turn the instrument off. Press and hold **DIAG**, then press and release **I/O**. Release **DIAG** when the software version number disappears from the display. (For models with serial number less than 920300000800, **2100** disappears). This clears any user-entered calibration from memory; the 2100P will use the default calibration for measurement. **CAL?** will appear and continue to flash until a user-entered calibration is successfully completed.

For best results, a user-entered calibration should be done every three months.

3.6 Calibration

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provide long-term stability and minimize the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. When calibration is necessary, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions.

Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

3.6.1 StablCal Stabilized Formazin Standards*

Most consistent results will be achieved with the use of StablCal Stabilized Formazin Standards for calibration. Refer to *Section 3.6.1.2* and *Section 3.6.1.3* for information on preparing the standards for use.

Note: *Hach StablCal Stabilized Formazin in 20-, 100-, and 800-NTU values is packaged in convenient sets for calibration of the 2100P Turbidimeter. The set may be ordered in 500-mL size bottles by specifying Cat. No. 26594-00, in 100-mL size bottles by specifying Cat. No. 26594-10 or in sealed vials by ordering Cat. No. 26594-05. (See OPTIONAL ACCESSORIES AND REAGENTS on page 74.)*

3.6.1.1 Storing and Handling StablCal Stabilized Standards

For optimum results when using StablCal Stabilized Standards, adhere to the following recommendations:

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* StablCal Stabilized Formazin is cited as a primary standard in Hach Method 8195, an acceptable version of USEPA Method 180.1.

- Do not transfer the standard to another container for storage.
- Do not return standard from the sample cell back into the its original container. Standard contamination will result.
- Store standards between 0 and 25 °C.
- For long-term storage, refrigeration at 5 °c is recommended. Do not store above 25 °C.
- Allow the standard to acclimate to ambient instrument conditions before use (not to exceed 40 °C).
- Store away from direct sunlight. Store vials in their respective kit or shipping box with the cover in place.

3.6.1.2 Preparing Bulk StablCal Stabilized Standards

Bulk standards that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the bottle of StablCal 5 to 7 times.
4. Prepare the sample cell for measurement using traditional preparation techniques. This usually consists of oiling the sample cell (see*Section 2.3.2* on page *23*) and marking the cell to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample cell.

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* Used in place of the dilution water standard when performing a calibration.

5. Rinse the sample cell at least one time with the standard and discard the rinse.

6. Immediately fill the sample cell with the standard. Cap the sample cell and let it stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

3.6.1.3 Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*

Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.

2. Allow the standard to stand undisturbed for 5 minutes.

3. Gently invert the vial of StablCal 5 to 7 times.

4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2* on page *23*) and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

3.6.2 Formazin Primary Standards

Perform the procedure in *Section 3.6.2.1* to prepare a 4000-NTU standard. Alternately, order a 4000-NTU stock solution from Hach by specifying Cat. 2461-49. Prepare the dilutions from the 4000-NTU stock solution by following the instructions in *Section 3.6.2.4*.

3.6.2.1 Preparing Formazin Stock Solution

Dilute formazin standard solutions from a 4000 NTU stock solution equivalent to Hach Cat. No. 2461-49. The prepared stock solution is stable for up to one year when properly prepared. An alternative to purchasing the 4000 NTU stock solution is preparing a stock solution as follows:

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \bullet H_2SO_4$) in 400 mL of distilled water.

2. Dissolve 50.000 grams of pure hexamethylenetetramine in 400 mL of distilled water.

3. Pour the two solutions into a 1000-mL volumetric flask and dilute to the mark with distilled water.

4. Let the solution stand for 48 hours at 25 °C (77 °F) to develop the 4000-NTU stock suspension. The standing temperature is critical for correct formation of formazin polymers.

5. Mix the 4000 NTU suspension for at least ten minutes before use. Then it can be diluted with distilled or demineralized water to achieve a solution of the desired NTU value.

Instead of diluting a formazin stock solution, StablCal Stabilized Formazin Standards may be used. Order the StablCal Calibration Set for the 2100P Turbidimeter, Cat.No. 26594-00 (500-mL bottles), Cat. No. 26594-10 (100 mL bottles), or Cat. No. 26594-05 (sealed vials). (See *OPTIONAL ACCESSORIES AND REAGENTS* on page *74*.)

3.6.2.2 Correcting for Turbidity of Dilution Water

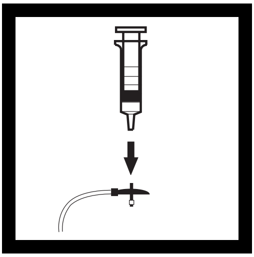
The 2100P Turbidimeter automatically compensates for turbidity contributed by dilution water when calculating the true value of the lowest formazin standard. Use high quality distilled or deionized water less than 0.5 NTU. The instrument will display E 1 after calibration if the dilution water turbidity is greater than 0.5 NTU. In this case, prepare the water as directed below.

The value of the dilution water can be arbitrarily forced to zero (see calibration procedure). This is not recommended for most applications and, if done, should be done only if the dilution water turbidity is less than 0.2 NTU.

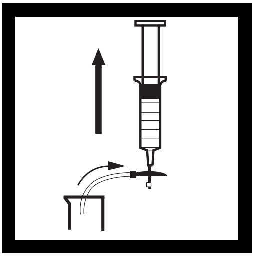
3.6.2.3 Preparing Dilution Water

Note: *Use the same dilution water for all dilutions and the sample blank.*

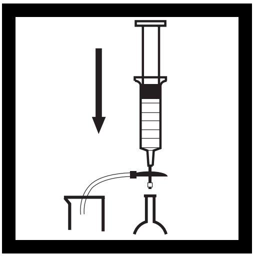
Collect at least 1000 mL of high quality dilution water (distilled or deionized water). The 2100P Turbidimeter, as received from the factory, is precalibrated and may be used to check the dilution water turbidity. If the turbidity is greater than 0.5 NTU, filter the water with the Sample Filtration and Degassing Kit (Cat. No. 43975-10) or equivalent. When measuring low range turbidity, clean all glassware with 1:1 hydrochloric acid and rinse several times with dilution water. If the glassware is not used immediately, use stoppers to prevent contamination from small particles.



1. Attach the syringe to the 3-way valve by gently twisting the square end into the syringe tip. Attach the connector, tubing and a 0.2 micron filter (clear part faces syringe) as shown. Be sure the connections are tight.



2. Fill a beaker or container with the water to be filtered. Insert the tubing into the container. Slowly draw the water into the syringe by pulling up on the syringe plunger.



3. Draw about 50 mL of sample into the syringe. Slowly push on the plunger to force the water through the filter and into a graduated cylinder or volumetric flask. Repeat Steps 2 and 3 until the desired amount of water is obtained.

Note: *As the filter clogs, it gets more difficult to push water through it. At this point, discard the filter and attach a new filter. Replacement filters are available in packages of 10 (Cat. No. 23238-10).*

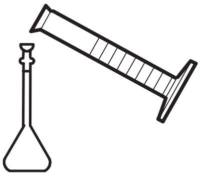
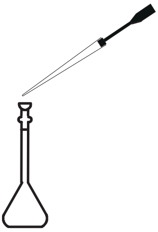
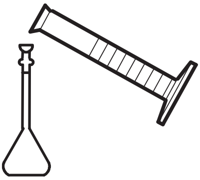
3.6.2.4 Preparing Formazin Dilutions (Factory recommended)

Hach Company recommends using 20, 100, and 800 NTU formazin standards for calibrating the 2100P Turbidimeter. Dilutions with other NTU values can be prepared and used (see *Section 3.6.3.1* on page *48*). If problems occur when using alternate solutions, use the dilutions specified here.

Prepare all formazin dilutions immediately before use and discard after calibration. The 4000 NTU solution is stable for up to a year, but dilutions deteriorate more rapidly. Use the same high quality water (turbidity <0.5 NTU) for the dilutions and the blank.

Preparing the 20, 100 and 800 NTU standards

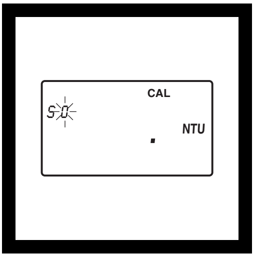
Table 1 Formazin Standard Preparation

	Step 1	**Step 2**	**Step 3**
Standards			
20 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette* pipet, add 1.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
100 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette pipet, add 5.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
800 NTU	Add 50 mL of dilution water to a clean **100-mL** class A volumetric flask.	With a TenSette pipet, add 20.00 mL of well-mixed 4000 NTU Formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.

* A class A volumetric pipet may be used in place of a TenSette Pipet.

3.6.3 Calibrating the Turbidimeter

***Note:** For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the cell so the orientation mark placed on the cell during the matching procedure is correctly aligned. (See Section 2.3.4 on page 26 for matching sample cells).*



1. Rinse a clean sample cell with dilution water several times. Then fill the cell to the line (about 15 mL) with dilution water or use StablCal <0.1 NTU standard.

***Note:** The same dilution water used for preparing the standards must be used in this step.*

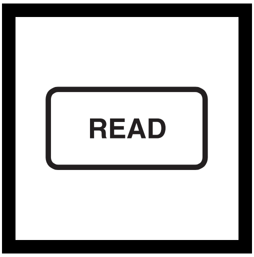
2. Insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.

***Note:** Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*

3. Press: **CAL**

The **CAL** and **S0** icons will be displayed (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank (as shown). Press → to get a numerical display.

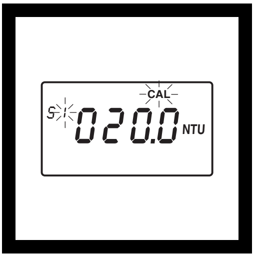
Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions. DO NOT calibrate with Gelex® Secondary Standards.



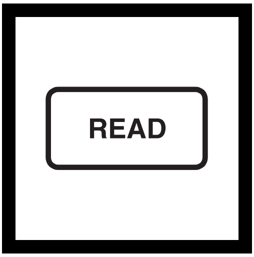
4. Press: **READ**

The instrument will count from 60 to 0, (67 to 0 if signal average is on), read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (See *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

Note: *The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show* **S0 NTU** *and the ↑ key must be pressed to continue with the next standard.*

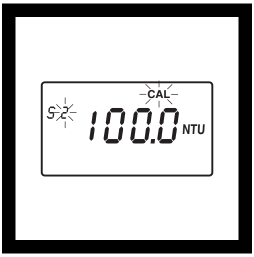


5. The display will show the **S1** (with the 1 flashing) and **20 NTU** or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 20 NTU StablCal Standard or 20 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

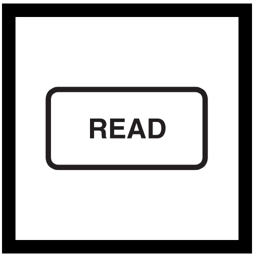


6. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

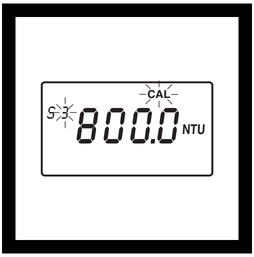


7. The display will show the **S2** (with the 2 flashing) and **100 NTU** or the value of the S2 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 100 NTU StablCal Standard or 100 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

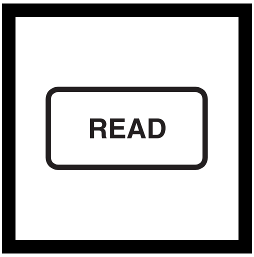


8. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then, the display will automatically increment to the next standard. Remove the sample cell from the cell compartment.



9. The display will show the **S3** (with the 3 flashing) and **800 NTU** or the value of the S3 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 800 NTU StablCal Standard or 800 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.



10. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the sample cell from the cell compartment.

11. Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

3.6.3.1 Preparing User-selected Formazin Dilutions

The formazin solutions should span the entire range of the instrument. Hach recommends preparing three standards:

1. 10 to 30 NTU

2. 90 to 110 NTU

3. 700 to 900 NTU

The standards must have a difference of at least 60 NTU.
In addition, a blank made from the dilution water should be prepared.

Prepare the formazin standard solutions from the well mixed 4000 NTU stock solution as specified in *Section 3.6.2.4* on page *42* and dilution water as specified in *Section 3.6.2.2* and *Section 3.6.2.3* on page *41*. Make the standards **immediately** before use and discard them after calibration is done.

3.6.3.2 Calibrating with User-selected Standards

Note: *For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the sample cell with the same orientation.*

1. Fill a clean sample cell to the line (about 15 mL) with dilution water.

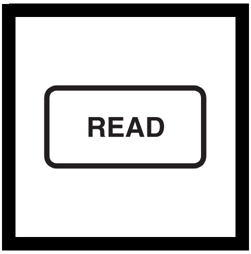
Note: *The same dilution water used for preparing the standards must be used in this step.*

2. Insert the sample cell into the cell compartment and close the lid. Press **I/O**.

Note: *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*

3. Press: **CAL**.

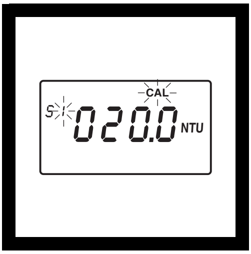
The **CAL** and **S0** icons will appear (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration.



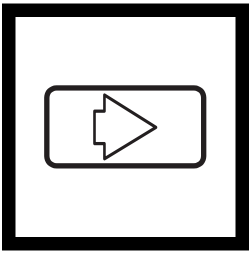
4. Press: **READ**.

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the blank and use it to calculate a correction factor for the lowest standard. If the dilution water is ≥0.5 NTU, **E 1** will appear (see *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

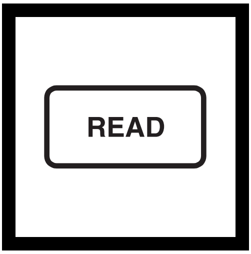
5. Thoroughly mix the 10 to 30 NTU range standard, then fill a clean sample cell to the line with the standard. Insert the sample cell into the cell compartment



6. The display will show the **S1** icon (with the **1** flashing) and **20 NTU** or the value of the S1 standard for the previous calibration.

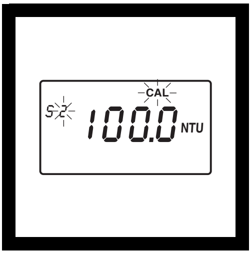


7. Edit the standard concentration by pressing →. The **1** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.

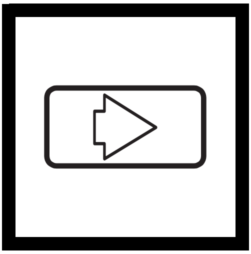


8. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

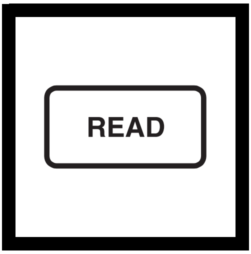
9. Thoroughly mix the 90 to 110 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.



10. The display will show the **S2** icon (with the **2** flashing) and **100 NTU** or the value of the S2 standard for the previous calibration.

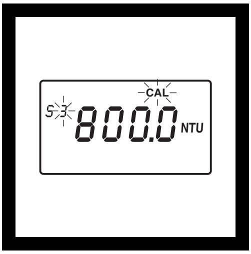


11. Edit the standard concentration by pressing →. The **2** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.

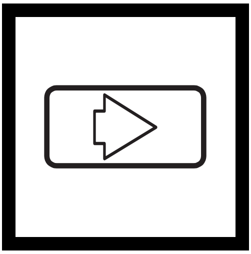


12. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Remove the sample cell from the cell compartment.

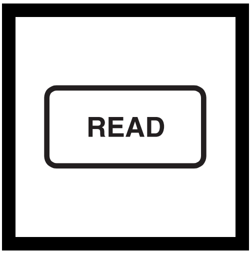
13. Thoroughly mix the 700 to 900 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.



14. The display will show the **S3** icon (with the **3** flashing) and **800 NTU** or the value of the S3 standard for the previous



15. Edit the standard concentration by pressing →. The **3** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



16. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The instrument will increment back to **S0**. Remove the sample cell from the cell compartment.

17. Press: **CAL**.

The instrument will store the new calibration data and return the instrument to the measurement mode. It will use the new calibration to calculate turbidity for subsequent measurements.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.
- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. If the error messages recur, calibrate using the factory specified standards, *Section 3.6.2.4* on page *42* and *Section 3.6.3* on page *44*. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.
- To review a calibration, press **CAL** and then only ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** isn't flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

3.6.4 Using Gelex® Secondary Turbidity Standards

Note: *Store Gelex standards at room temperature. Do not allow to freeze or exceed 50 °C.*

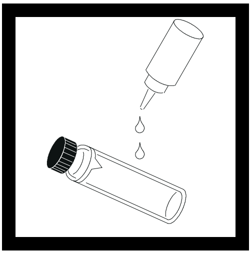
The instrument comes with Gelex Secondary Standards which are particulate suspensions similar to formazin primary standards in light scattering characteristics. NTU values on the Gelex standards indicate the range for which they should be used. Due to minor variations in glass and individual instrument optical systems, the true value of the Gelex standards must be determined against formazin in the same instrument they will be used with for later calibration checks.

3.6.4.1 Assigning Values to Gelex Standards

Calibrate
2100P with
formazin

1. Calibrate the instrument with formazin.

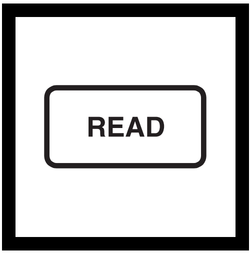
2. Select automatic range mode using the **RANGE** key.



3. Thoroughly clean the outside of the Gelex vials and apply a thin coating of silicone oil.

4. Place the 0-10 NTU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument. Close the sample lid.

Note: *Correct cell orientation is essential to obtain accurate Gelex values. Always orient the cell so the diamond mark aligns with the orientation mark on the instrument.*



5. Press: **READ**.

Record the displayed value, remove the vial from the instrument and mark the value on the band near the top of the vial.

6. Repeat *step 3* through *step 5* for the other Gelex standards, being careful to orient the cells properly.

Re-assign with every formazin calibration

7. Re-assign values to the Gelex standards each time the instrument is calibrated with formazin.

3.6.4.2 Routine Calibration Check With Gelex Standards

The 2100P Turbidimeter does not require standardization before every measurement as some turbidimeters do. Periodically, as experience dictates, check the instrument calibration using the appropriate Gelex Secondary Standard. Be sure the Gelex standards are aligned correctly when inserting them (diamond aligns with orientation mark). If the reading is not within 5% of the previously established value, recalibrate the instrument with StablCal Stabilized Formazin Primary Standard or formazin primary standard (*Section 3.6.3* on page *44*).

Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

MAINTENANCE

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the maintenance tasks described in this portion of the manual.

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détoriation de l'appareil. Les tâches d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.

Algunos de los capítulos del manual que presentamos contienen muy importante información en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vyyyermeiden. In diesem Abschnitt beschriebene Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

Algumas das seguintes secções do manual contêm informações em forma de advertências, precauções e notas que requerem especial atenção. Leia e siga atentamente as presentes instruções para evitar ferimentos pessoais e não danificar o instrumento. As tarefas de manutenção descritas nesta parte do manual só poderão ser executadas por pessoal qualificado.

SECTION 4 MAINTENANCE

4.1 Cleaning

Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1* on page *23* for more information about sample cell care.

4.2 Battery Replacement

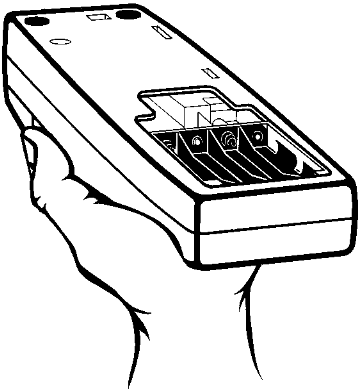
AA alkaline cells typically last for about 300 tests with the signal averaging mode off, about 180 tests if signal averaging is used. The “battery” icon flashes when battery replacement is needed. Refer to *Section 1.4.2* on page *15* for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings.

If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

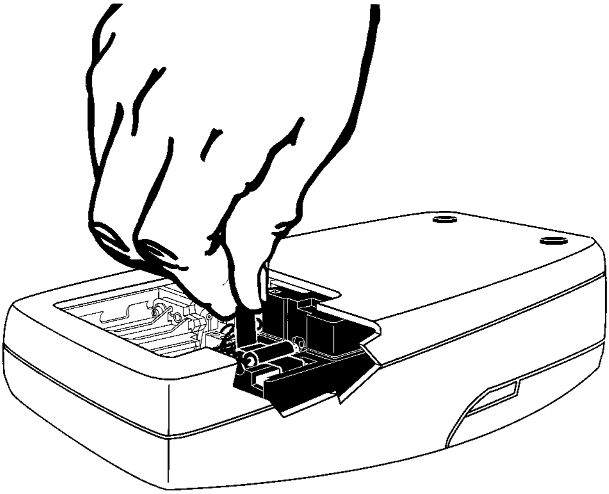
4.3 Lamp Replacement

The procedure below explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

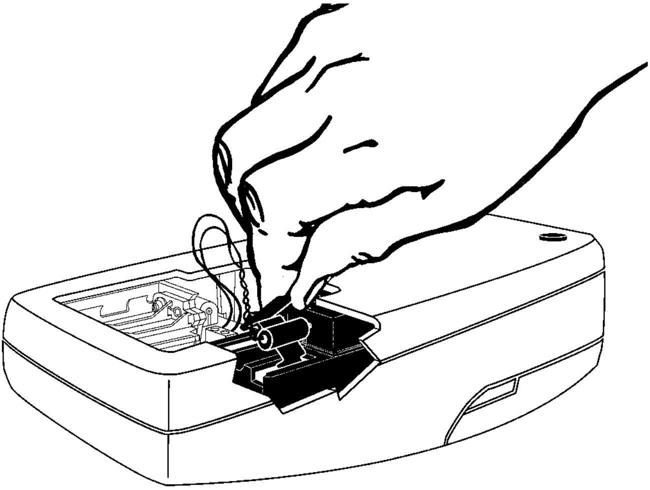
1. Orient the instrument so it is upside down and the top faces away from you. Remove the battery cover and at least one battery.



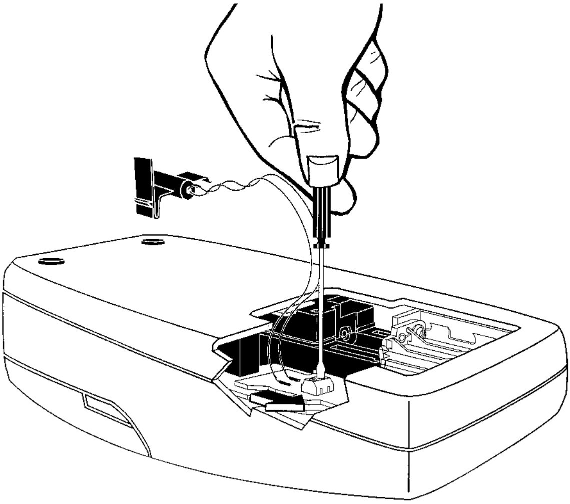
2. Remove the lamp assembly by grasping the tab on the left side of the assembly. Firmly, but gently, slide the assembly towards the rear of the instrument.



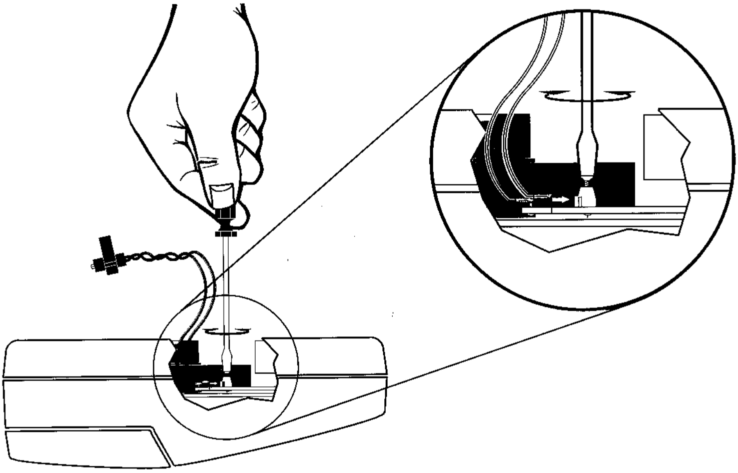
3. Rotate the tab towards the nearest outside edge. The assembly should release and slip out easily.



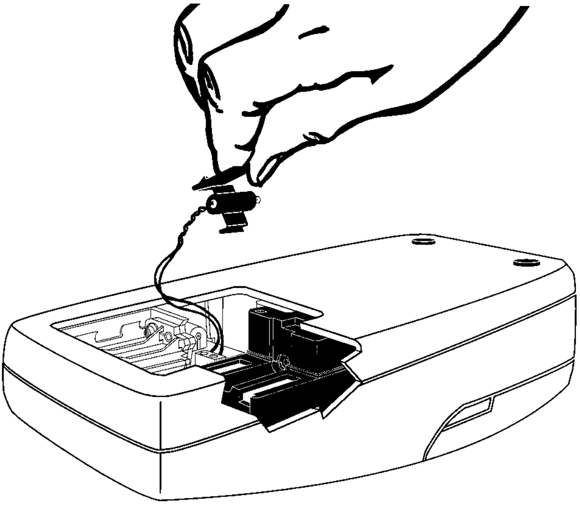
4. Back the terminal block screws **partially** out (1 to 2 turns) and remove the old lamp leads.



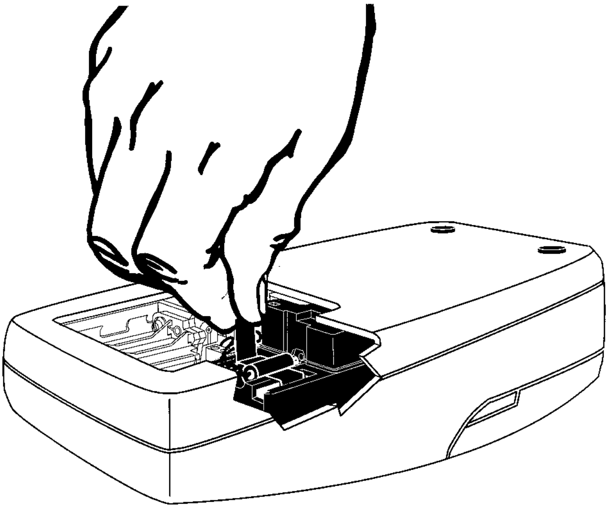
5. Gently bend the wires of the new lamp assembly into an "L" shape so they fit easily into the housing. Insert the leads into the terminal screws and tighten with clockwise turns. Gently tug on the wires to make sure they are connected to the terminal block.



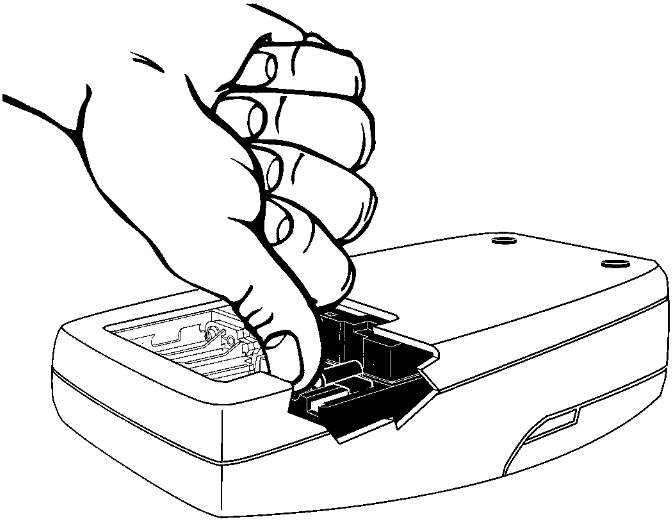
6. Hold the new lamp assembly by the tab with the lamp facing the tope (keyboard) of the instrument. Slide the small catch on the other side of the assembly into the black plastic slot (towards the nearest edge of the instrument).



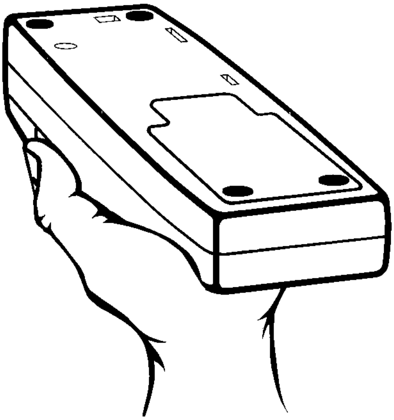
7. Snap the U-shaped bottom of the tab into the slot on the left side of the black plastic that holds the lamp assembly.



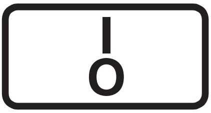
8. With your thumb, firmly slide the assembly forward until it stops. Again, push firmly against the tab to make sure the lamp is seated correctly.



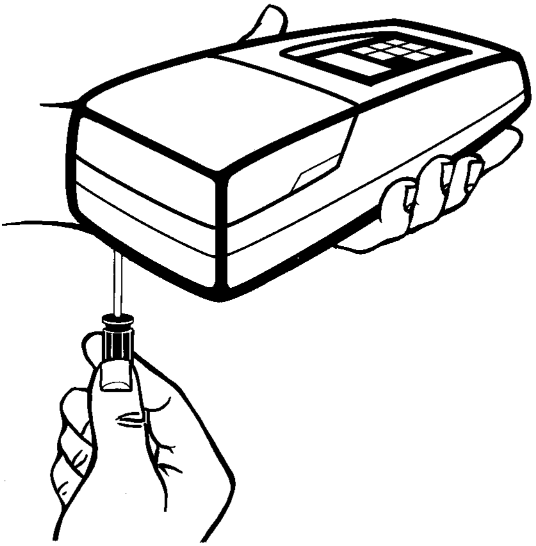
9. Replace the battery(s) and battery cover.



10. Insert the 800 NTU formazin standard into the sample cell. Press and hold **READ**. Then press **I/O**. Release the **READ** key after the software version number disappears from the display (for models with serial numbers less than 920300000800, **2100** disappears).



11. Adjust the scattered light amplifier output by inserting a small flat-bladed screwdriver into the trimpot hole (located on bottom). Adjust the display to read 2.5 ± 0.3 volts (2.0 volts for models that display **2100** when turned on).



12. Press **I/O** to exit gain adjust mode.

13. Perform a formazin calibration according to *Section 3.6.3* on page *44* or *Section 3.6.3.1* on page *48*.

SECTION 5 TROUBLESHOOTING

5.1 Using the Diagnostic Functions Key

Enter the diagnostic mode by pressing the **DIAG** key. Exit this mode at any time by pressing the key again. The diagnostic mode allows access to information about instrument function which may be useful for servicing and troubleshooting.

5.1.1 Basic Diagnostic Codes

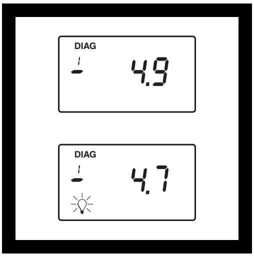
The diagnostic codes are:

Code	Description
1	Checks the battery voltage with the lamp on, then with the lamp off. This is a dual diagnostic code.
2	Displays calibration coefficient a_o
3	Displays calibration coefficient a_1
4	Displays calibration coefficient b_o
5	Displays calibration coefficient b_1
6	Displays the lamp voltage (about 3 volts)
7	Displays the dark voltage of the transmitted light detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.
8	Displays the high gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.*
9	Displays the low gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.

* Samples with turbidity >10 NTU may display **- - -** for the lamp-on amplifier voltage.

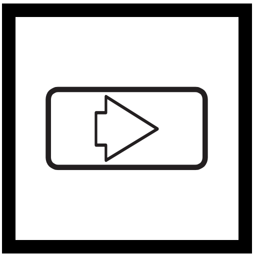
5.2 The Diagnostic Procedure

1. Fill a clean sample cell to the line with clear water, cap the cell and place it in the cell compartment. Press the **READ** key and wait until the reading is finished.

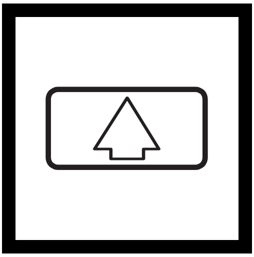


2. Press: **DIAG**

The **DIAG** icon will turn on and **1** will be displayed below the icon. The instrument will measure the battery voltage with the lamp off and display the result in volts (V). Then the lamp icon will turn on and the instrument will measure the voltage with the lamp on. The value is briefly displayed before defaulting to the lamp-off reading. To repeat the measurement, press **READ**.



3. To continuously display the lamp-on voltage, press →. The lamp icon will flash. Press → to turn the lamp icon off (the lamp is not on during this display).



4. Press the ↑ key to scroll through the other diagnostics. Each press of the key increments the digit in the small numerical display below the **DIAG** icon and the result of the diagnostic measurement is then displayed. Each press of the **READ** key updates the value. For measurements made with the lamp off and again with the lamp on, the measurement with the lamp off is displayed when the diagnostic is entered. To see the second measurement with the lamp on, press the → key (only works with diagnostic codes 1, 7, 8, & 9). The lamp icon will flash and the lamp-on measurement will be displayed in volts. Press → to turn the lamp icon off.

Note:** DIAG 8 will display* ***---- *for the lamp-on voltage if a of >10 NTU is placed in the cell compartment.*

5.3 Other Instrument Diagnostics

5.3.1 Display Test

Pressing and holding the **I/O** key turns on all the display icons and elements so you can determine if all the elements and icons are functioning. The display test sequence will cycle as long as the key is held down.

5.4 Error Messages

Error messages indicate sample interferences and/or instrument malfunction.

5.4.1 Flashing Numeric Display

If the highest value in the range selected is flashing in the display, the sample is too turbid (or overrange) for the selected range. In automatic or manual range, **1000** flashes if the sample is over the instrument's range. In manual range mode, select the next higher range mode if **9.99** or **99.9** flashes. See *Section 2.3.6* on page *31* for measuring overrange samples. The display will stop flashing if a sample within range is inserted and read.

5.4.2 E Messages

An error message indicates either an instrument failure or an operation cannot be performed. **An error message can be cleared by pressing DIAG** (display will return to previous measurement or calibration value). The meter continues to operate as best it can. If the message occurs during a calibration, calibration can continue. If the error message occurs when a calibration is being calculated, the instrument will discard the new calibration and retain the old calibration. Error messages and corrective actions are listed below.

5.4.3 CAL?

A flashing **CAL?** appears when the instrument is using the default calibration programmed at the factory. It will appear if the analyst has erased the user-entered calibration using the procedure to restore the default calibration or after and E 4 error is cleared by pressing DIAG. Recalibrate as soon as possible when **CAL?** appears. **CAL?** (not flashing) appears when a calibration has questionable validity.

Message*	Probable Cause	Corrective Action
E1	Dilution water is ≥ 0.5 NTU.	Start calibration over with better quality dilution water or use a membrane filter to filter the water before use.
E2	Two standards have the same value or their difference is less than 60 NTU. Not all standards were read during the calibration. Standard 1 is too low (<10 NTU).	Recheck preparation of standards and repeat calibration.
E3	Low light error.	Re-read measurement. Check lamp** Check for obstructed light path. Dilution may be necessary.
E4	EEPROM malfunction.	Check sum failed. Press **I/O**. If E 4 reappears, call Hach service. If **CAL?** appears, recalibrate.
E5	A/D overrange.	Check for obstructed light path. Call Hach Service.
E6	A/D underrange.	Check for open lid during reading and re-read. Check for obstructed light path. If persists, call Hach Service.
E7	Light Leak.	Close lid before pressing **READ** key.
E8	Bad lamp circuit.	Reinsert lamp leads at terminal block-make sure the lead ends are not touching each other.If this fails, call Hach Service.

* Error messages 4, 5, and 6 may indicate a failure in the internal electronics.

** Check lamp by inserting a pencil or piece of paper into the cell compartment and pressing READ. Light should be visible on the inserted object.

GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

Replacement Parts & Accessories

REPLACEMENT PARTS

Description	**Cat. No.**
StablCal Calibration Set for 2100P, Sealed Vials: <0.1 NTU, 20 NTU, 100 NTU, and 800 NTU	26594-05
AA Batteries, 4/pkg	19380-04
Battery Door	46005-00
Carrying Case	46506-00
Gelex® Standards, set (includes standards and 3 sample cells)	24641-05
Instrument Manual	46500-88
Lamp Assembly, with leads	46539-00
Mounting Feet, 4/pkg	41093-00
Oiling Cloth	47076-00
Sample Cells, 1 inch, with cap, 6/pkg	24347-06
Silicone Oil, 15 mL	1269-36

OPTIONAL ACCESSORIES AND REAGENTS

Deionized Water, 3.78 L	272-17
Bath, Ultrasonic, 2.8 L (0.75-gal), w/heater	24895-00
Battery Charger, 120 V	46479-00
Battery Charger, 230 V	46479-01
Battery Eliminator, 120 V	46079-00
Battery Eliminator, 230 V	46080-00
Filter, 0.2 micron, 10/pkg	23238-10
Formazin, 4000 NTU, 500 mL	2461-49
Formazin, 4000 NTU,100 mL	2461-42
Hexamethylenetetramine, 100 g	1878-26
Hexamethylenetetramine, 500 g	1878-34
Hydrazine Sulfate, 20 g	742-46
Hydrazine Sulfate, 100 g	742-26
NiCad Rechargeable Battery (4 required)	16077-00
Pipet, serologic, 1.00 mL	532-35

OPTIONAL ACCESSORIES AND REAGENTS, continued

Description	Cat. No.
Pipet, TenSette®*, 1-10 mL	19700-10
Pipet Tips, for 1-10 mL TenSette Pipet, 50/pkg	21997-96
Pipet Tips, for 1-10 mL TenSette Pipet, 1000/pkg	21997-28
Pipet, Volumetric, Class A, 1.00 mL	14515-35
Pipet, Volumetric, Class A, 5.00 mL	14515-37
Pump, Vacuum, Hand-Operated	14283-00
Pump, Vacuum, 115 V, 60 Hz	14697-00
Pump, Vacuum, 230 V, 50 Hz	14697-02
Sample Degassing Kit	43975-00
Sample Filtration and Degassing Kit	43975-10
StablCal® Calibration Set for 2100P Turbidimeter	
<0.1, 20, 100, 800 NTU, 500 mL each	26594-00
<0.1, 20, 100, 800 NTU, 100 mL each	26594-10
<0.1 NTU** StablCal®*** Stabilized Formazin Standard,100 mL	26597-42
20 NTU StablCal® Stabilized Formazin Standard, 100 mL	26601-42
100 NTU StablCal® Stabilized Formazin Standard, 100 mL	26602-42
800 NTU StablCal® Stabilized Formazin Standard, 100 mL	26605-42
Triton-X Solution, 118 mL (4 oz)	14096-32
Volumetric Flask, 100 mL	14574-42
Volumetric Flask, 200 mL	14574-45

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* TenSette™ is a Hach Company trademark.

** <0.1 NTU StablCal® Standard is used in place of dilution water standard when performing a calibration.

*** StablCal® is a registered trademark of Hach Company.

HOW TO ORDER

By Telephone:

6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
By FAX: (970) 669-2932

By Mail:

Hach Company
P.O. Box 389
Loveland, CO 80539-0389
U.S.A.

Ordering information by E-mail: orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you. Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or contact:

In Canada, Latin America, Africa, Asia, Pacific Rim:
Telephone: (970) 669-3050; FAX: (970) 669-2932

In Europe, the Middle East, or Mediterranean Africa:
HACH Company, c/o
Dr. Bruno Lange GmbH
Willstätterstr. 11
D-40549 Düsseldorf
Germany
Telephone: +49/[0]211.52.88.0
Fax: +49/[0]211.52.88.231

REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the HACH Service Center serving your location.

In the United States:
Hach Company
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa, Europe, or the Middle East:
Hach Company World Headquarters
P.O. Box 389
Loveland, Colorado, 80539-0389
U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

WARRANTY

Hach warrants most products against defective materials or workmanship for at least one year from the date of shipment; longer warranties may apply to some items.

HACH WARRANTS TO THE ORIGINAL BUYER THAT HACH PRODUCTS WILL CONFORM TO ANY EXPRESS WRITTEN WARRANTY GIVEN BY HACH TO THE BUYER. EXCEPT AS EXPRESSLY SET FORTH IN THE PRECEDING SENTENCE, HACH MAKES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO ANY PRODUCTS. HACH EXPRESSLY DISCLAIMS ANY WARRANTIES IMPLIED BY LAW, INCLUDING BUT NOT BINDING TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION OF REMEDIES: Hach shall, at its option, replace or repair nonconforming products or refund all amounts paid by the buyer. **THIS IS THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.**

LIMITATION OF DAMAGES: IN NO EVENT SHALL HACH BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND FOR BREACH OF ANY WARRANTY, NEGLIGENCE, ON THE BASIS OF STRICT LIABILITY, OR OTHERWISE.

This warranty applies only to Hach products purchased and delivered in the United States.

Catalog descriptions, pictures and specification, although accurate to the best of our knowledge, are not a guarantee or warranty.

For a complete description of Hach Company's warranty policy, request a copy of our Terms and Conditions of Sale for U.S. Sales from our Customer Service Department.

Oxygen, Dissolved

✭Method 8166

HRDO Method

AccuVac® Ampuls

HR (0.3 to 15.0 mg/L O_2)

Scope and Application: For water and wastewater

Test Preparation

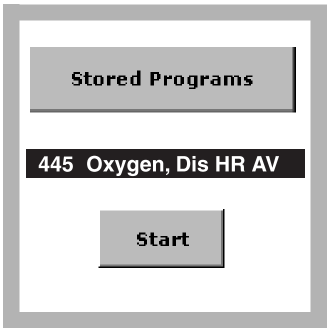
Before starting the test:

Analyze samples on-site. Do not store for later analysis

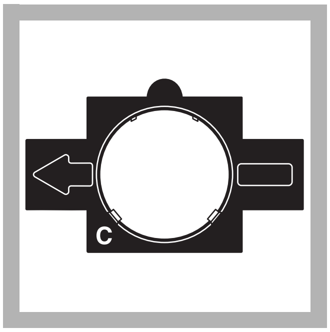
Collect the following items:	**Quantity**
High Range Dissolved Oxygen AccuVac® Ampuls with reusable Ampul caps	1
Polypropylene Beaker, 50-mL	1
Sample Cell, 10-mL	1

Note: *Reorder information for consumables and replacement items is on page 4.*

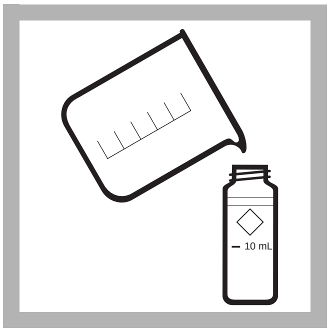
AccuVac Ampul® Method 8166



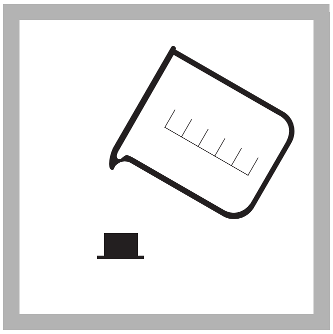
1. Select the test.



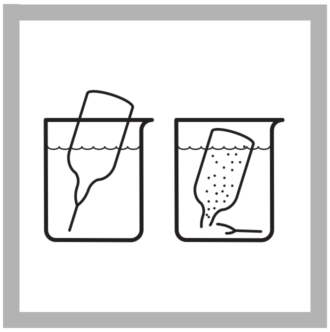
2. Insert Adapter C.



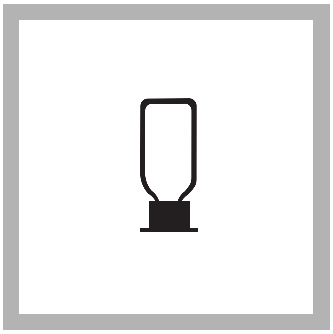
3. Blank Preparation: Fill a round sample cell with 10 mL of sample.



4. Fill a blue Ampul cap with sample.

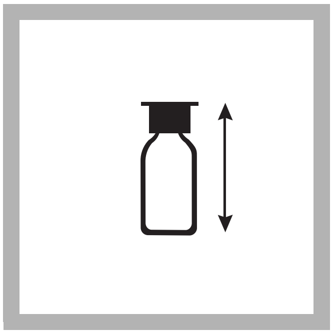


5. **Prepared Sample:** Fill a High Range Dissolved Oxygen AccuVac Ampul with sample. Keep the tip immersed while the Ampul fills completely.



6. Hold the Ampul with the tip pointing down and immediately insert the Ampul into the Ampul cap.

The cap prevents contamination from atmospheric oxygen.

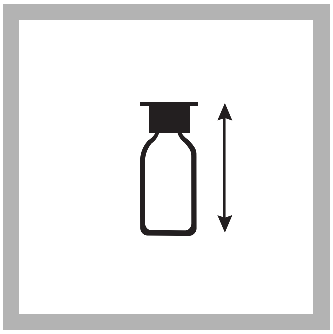


7. Shake the Ampul for 30 seconds.

A small amount of undissolved reagent will not affect results.

8. Press **TIMER>OK**.

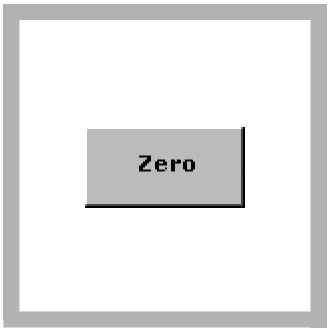
A two-minute reaction period will begin. This enables the oxygen that was degassed during aspiration to redissolve and react.



9. When the timer expires, shake the Ampul for 30 seconds.

Allow any bubbles to dissipate before proceeding.

10. Insert the blank in the cell holder.



11. Press **ZERO**.

The display will show:

0.0 mg/L O_2

12. Insert the prepared sample into the cell holder.

Press **READ**. Results will appear in mg/L O_2.

Interferences

Table 1 Interfering Substances and Levels

Interfering Substance	Interference Levels and Treatments
Cr^{3+}	Greater than 10 mg/L
Cu^{2+}	Greater than 10 mg/L
Fe^{2+}	Greater than 10 mg/L
Mg^{2+}	Magnesium is commonly present in seawater and causes a negative interference. If the sample contains more than 50% seawater, the oxygen concentration obtained by this method will be 25% less than the true oxygen concentration. If the sample contains less than 50% seawater, the interference will be less than 5%.
Mn^{2+}	Greater than 10 mg/L
Ni^{2+}	Greater than 10 mg/L
NO^{2-}	Greater than 10 mg/L

Sample Collection, Preservation, and Storage

The main consideration in sampling with the High Range Dissolved Oxygen Ampul is to prevent the sample from becoming contaminated with atmospheric oxygen between breaking open the Ampul and reading the absorbance. This is accomplished by capping the Ampul with an Ampul cap. If the Ampul is securely capped, the Ampul should be safe from contamination for several hours. The absorbance will decrease by approximately 3% during the first hour and will not change significantly afterwards.

Sampling and sample handling are important considerations in obtaining meaningful results. The dissolved oxygen content of the water being tested may change with depth, turbulence, temperature, sludge deposits, light, microbial action, mixing, travel time, and other factors. A single dissolved oxygen test rarely reflects the accurate overall condition of a body of water. Several samples taken at different times, locations, and depths are recommended for most reliable results. Samples must be tested immediately upon collection, although only a small error results if the absorbance reading is taken several hours later.

Accuracy Check

The results of this procedure may be compared with the results of a titrimetric procedure (request Lit. Code 8042), or by using any of the following dissolved oxygen meters: sens***ion***™6 Dissolved Oxygen Meter*, HQ10 Portable LDO Dissolved Oxygen Meter*, or HQ20 Portable LDO Dissolved Oxygen/pH Meter*.

Summary of Method

The High Range Dissolved Oxygen AccuVac Ampul contains reagent vacuum-sealed in a 14-mL Ampul. When the AccuVac Ampul is opened in a sample containing dissolved oxygen, it forms a yellow color which turns purple. The purple color development is proportional to the concentration of dissolved oxygen. Test results are measured at 535 nm.

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* See Optional Reagents and Apparatus on page 4.

Consumables and Replacement Items

Required Reagents

Description	Quantity/Test	Unit	Cat. No.
High Range Dissolved Oxygen AccuVac® Ampuls with 2 reusable Ampul caps	1	25/pkg	25150-25

Required Apparatus

Description	Quantity/Test	Unit	Cat. No.
Adapter, 1-inch round, for AccuVac Ampuls	1	each	LZV584
Polypropylene Beaker, 50-mL	1	each	1080-41
Sample Cell, 10-mL, with cap	1	each	21228-00

Optional Reagents and Apparatus

Description	Cat. No.
HQ10 Portable LDO Dissolved Oxygen Meter	51815-00
HQ20 Portable LDO Dissolved Oxygen/pH Meter	51825-00
sens*ion*™6 Dissolved Oxygen Meter	51850-01

Updated November 2005 Edition 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 2 6 2006

OFFICE OF
WATER

MEMORANDUM

SUBJECT: Recommendation for Use of Hach Method 10360 [Revision 1.1, January 2006] (ATP Case No. N04-0013)

FROM: Robin K. Oshiro, Ph.D.
ATP Coordinator
Engineering and Analytical Support Branch (4303 T)

TO: USEPA Regional Administrators (all Regions)

We have reviewed the Hach Method 10360 (Revision 1.1, January 2006, *Luminescence Measurement of Dissolved Oxygen in Water and Wastewater*), and the supporting validation data in ATP Case No. N04-0013. We have determined that this method meets all requirements for measurements of dissolved oxygen in water and wastewater. That is, the performance of this method is substantially similar to part 136 methods for measurement of dissolved oxygen (DO) in wastewater. We believe that this method also may be used to measure DO when a Part 136 method requires measurement of DO in determining biochemical oxygen demand in wastewater.

We will recommend that this method be included in future regulatory actions in which we periodically update the methods approved at 40 CFR Part 136.3. Meanwhile, Regions may wish to exercise their authority under 40 CFR part 136.5 to allow use of this method.

If I can be of any additional assistance on this matter or others, please contact me at oshiro.robin@epa.gov.

cc: Quality Assurance Managers (all Regions)
Water Management Division Directors (all Regions)
ATP Coordinators (all Regions)
Carey Jackson, Ph. D., Hach Company
Kevin Roberts, CSC, SCC

DATA SHEET

HACH LDO®
Dissolved Oxygen Probe

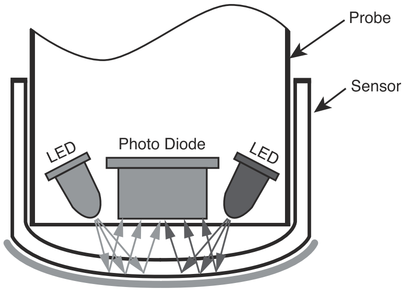
Luminescent Dissolved Oxygen

Features and Benefits

Method of Detection

The HACH LDO sensor is coated with a luminescent material. Blue light from an LED is transmitted to the sensor surface. The blue light excites the luminescent material. As the material relaxes it emits red light. The time for the red light to be emitted is measured. Between the flashes of blue light, a red LED is flashed on the sensor and used as an internal reference.

Increased oxygen in the sample decreases the time it takes for the red light to be emitted. The time measurements correlate to the oxygen concentration.



Accuracy and Speed

The sensor is unaffected by pH swings, hydrogen sulfide, wastewater chemicals, heavy metals, or organic build-up on the sensor. Warm-up time is unnecessary so the analyzer can start measuring within 30 seconds of when it's turned on.

Simple Installation and Maintenance

The HACH LDO probe can be installed with a choice of pole or ball-float mounting kits. The probe has only one inexpensive replacement part—the sensor cap that is simple to replace. The sensor cap is warranted for one year. The probe is warranted for three years.

An internal standard calibrates the instrument with every reading. Factory calibration and membrane replacement are unnecessary. Periodic wiping of the sensor with a wet rag is all that is required for continuous measurement.

Applications

- ***Aeration Tanks—****Adequate dissolved oxygen levels in aeration basins are required for microorganisms to remain viable. The HACH LDO probe can be used with a variable frequency drive or PLC control system to control the amount of oxygen being injected into the tank.*
- ***Nitrification & Denitrification Tanks***
- ***Anaerobic Digesters***
- ***Aerobic Digesters***
- ***NPDES Permit Monitoring—****Up and downstream from plant effluent and plant outfall.*

Break-through luminescent technology for dissolved oxygen. The HACH LDO® Dissolved Oxygen Probe continuously monitors DO with this revolutionary method of detection. It's virtually maintenance-free with no membranes to replace, no electrolyte solution to replenish, and no anode or cathode to clean or replace.

DW

WW

IW

Full Featured "Plug and Play" sc100 Digital Controller

There's no complicated wiring or set up procedures with the Hach sc100 controller. Just plug in any Hach digital sensor and it's ready to use—it's "plug and play."

One or two sensors—Use the sc100 Digital Controller to receive data from up to two Hach digital sensors in any combination.

Communications—Multiple alarm/control schemes are available using three relays and two PID control outputs. Communications use analog 4-20 mA and digital MODBUS®/RS485, MODBUS®/RS232 protocols. (Other digital protocols are available. Contact your Hach representative for details.) Every sc100 controller is equipped with wireless communication through an infrared port.

Data logger—A built-in data logger collects measurement data, calibration, verification points, and alarm history for up to 6 months.

DW = drinking water ***WW = wastewater municipal*** ***PW = pure water / power***
IW = industrial water ***E = environmental*** ***C = collections*** ***FB = food and beverage***

HACH®

Be Right™

Specifications*

Measuring Range

0 to 20.0 ppm,

0 to 20.0 mg/L,

0 to 200% saturation

Sensitivity

±0.5% of span

Accuracy

Measurement:
Below 1 ppm: ±0.1 ppm
Above 1 ppm: ±0.2 ppm

Temperature: ±0.2°C

Repeatability

±0.5% of span

Response Time at 20ºC

To 90% in less than 40 seconds

To 95% in less than 60 seconds

Resolution

Below 10 ppm:
±0.01 ppm or mg/L, ±0.1% saturation

Above 10 ppm:
±0.1 ppm or mg/L, ±0.1% saturation

Operating Temperature

0 to 50°C (32 to 122°F)

Flow Rate

None required

Probe Immersion Depth and Pressure Limits

107 m (350 ft.), 1050 kPa (150 psi), maximum

Transmission Distance

100 m (328 ft.) maximum

1000 m (3280 ft.) maximum when used with a termination box

Sensor Cable (integral)

10 m (33 ft.) terminated with quick-disconnect plug

Wetted Materials

Probe: Foamed Noryl® and 316 stainless steel

Sensor: Polybutyl methacrolate

Dimensions

60 x 292 mm (2.4 x 11.5 in.)

Weight

1.4 kg (3 lb., 2 oz.)

Warranties

Probe: 3 Years

Sensor Cap: 1 Year

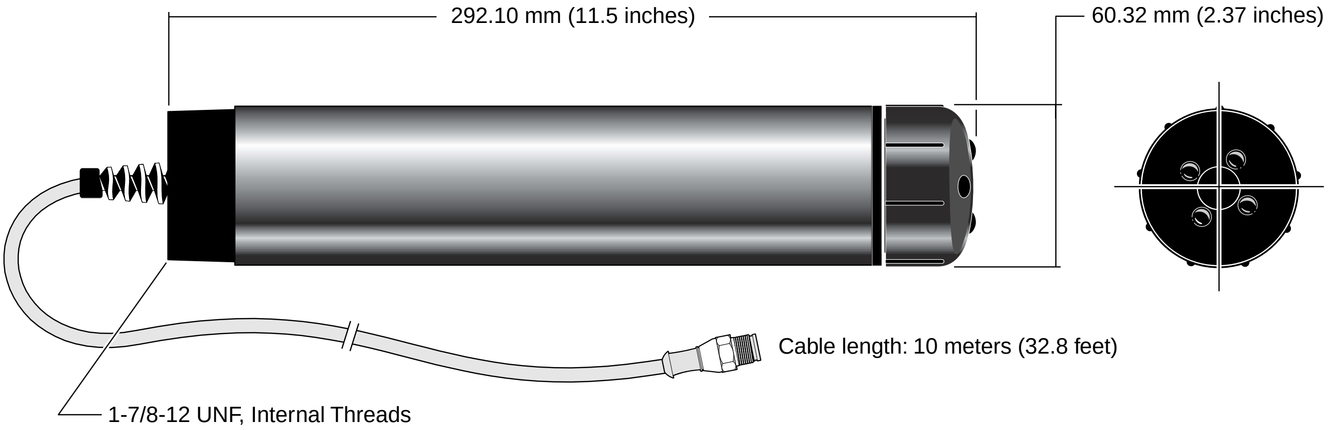
Noryl® is a registered trademark of General Electric Co.

**Specifications subject to change without notice.*

Engineering Specifications

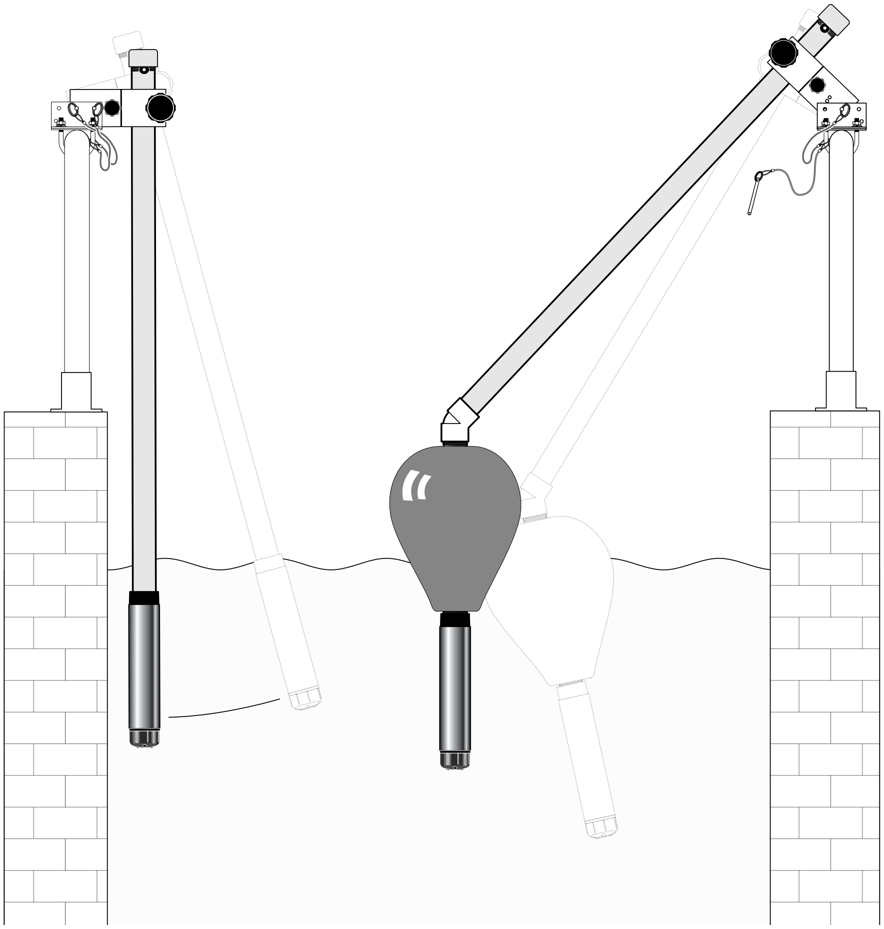
1. The dissolved oxygen probe shall be a continuous-reading probe that utilizes luminescent sensor technology.
2. The probe material shall be foamed Noryl® and 316 stainless steel. All parts of the probe shall be corrosion-resistant and fully-immersible.
3. The sensor material shall be polybutyl methoacrolate.
4. The measurement range shall be 0.00 to 20.00 mg/L dissolved oxygen.
5. The operation of the analyzer shall not be affected by H_2S, pH, K^{+1}, Na^{+1}, Mg^{+2}, Ca^{+2}, NH_4^{+1}, Al^{+3}, Pb^{+2}, Cd^{+2}, Zn^{+2}, Cr (total), Fe^{+2}, Fe^{+3}, Mn^{+2}, Cu^{+2}, Ni^{+2}, Co^{+2}, CN^{-1}, NO_3^{-1}, SO_4^{-2}, S^{-2}, PO_4^{+3}, Cl^{-1}, anion active tensides, crude oils, or Cl_2^{-1}.
6. The probe shall provide electrolyte-free operation without the requirements of sample conditioning.
7. The probe shall be furnished with choice of pole or ball-float mount kit.
8. The sensor cap shall be warranted for one full year against defects in material and workmanship.
9. The probe shall be warranted for three full years against defects in material and workmanship.
10. The analyzer shall be HACH LDO® Probe for dissolved oxygen measurement, manufactured by Hach Company.

Dimensions



Installation Examples

The HACH LDO® Probe can be mounted using the optional Pole Mount Kit (P/N 57944-00) or Ball Float Mount Kit (P/N 57943-00).



Ordering Information

57900-00	HACH LDO® Dissolved Oxygen Probe with 10 m (32.8 ft.) integral cable

Accessories

58670-00	Termination Box, required for total cable lengths greater than 100 m (328 ft.)
61224-00	Extension Cable, 1 m (3.3 ft.)
57960-00	Extension Cable, 7.7 m (25 ft.)
57961-00	Extension Cable, 15 m (50 ft.)
57962-00	Extension Cable, 31 m (100 ft.)
57951-00	Air Blast Cleaning System, 115 V
57952-00	Air Blast Cleaning System, 230 V

Replacement Parts

57911-00	Replacement Sensor Cap

Mounting Kits

57944-00	Pole Mount Kit
57943-00	Ball Float Mount Kit

To complete your dissolved oxygen measurement system, choose the sc100 or the sc1000 controller...

Model sc100 Controller

(see Lit. #2463)

LXV401.52.00002	sc100 Controller Standard
LXV401.52.01002	sc100 Controller with RS-232 MODBUS®
LXV401.52.02002	sc100 Controller with RS-485 MODBUS®

Model sc1000 Controller

(see Lit. #2403)

LXV402.99.00002	sc1000 Display Module
LXV400.99.1R572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, 110-230V
LXV400.99.1B572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, RS-485 (MODBUS), 110-230V
LXV400.99.1F572	sc1000 Probe Module, 4 sensors, 4 mA Out, 4 mA In, 4 Relays, PROFIBUS DP, 110-230V
LXV400.99.1R582	sc1000 Probe Module, 6 sensors, 4 mA Out, 4 mA In, 4 Relays, 110-230V

Lit. No. 2455
D7X Printed in U.S.A.

At Hach, it's about learning from our customers and providing the right answers. It's more than ensuring the quality of water—it's about ensuring the quality of life. When it comes to the things that touch our lives...

Keep it pure.

Make it simple.

Be right.

For current price information, technical support, and ordering assistance, contact the Hach office or distributor serving your area.

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TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Title: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) SYNTHETIC PRECIPITATION LEACHING PROCEDURE (SPLP) AND THE CALIFORNIA WET LEACH PROCEDURE (CWET)

Approvals (Signature/Date):

11/20/07
Fernando Cruz — Date
Metals Supervisor

11/20/07
Michael Ridenhower — Date
Health & Safety Manager / Coordinator

11·20·07
Marti Ward — Date
Quality Assurance Manager

Martha Jo Cahill 11/26/07
Martha Jo Cahill — Date
Laboratory Director

This SOP was previously identified as SOP No. STL-IP-0016 Rev. 5

Any reference within this document to Severn Trent Laboratories, Inc. or STL, should be understood to refer to TestAmerica Laboratories, Inc. (formerly known as Severn Trent Laboratories, Inc.)

Facility Distribution No.: 0 **Distributed To:** See Electronic Distribution Sheet

1.0 SCOPE AND APPLICATION

1.1 This SOP describes the application of the Toxicity Characteristic Leaching Procedure (TCLP), SW-846 Method 1311.

1.1.1 The Toxicity Characteristic (TC) of a waste material is established by determining the levels of 8 metals and 31 organic chemicals in the aqueous leachate of a waste. The TC is one of four criteria in 40 CFR Part 261 to determine whether a solid waste is classified as a hazardous waste. The other three are corrosivity, reactivity and ignitability. The TC Rule utilizes the TCLP method to generate the leachate under controlled conditions which were designed to simulate leaching through a landfill. EPA's "worst case" waste disposal model assumes mismanaged wastes will be exposed to leaching by the acidic fluids generated in municipal landfills. The EPA's model also assumes the acid/base characteristics of the waste will be dominated by the landfill fluids. The TCLP procedure directs the testing laboratory to use a more acidic leaching fluid if the sample is an alkaline waste, again in keeping with the model's assumption that the acid fluids will dominate leaching chemistry over time.

1.2 This SOP also describes the application of the Synthetic Precipitation Leaching Procedure (SPLP) which was designed to simulate the leaching that would occur if a waste was disposed in a landfill and exposed only to percolating rain water. The procedure is based on SW846 Method 1312.

1.2.1 The list of analytes for SPLP may extend beyond the toxicity characteristic compounds shown in Appendix A. With the exception of the use of a modified extraction fluid, the SPLP and TCLP protocols are essentially equivalent. Where slight differences may exist between the SPLP and TCLP they are distinguished within this SOP.

1.3 This SOP describes the procedure for obtaining a leachate of solid, liquid, or multiphasic samples, as provided by the California Title 22, Waste Extraction Test (WET).

1.3.1 The leachate procedure is intended to determine the mobility of both organic and inorganic analytes, however, this SOP covers only the application of this procedure for inorganic analytes.

1.4 Results obtained are highly dependent on the pH of the extracting solution, the length of time that the sample is exposed to the extracting solution, the temperature during extraction, and the particle size/surface area of the sample. These parameters must be carefully controlled.

1.5 The laboratory target analytes supported by this method, the reporting limits, method detection limits and QC limits are maintained in the Information Management System (QuantIMS). This information is found in the respective analysis SOPs, STL-MT-0003 (metals by ICP), STL-MT-0005 (mercury), STL-GC-0016 (pesticides), STL-GC-0017 (herbicides), STL-MS-0001 (Semivolatiles) and STL-MS-0002 (Volatiles).

2.0 SUMMARY OF METHOD

2.1 For liquid wastes that contain less than 0.5% dry solid material, the waste, after filtration through 0.6 to 0.8 μm glass fiber filter, is defined as the TCLP leachate.

2.2 For wastes containing greater than or equal to 0.5% solids, the liquid, if any, is separated from the solids and stored for later analysis. The particle size of the remaining solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. For TCLP, the extraction fluid employed for extraction of non-volatile analytes is a function of the alkalinity of the solid phase of the waste. For SPLP, the extraction fluid employed is a function of the region of the country where the sample site is located if the sample is a soil. If the sample is a waste or wastewater the extraction fluid employed is a pH 4.2 solution. Two leachates may be generated: a) one for analysis of non-volatile constituents (semi-volatile organics, pesticides, herbicides and metals and/or b) one from a Zero Headspace Extractor (ZHE) for analysis of volatile organic constituents. Following extraction, the liquid leachate is separated from the solid phase by filtration through a 0.6 to 0.8 μm fiber filter.

2.3 If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid leachate and these are prepared and analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

3.0 DEFINITIONS

3.1 See the TestAmerica Quality Management Plan (QMP) and TestAmerica St. Louis Laboratory Quality Manual (LQM) for a glossary of common laboratory terms and data reporting qualifiers.

3.2 "Leachate" is used to refer to the TCLP solution generated from this procedure.

3.3 "Percent Wet Solids" is that fraction of a waste sample (as a percentage of the total sample) from which no liquid may be forced out by an applied pressure.

4.0 INTERFERENCES

4.1 Oily wastes may present unusual filtration and drying problems. As recommended by EPA (see Figure 3), oily wastes that are unfilterable will be assumed to be 100% liquid and analysis for total concentrations of contaminants will be performed. This applies specifically to samples containing viscous non-aqueous liquids that would be difficult to filter.

4.2 Wastes containing free organic liquids (i.e., those with separable non-aqueous liquid phases) will be assumed to be 100% liquid and totals analysis will be performed to determine if the oil exceeds TCLP limits.

4.3 Solvents, reagents, glassware and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks.

4.4 Glassware and equipment contamination may result in analyte degradation. Soap residue on glassware and equipment may contribute to this. All glassware and equipment should be rinsed very carefully to avoid this problem.

4.5 Phthalates may be eliminated by proper glassware cleanup and by avoiding plastics. Only glass, Teflon or Type 316 stainless steel tumblers may be used for leachates to be analyzed for organics. Plastic tumblers may be used for leachates to be analyzed for the metals.

4.6 Overexposure of the sample to the environment will result in the loss of volatile components.

4.7 Glass fiber filters must be pre-cleaned with 1:1 nitric acid before use with leachates to be analyzed for the metals.

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

5.2.1 None.

5.3 PRIMARY MATERIALS USED

5.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Acetic Acid	Corrosive Poison Flammable	10 ppm (TWA)	Contact with concentrated solution may cause serious damage to the skin and eyes. Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur.
Hydrochloric Acid	Corrosive Poison	5 ppm (Ceiling)	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Sodium Hydroxide	Corrosive	2 Mg/M3 (Ceiling)	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			
STEL – Short Term Exposure Limit			
TWA – Time Weighted Average			
Ceiling – At no time should this limit be exceeded.			

6.0 EQUIPMENT AND SUPPLIES

6.1 Extraction vessels

6.1.1 For volatile analytes - zero-headspace extraction (ZHE) vessel, gas-pressure actuated, Millipore YT3009OHW or equivalent (see Figure 2).

6.1.1.1 ZHE Cleaning Procedure

6.1.1.1.1 Clean all parts, thoroughly, in warm, soap water using a brush and/or steel wool. Rinse completely with tap water followed by DI water. Set aside any plastic parts.

6.1.1.1.2 If the ZHE is suspected to be highly contaminated based on visual examination, screening information and/or technical judgment, proceed with these additional steps.

6.1.1.1.2.1 Completely disassemble the ZHE including all valves, pressure gauge and Teflon tape.

6.1.1.1.2.2 Place all stainless steel parts in a 200°C oven for 3 hours, minimum.

6.1.1.1.2.3 Remove parts from oven and allow to air cool for 1 hour, minimum, and rinse with DI water.

6.1.1.1.2.4 Reassemble using new O-rings and Teflon tape.

6.1.1.2 ZHE Leak Testing

6.1.1.2.1 The ZHE should be checked for leaks after every extraction.

6.1.1.2.1.1 If device has a built in pressure gauge, pressurize the device to 50 psi and allow to stand for one hour. Recheck the pressure.

6.1.1.2.1.2 If the device does not have a built in guage, pressurize to 50 psi and submerge in water. Check for the presence of escaping air bubbles.

6.1.1.2.1.3 If pressure is lost, check all fittings and inspect or replace O-rings as needed.

6.1.1.2.1.4 Re-test the device.

6.1.2 For metals - 2 L HDPE (Nalgene or equivalent) bottles may be used.

6.2 Vacuum filtration apparatus

6.2.1 Cleaning procedure

6.2.1.1 Clean all parts, thoroughly, in warm, soap water using a brush. Rinse completely with tap water followed by DI water.

6.3 Borosilicate glass fiber filters, 0.6 - 0.8 μm (Whatman GF/F 14.2 cm, 0.7 μm or equivalent). When analyzing for metals, wash the filters with 1 N nitric acid and de-ionized water prior to use, or purchase filters that are pre-washed with acid. Glass fiber filters are fragile and should be handled with care.

6.4 Rotary agitation apparatus, multiple-vessel, Associated Design and Manufacturing Company 3740-6 or equivalent (see Figure 1). The apparatus must be capable of rotating the extraction vessel in an end-over-end fashion at 30 ± 2 rpm.

6.5 ZHE Extract Collection Devices are used to collect the initial liquid phase and the final extract of the waste from the ZHE device, either of the following may be used:

6.5.1 Gas-tight syringes, 25 mL, Hamilton 0158330 or equivalent, or Tedlar bags

6.6 Sieves, 9.5mm and 1mm nominal opening (U.S. standard 3/8 and no.18 respectively)

6.7 Top loading balance (all measurements are to be within ± 0.1 grams).

6.8 pH meter and probe capable of reading to the nearest 0.01 unit, and with automatic temperature compensation.

6.9 Magnetic stirrer/hotplate and 1.5 inch magnetic stirring bars.

6.10 VOA vials, 20 mL, with caps and septa, prepreserved with 0.5ml HCl

6.11 HDPE plastic bottles, 2 liter.

6.12 Glass fiber filters (pre-filters), acid washed with 1:1 nitric, then rinsed with copious amounts of deionized water.

6.13 Sieve, No. 10

7.0 REAGENTS AND STANDARDS

7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP STL-QA-0002, current revision.

7.2 Reagent water for non-volatile constituents must be produced by a Millipore DI system or equivalent. For volatile constituents, water must be passed through an activated carbon filter bed (Milli-Q or tap water passed through activated carbon). Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.3 Hydrochloric acid, 1 N: Carefully add 83 mL concentrated reagent grade HCl to 800 mL reagent water, cool and dilute to 1 liter with reagent water. Cap and shake to mix well.

7.4 Nitric acid, 1 N: Carefully add 64 mL concentrated reagent grade HNO_3 to 800 mL of reagent water, cool and dilute to 1 liter with reagent water. Cap and shake to mix well.

7.5 Sodium hydroxide, 5N and 10 N

7.6 Acetic acid, glacial: concentrated, reagent grade liquid (HOAc).

7.7 pH calibration solutions: buffered to a pH of 4, 7, and 10. Commercially available.

7.8 Citric acid, anhydrous, ACS reagent grade

7.9 TCLP Leaching Fluids

- 7.9.1 The pH of both solutions listed below shall be monitored daily and the pH probes are to be calibrated on a daily basis.
    - 7.9.1.1 The leaching fluids MUST be prepared carefully. If the desired pH range is not achieved and maintained, the TCLP may yield erroneous results due to improper leaching. If the pH is not within the specifications, the fluid must be discarded and fresh extraction fluid prepared.
    - 7.9.1.2 Additional volumes of extraction fluids listed above may be prepared by multiplying the amounts of acetic acid and NaOH by the number of liters of extraction fluid required.
- 7.9.2 TCLP Fluid #1: Carefully add 250 mL glacial acetic acid and 290 mL of 10 N NaOH to 45 L reagent water in a 45 liter carboy. Cap and shake to mix well. The pH of this solution is 4.93 ± 0.05.
    - 7.9.2.1 Alternatively, add 11 mL of acetic acid and 26.8 mL of 5N NaOH to 2000 g of reagent water.
        - 7.9.2.1.1 Fill the extraction vessel to approximately 1900 g of reagent water, add 26.8 mL 5N NaOH and 11 mL of acetic acid then bring to a 2000 g final weight with reagent water.
- 7.9.3 TCLP Fluid #2: Carefully add 250 mL glacial acetic acid to 45 L reagent water in a 45 liter carboy. Cap and shake to mix well. The pH of this solution is 2.88 ± 0.05.
    - 7.9.3.1 Alternatively, add 11 mL acetic acid to 2 L reagent water.

7.9.3.1.1 Fill the extraction vessel to approximately 1900 g of reagent water, add 11 mL of acetic acid then bring to a 2000 g final weight with reagent water.

7.10 Nitric acid, 50% solution: Slowly and carefully add 500 mL concentrated HNO_3 to 500 mL reagent water. Cap and shake to mix well.

7.11 Sulfuric acid / nitric acid (60/40 weight percent mixture) H_2SO_4/HNO_3. Cautiously mix 60 g of concentrated sulfuric acid with 40 g of concentrated nitric acid. A more dilute acid mixture may be prepared, if desired. (1000X dilution is recommended)

7.12 SPLP Leaching fluids

7.12.1 SPLP solutions are unbuffered and exact pH may not be attained. The pH of TCLP and SPLP fluids should be checked prior to use. If not within specifications, the fluid should be discarded and fresh fluid prepared.

7.12.2 SPLP fluid #1: Add 60/40 weight percent mixture of sulfuric and nitric acids to reagent water until the pH is 4.20 ± 0.05 This fluid is used for soils from a site that is east of the Mississippi River and for wastes and wastewaters.

7.12.3 SPLP fluid #2: Add 60/40 weight percent mixture of sulfuric and nitric acids to reagent water until the pH is 5.00 ± 0.05. This fluid is used for soils from a site that is west of the Mississippi River.

7.12.4 SPLP fluid #3: This fluid is reagent water and is used for leaching of volatiles. Additionally, any cyanide-containing waste or soil is leached with fluid #3 because leaching of cyanide containing samples under acidic conditions may result in the formation of hydrogen cyanide gas.

7.13 CWET Leaching fluid

7.13.1 0.2 M Sodium Citrate Extraction Fluid. Add 18L of DI water to a 20 liter carboy. Carefully add 924 g of anhydrous citric acid and 1950 ml of 5N NaOH. Place on a magnetic stirrer and stir until all the solids dissolve. Measure the pH and adjust until the pH is 5.0 +/- 0.1. Alternatively, the fluid may be purchased. The pH of the fluid must be checked and recorded daily prior to use.

8.0 SAMPLE COLLECTION, PRESERVATION, STORAGE AND SHIPMENT

8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in STL-PM-0002.

8.2 Samples being analyzed for non-volatile organic compounds should be collected and stored in glass containers with Teflon lid liners. Chemical preservatives shall NOT be added UNTIL AFTER leachate generation.

8.3 Samples being analyzed for metals only can be collected in either glass or polyethylene containers.

8.4 When the waste is to be evaluated for volatile analytes, care should be taken to minimize the loss of volatiles. Samples shall be collected and stored in a manner intended to prevent the loss of volatile analytes (e.g., samples should be collected in Teflon lined septum capped vials with minimal headspace and stored at 4 ± 2 ^oC). Samples should be opened only immediately prior to extraction.

8.5 Samples should be refrigerated to 4 ± 2 ^oC unless refrigeration results in irreversible physical changes to the waste. If precipitation occurs, the entire sample (including precipitate) should be extracted.

8.6 The minimum TCLP sample collection size is determined by the physical state or states of the waste and the analytes of concern. The amount of waste required varies with the percent solids. The lower the percent solids, the more waste will be required for preliminary and final testing. For aqueous samples containing between 0.5 and 10% solids, several kilograms of sample are required to complete the analyses. The general minimal requirements when the samples are 100% solids include: 1 - 32 oz jar for semi-volatile organic analysis and metals, and 1 - 4 oz jar for volatile organic analysis. Low density sample materials, such as rags or vegetation, will require larger volumes of sample. For liquid samples (less than 50% solids), minimum requirements are 2 - 32 oz jars for semi-volatile organic analysis and metals, and 2 - 8 oz jars for volatile organic analysis. If volatile organic analysis is the only requested parameter, 2 separate jars are required. If matrix spike or duplicate control samples are requested, additional sample volume is required. If sufficient sample volumes were not received, analyses cannot be started and the client should be notified as soon as possible.

8.7 TCLP leachates should be prepared for analysis and analyzed as soon as possible following extraction. Leachates or portions of leachates for metallic analyte determinations must be acidified with nitric acid to a pH less than 2, unless precipitation occurs. **If precipitation occurs upon addition of nitric acid to a small aliquot of the leachate, then the remaining portion of the leachate shall not be acidified** and the leachate shall be analyzed as soon as possible. All other leachates should be stored under refrigeration (4 ± 2 °C) until analyzed. ZHE leachates must be stored in HCl preserved VOA vials filled to eliminate all headspace.

8.8 Samples are subject to appropriate treatment within the following time periods:

Table 1 – Holding Times (days)

Parameter	Collection to Leach	Leach to Preparation	Preparation to Analysis	Total Elapsed Time
Volatiles:	14	N/A	14	28
Extractable Organics:	14	7	40	61
Mercury:	28	N/A	28	56
Other Metals:	180	N/A	180	360

NOTE: The initial holding time is measured from date of collection to date extraction started, and subsequent holding times are measured from the date extraction starts. If sample holding times are exceeded, the values obtained will be considered minimal concentrations. Exceeding holding times is not acceptable in establishing that a waste does not exceed the regulatory level. Exceeding the holding time will not invalidate characterization if the waste exceeds the regulatory limit.

9.0 QUALITY CONTROL

9.1 Batch

9.1.1 Definition: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of a similar matrix, meeting the above mentioned criteria. Where no preparation method exists (example, volatile organics, water) the batch is defined as environmental samples that are analyzed together with the same process and personnel, using the same lots of reagents, not to exceed 20 environmental samples. An analytical batch is composed of prepared environmental samples, extracts, digestates or concentrates that are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

9.1.2 Each LEACHATE batch may contain up to 20 environmental samples, a method blank for each fluid.

9.1.3 Samples that have assigned QC limits different than the standard limits contained in QuantIMS QC code 01 must be batched separately, but can share the same QC samples.

9.2 Method Blank

9.2.1 Definition: a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.2.2 One leachate (method) blank must be prepared and leached for each leachate batch.

9.2.3 One leachate blank is prepared for each leachate fluid used. The leachate blank must consist of the same extraction fluid as used for the samples, or reagent water if only filtration of the sample(s) was required.

9.3 LCS and MS/MSD

9.3.1 For metals analysis, a MS/MSD is performed after leaching but prior to preservation and submittal for metals sample preparation. All Laboratory Control Samples (LCS) and Organic MS/MSD are initiated in inorganic and organic sample preparation procedures and not included in this SOP. See SOPs: STL-IP-0013 (ICP metals digestion), ST-MT-0005 (mercury), STL-OP-0002 (pesticides and semivolatile extraction), and STL-OP-0007 (herbicide extraction)

9.3.2 See appendix table for metals MS/MSD spiking concentrations.

9.4 Procedural Variations

9.4.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. The Nonconformance Memo shall be filed in the project file and incorporated into the report narrative.

9.5 Nonconformance and Corrective Action

9.5.1 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the facility QA Manager. See SOP STL-QA-0036 for details regarding the NCM process.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Sample analysis instrumentation calibration requirements are found in the respective analytical SOPs: STL-MT-0003 (metals by ICP), ST-MT-0005 (mercury), STL-GC-0016 (pesticides), STL-GC-0017 (herbicides), STL-MS-0001 (Semivolatiles) and STL-MS-0002 (Volatiles).

10.2 The rotation devices must be checked once a month for proper rotation speed. Count the number of rotations in exactly 60-seconds. The number of rotations must be between 28 and 32, or corrective action is required. Record the result in a logbook.

10.3 Calibrate the pH meter daily when used. The pH meter is calibrated in accordance with SOP: STL-WC-0011.

10.4 Calibrate the top loading balance with 10g, 2000g and 5000g weights. See SOP, STL-QA-0005, for details regarding balance calibration and documentation.

11.0 PROCEDURE

11.1 Preliminary evaluations (percent solids, particle size, selection of extraction fluid, and fluid/leachate compatibility)

11.1.1 Preliminary evaluations are required to be done using a minimum of a 100 gram aliquot of waste. This aliquot may also undergo the actual leachate extraction for Non-volatiles ONLY

IF it has NOT been oven dried. If the solid portion is oven dried, a separate aliquot must be used for the actual leaching procedure.

11.1.2 Determine the total volume of leachate (solid phase leachate + liquid filtrate) that needs to be generated for analysis according to the following:

Minimum Required Leachate Volume

Analysis	Required Volume (mL)
Volatiles	2 x 20
Semi-volatiles	200
Pesticides/ PCBs/Herbicides	100 each
Metals	100

11.1.2.1 If extractable organics are required on the same sample, a full 1 L volume must be prepared for each test requested.

11.1.2.2 For samples used for matrix spike and matrix spike duplicate analysis, three times the listed volumes are required.

11.1.3 Check the number of phases observed in the sample. It is common that when more than one container of multi-phasic materials is received from the field, each container will show different amounts of each phase.

11.1.3.1 If the sample has multiple phases and is received in more than 1 bottle then the contents of each bottle should be combined in a single larger container prior to processing the sample further. If this is not possible, then the alternate procedure described in the following section should be used.

11.1.4 Properly record the relative amounts of each phase by measuring the depth of the layers in each container after the contents have been allowed to settle. Determine the combined volume of each phase for all containers. Then mark the phase composition on a single container, mix thoroughly to obtain a representative subsample, and accurately measure the phase composition according to the following procedure. The two sets of values (combined volumes per phase and phase composition for one container) are used to determine the correct volume/mass adjustments on the final result. This procedure is not appropriate if testing will be done for volatile organic compounds.

11.2 Percent Solid Phase

11.2.1 If the waste will obviously yield no free liquid when subjected to pressure filtration (i.e., it is 100% solid), then proceed to Section 11.4 (Particle-size Reduction).

11.2.2 If the waste will obviously yield no solid when subjected to pressure filtration (i.e. it is 100% liquid), then proceed to Section 11.3.7.

11.2.3 For TCLP and SPLP determinations:

11.2.3.1 Percent Solids and ZHE Extractions - The ZHE filtration apparatus cannot accurately determine percent **solids less than 5%**. If an extraction is to be performed solely for volatile organic compounds and the percent solids concentration is apparently greater than 5%, proceed to Section 11.7. (Procedure: ZHE Extraction Procedure, Volatile Constituents). Otherwise, continue with the steps in this section. The aliquot of sample used here cannot be used again for the ZHE extraction.

11.2.3.2 Weight of filter - Measure and record this value on the extraction record before loading the filter into the filter holder.

11.2.3.3 Assemble the filtration apparatus.

11.2.3.3.1 Homogenize the waste, transfer a minimum of a 100 g subsample to the weighing vessel. Measure and record the gross weight.

11.2.3.3.2 Determine the exact amount of sample transferred by weighing a beaker containing the sample before and after transfer of the sample.

11.2.3.4 Transfer the sample to the filtration device attempting to spread the waste sample evenly over the surface of the filter. Measure and record the tare weight of the empty weighing vessel and any residual sample.

11.2.3.5 Calculate and record the net weight of sample used for testing.

11.2.4 For CWET determinations

NOTE: Percent solids for WET is not the same as the percent solids normally referred to in other extractions and is not at all related to the percent moisture. Here, the percent solids is the dried fraction of the sample from which no liquid may be forced by applied pressure.

11.2.4.1 If visual inspection indicated that the sample will yield no liquid upon filtration, the sample is declared to be 100% solids.

11.2.4.2 If the sample is liquid or multiphasic, filtration must be used to determine the percent solids.

11.2.4.3 Record the weight of the filter and pre-filter in the laboratory notebook. Securely assemble the filter holder, screen, pre-filter, filter, and head onto the filtration unit. Leave off the screw-on cap on the filtration head.

11.2.4.4 Weigh a minimum 50-gram aliquot of the sample into a 250-ml beaker, after homogenizing the sample. If the percent solids are expected to be low, it may be advantageous to use a larger amount of the sample in order to obtain enough filtrate for subsequent metals analysis. Record the weight to the nearest 0.1 gram. Quantitatively transfer (>99%), the aliquot into the filter unit through the opening at the top of the filtration head using physical means only. Do not rinse with water. Tightly screw the cap onto the opening.

11.2.4.5 Collect the filtrate into a clean collection flask. Filtration stops when no additional filtrate in two-minute interval, is collected.

11.2.4.6 After filtration is complete, if liquid remains, it is considered part of the solids content since it would not filter.

11.2.4.7 Remove the screen with the pre-filter, filter and solids on it. If the solids are obviously greater than 0.5% by weight, it is not necessary to dry the filter and the weight of the pre-filter, filter and solids can be immediately determined. If it is not obvious, transfer the screen, pre-filter, filter, and solids to the oven. Dry in the oven at 100 +/- 20 degrees C for approximately 1-hour. Remove from the oven and allow to cool. Using forceps, transfer the pre-filter and filter onto the balance. Record the weight in the logbook. **Note:** if no liquid was obtained from the filtration, the sample is considered 100% solids, and it is not necessary to continue with drying the filter, etc.

11.2.4.8 Calculate and record the percent solids in the logbook. If the percent solids is < 0.5%, the sample is considered 100% liquid, otherwise, the sample is multiphasic. If the solids were not dried, they may be used to obtain the leachate, which must be combined with the original filtrate (if the liquids are compatible). If the solids were dried, and the percent solids is less than or equal to 0.5%, then a fresh aliquot of waste must be filtered to obtain solids to be leached.

11.3 Filtration for percent solids

11.3.1 Slowly apply gentle pressure of 10 psi to the filtration apparatus. Allow the sample to filter until no SIGNIFICANT additional liquid has passed through the filter during a 2 minute period.

11.3.2 Repeat previous step by increasing the pressure in 10 psi increments until a maximum of 50 psi is reached. Stop the filtration when no additional filtrate is generated within a 2 minute period.

NOTE: Some samples will contain liquid material that does not filter (e.g., oil). Do not attempt to filter the sample again by exchanging filters. Viscous oils or any wastes which does not pass through the filter is classified as a solid.

11.3.3 Weight percent of dry solids (skip this step for oily samples).

NOTE: These steps are required only if it is noticed that a small amount of the filtrate is entrained in wetting of the filter and the percent wet solids (if measured) is ≥ 0.5%.

11.3.3.1 Remove the filter with the wet solids from the filtration apparatus.

11.3.3.2 Dry the filter and solid phase at 100 ± 20 ° C.

11.3.3.3 Remove the filter from the oven and allow to cool in a desiccator.

11.3.3.4 Weigh and record the gross dry weight.

11.3.4 If not dried > 18 hours, repeat the drying step. Weigh and record the second gross dry weight. If the two weightings do not agree within 1%, perform additional drying and weighing until successive weighings agree within 1%.

11.3.5 Calculate and record the weight percent of dry solids.

11.3.6 If the dry solids result is ≥ 0.5% and the sample will be extracted for non-volatile constituents, proceed to Section 11.4 (Particle Size Reduction) using a fresh wet portion of waste.

11.3.7 If the percent solids result is less than 0.5%, discard the solid phase. No leaching will be necessary; the filtrate is the TCLP leachate. Proceed to Section 11.6.11 for non-volatile constituents and Section 11.7.9.2 for volatile constituents.

11.4 Particle-size Reduction for Fluid Selection

11.4.1 For TCLP and SPLP determinations:

11.4.1.1 The subsample used for fluid selection must consist of particles less than 1 mm in diameter (versus the less than 1 cm requirement for the material used for the actual extraction). The method requires a smaller particle size to partially compensate for the shorter duration of contact time with the leachate solution as compared to the full extraction. Inappropriate use of coarser materials could result in the selection of the wrong fluid type.

11.4.1.2 Surface area exclusion - size reduction is not required if the sample surface area is greater than or equal to 3.1 cm^2 per gram., such as might be the case with pieces of paper, cloth, etc.

11.4.1.3 If the sample contains particles greater than 1 mm in diameter, crush, cut, or grind the solids to the required size. Note the type of particle size reduction performed on the extraction record.

11.4.2 For CWET determinations:

11.4.2.1 Determine if particle-size reduction is required by sieving the solids through a No. 10 sieve (unless it is obvious that all material will pass through the sieve). Material that does not pass through the sieve must be crushed, ground, etc. in order to pass through the sieve.

11.4.2.2 Perform any particle size reduction on the solid portion of the sample as necessary, for sample to pass through a no. 10 sieve.

11.4.2.2.1 For a multiphasic sample, quantitatively transfer the entire solids portion obtained, including filter, into an extraction bottle.

11.5 Determination of Appropriate Extraction Fluid

11.5.1 If the solid content is greater than or equal to 0.5%, and if the sample is being analyzed for metals or nonvolatile organic compounds, the type of leaching solution must be determined.

11.5.2 For SPLP, refer to Section 7.12 for fluid selection. Matrix type must be specified by the client. Check special instructions or see the project manager, then put a check mark by the fluid type selected.

11.5.3 For CWET use the equation in section 12.1.5, to determine the appropriate volume of 0.2-M sodium citrate solution to add to the extraction bottle. Add this volume to the extraction bottle.

11.5.4 The TCLP leaching fluid for all volatiles is Fluid #1.

11.5.5 For TCLP leach fluid determination for non-volatile analytes, continue with the following steps.

11.5.5.1 Weigh out a 5.0 ± 0.1 g subsample (less than 1 mm particle size) of the solid phase into a 150-mL disposable plastic bottles.

11.5.5.2 Add 96.5 ± 1.0 mL of reagent water, cover with a disposable watchglass, and stir with a 1.5 inch stirring bar for 5 minutes.

11.5.5.3 Measure and record the sample pH.

NOTE: To avoid damaging the pH probe when organic liquid is present, use narrow range pH indicator paper.

11.5.5.4 If the pH is less than or equal to 5.0, use Fluid #1 and proceed to Section 11.5.6.

11.5.5.5 If the fluid pH is greater than 5.0, add 3.5 mL 1 N HCl, cover with a disposable watchglass. Slurry the sample briefly then transfer to a hotplate. Place a thermometer in sample, heat at 50 ^{o} C - 55 ^{o}C for 10 minutes.

NOTE: The heating cycle is a critical step. If the solid waste does not remain in contact with the acidic solution under specified time and temperature conditions, an erroneous pH may be measured.

11.5.5.6 Allow sample to cool until to reaches between 25 ^{o}C (room temperature) and 30 ^{o}C.

11.5.5.7 Slurry the sample briefly and let the solids settle.

11.5.5.8 Measure and record the pH. Record the selected fluid number on the extraction record.

11.5.5.9 If the pH is less than or equal to 5.0, use Fluid #1.

11.5.5.10 If the pH is greater than 5.0, use Fluid #2.

11.5.6 For samples requiring analysis for semi-volatile organics, pesticides, herbicides or metals proceed to Section 11.6.

11.5.7 For samples requiring analysis for volatile organics (ZHE), proceed to Section 11.7.

11.6 TCLP/SPLP Bottle Extraction Procedure: Non-Volatile Constituents

11.6.1 All masses should be recorded to the nearest 0.1 g.

11.6.2 The aliquot used in the Preliminary Evaluation MAY be used for this procedure ONLY if it was not oven dried. If the sample is 100% solid or if the preliminary aliquot was not oven dried proceed directly to Section 11.6.8 (Particle Size Reduction). If the Preliminary Evaluation aliquot was oven dried then, using a fresh aliquot of sample, continue as described in Sections 11.6.3 through 11.6.5.

11.6.3 Determine the minimum total volume of solid phase leachate that needs to be generated. Refer to Section 11.1.2.

11.6.4 Divide the total volume of solid phase leachate required by 20 to determine the mass of solid phase required for leaching. Round this mass UP to the nearest 5 g.

11.6.5 Repeat the steps outlined in Sections 11.2.3 through 11.3.2. (skipping CWET section inserts)

11.6.6 Determine and record the volume (mass) of the initial filtrate. Cover with aluminum foil or retain in a glass bottle for use.

11.6.7 Determine and record the “solid” phase mass by subtracting the mass of the liquid filtrate from the mass of the subsample.

11.6.8 Evaluate the solid portion of the waste for particle size. If it contains particles greater than 1 cm in size, prepare the solid portion of the waste for leaching by crushing, cutting, or grinding such that all particles are less than 1 cm in size (i.e., capable of passing through a 9.5 mm, 0.375 inch, standard sieve). Size reduction is not required if the sample surface area is greater than or equal to 3.1 cm^2 per gram. If particle size reduction was required, record the type of reduction used onto the extraction record.

11.6.8.1 Scissors or shears may be used to cut cloth, plastic or sheet metal. Saws may be used for wood or solid metal. Note that size reduction to fine powder is not appropriate, and could invalidate results. If necessary, consult client for guidance.

11.6.9 Weigh the required mass of solid phase into an appropriate plastic bottle and **slowly** add 20 times its mass of appropriate leaching fluid as determined under Section 11.5 (e.g., 20 g of sample would require 400 g of leaching fluid). Record the weight of the sample aliquoted for the extraction and the amount of extraction fluid added.

11.6.10 Ensure any effervescence has stopped before capping the bottle tightly. Secure in a rotary agitator and rotate end-over-end at 28-32 rpm for 16-20 hours. The temperature of the room should be 23 ± 2°C. The room temperature and time should be checked at both the start and end of the extraction and recorded on the extraction record.

NOTE: As agitation continues, pressure may build up within the bottle for some types of wastes. To relieve excessive pressure, the bottle may be removed and opened periodically in a properly vented hood to relieve any built-up pressure.

11.6.11 Remove the bottle and filter the sample using pressure filtration by filtering through a new glass fiber filter. For final filtration of the TCLP leachate, the glass fiber filter may be changed, if necessary, to facilitate filtration. Filters must be acid washed if metals are to be determined (see Section 6.3). The entire sample need not be filtered unless the sample yielded an initial liquid phase that needs to be combined with this filtrate; however, sufficient volume should be generated to support the required analyses.

11.6.12 If the waste contained no initial filtrate, this solution is defined as the leachate.

11.6.13 If the waste did yield an initial filtrate, and if this filtrate and the initial filtrate are compatible, they are to be combined in the correct proportions (see Section 12.1.4) and mixed well. This combined solution is defined as the TCLP leachate.

11.6.14 If the individual phases are NOT miscible, they are to be prepared and analyzed separately and the results combined mathematically. See Section 12.1.5.

11.6.15 Measure and record the pH of the TCLP leachate (do not attempt to measure the pH of oily samples as the probe may be rendered inoperable).

11.6.16 Prepare subsamples for metals for MS/MSD quality control testing using the appropriate TCLP spiking solution (do not spike for organics). Refer to the appropriate determinative SOPs for further guidance on the spike components, levels and action criteria.

11.6.17 Immediately preserve the leachate as follows:

11.6.17.1 Metals pH < 2 w/50% HNO_3 for non-oils (do not acidify oils)

11.6.17.1.1 If precipitate is observed upon addition of nitric acid to a small aliquot of the extract, the remaing portion of the extract for metals shall not be acidified and the extract shall be analyzed as soon as possible.

11.6.17.2 All others Refrigerate to 4 ± 2 ^{o}C

NOTE: Refer to Section 8.6 if precipitation occurs upon preservation.

11.6.18. Label each sample with the appropriate information and submit to the appropriate analytical groups for prep and analysis with copies of the TCLP preparation worksheets.

11.7. TCLP/SPLP ZHE Extraction Procedure: Volatile Constituents

11.7.1 Use the ZHE device to obtain a TCLP leachate for analysis of volatile compounds only. Leachate resulting from the use of the ZHE shall NOT be used to evaluate the mobility of non-volatile analytes (e.g., metals, pesticides, etc.).

11.7.2 Due to some shortcomings of the method, losses of volatile compounds may occur. Extra care should be observed during the ZHE procedure to ensure that such losses are minimized. Charge the ZHE with sample only once and do not open the device until the final extract has been collected. Do not allow the waste, the initial liquid phase or the extract to be exposed to the atmosphere any longer than necessary.

11.7.3 If the TCLP extraction is for volatile components only, refer to Section 11.2.3.1 before proceeding.

11.7.4 All masses should be recorded to the nearest 0.1 g.

11.7.5 Partially assemble the ZHE apparatus.

11.7.6 Adjust the ZHE piston in the ZHE body to the appropriate height (slightly moisten the O-rings with leaching fluid or DI water if necessary).

11.7.7 If the preliminary evaluations indicated the need for particle size reduction, homogenize the waste, weigh out a sufficient size subsample and prepare for leaching by crushing, cutting, or grinding such that all particles are less than 1 cm in size as measured with a ruler (Do NOT sieve the sample). Size reduction is not required if the sample surface area is greater than or equal to 3.1 cm^2 per gram If particle size reduction was required record they type of reduction used on the extraction record.

NOTE: To minimize loss of volatiles, samples for volatiles that require particle size reduction should be kept in sample storage (at 4 ºC) until immediately before size reduction. Aggressive reduction which would generate heat should be avoided and exposure of the waste to the atmosphere should be avoided to the extent possible. Size reduction to a fine powder is not appropriate.

11.7.7.1 Scissors or shears may be used to cut cloth, plastic or sheet metal. Saws may be used for wood or solid metal.

11.7.8 Place the ZHE apparatus on the balance and tare the balance.

11.7.9 Determine the appropriate size subsample to weigh using the percent solids information from Section 11.2.

11.7.9.1 For wastes that are 100% solids, a 25 g sample is used.

11.7.9.2 For wastes containing < 0.5% solids, the liquid portion of the waste, after filtration, is defined as the TCLP leachate. Filter enough of the sample to support all of the volatile analyses required.

11.7.9.3 For wastes containing ≥ 0.5% and < 5.0% solids, a 500 g subsample of waste is recommended.

11.7.9.4 If the sample has ≥ 5.0% solids, a smaller sample size can be determined using the equation in Section 12.1.2.

11.7.10 Homogenize and transfer an appropriate size subsample of the waste into the ZHE and record the weight on the extraction record.

11.7.11 If the waste is 100% solid, immediately pour in 20 times the aliquot’s weight onto the sample.

11.7.12 Carefully place the glass fiber filter between the support screens and secure to the ZHE. Tighten all the fittings.

11.7.13 Place the ZHE in an upright position; open both the gas AND liquid inlet/outlet valves. Attach a gas line to the gas inlet/outlet valve.

11.7.14 If the waste is 100% solid, carefully apply gentle pressure of 10 psi (or more, if necessary) to force all headspace slowly out of the ZHE. At the FIRST appearance of liquid from the liquid inlet/outlet valve, quickly close the valve and discontinue gas pressure. Proceed to Section 11.7.16.

11.7.15 If the waste is < 100% solids, proceed as follows:

11.7.15.1 Carefully apply gentle pressure of 10 psi (or more, if necessary) to force all headspace slowly out of the ZHE. At the FIRST appearance of liquid from the liquid inlet/outlet valve, quickly close the valve and discontinue gas pressure.

11.7.15.2 Attach a pre-weighed Tedlar bag to the liquid inlet/outlet valve and open the valve. Record the tare weight of the bag. A tared gas-tight syringe may also be used to collect the liquid phase.

11.7.15.3 Carefully apply gas pressure of no more than 10 psi to force out the liquid phase. Allow the sample to filter until no SIGNIFICANT additional filtrate has passed in a 2 minute period.

11.7.15.4 Repeat previous step increasing the pressure in 10 PSI increments until 50 psi is reached and no significant liquid has passed in a 2 minute period. Remove the Tedlar bag or syringe and record the total weight of the container with filtrate. Close the gas-inlet valve and discontinue gas pressure. Retain the Tedlar bag or syringe with filtrate at 4° C for recombination with the leachate.

11.7.15.5 If the original waste contained less than 0.5% solids (Section 11.2), this filtrate is defined as the TCLP leachate. Proceed to 11.7.23.

11.7.15.6 If the original waste contained greater than 0.5% solids (Section 11.2), the material remaining in the ZHE is defined to be the “solid” phase. Calculate the weight of the solid phase using Equation 4.

11.7.15.7 Based on the information from Sections 11.2. and using the formula in 12.1.3, determine the weight of fluid to load into the ZHE onto the “solid” phase.

11.7.15.7.1 Load ZHE with 500 mL of Fluid #1

11.7.16 Check the ZHE to make sure all the valves are closed and manually rotate the ZHE (end-over-end) 2 or 3 times. Reposition the ZHE in the vertical position.

11.7.17 Slowly open the liquid inlet/outlet valve to bleed out any headspace that may have been introduced during the introduction of the Fluid. Upon the first sign of liquid from the valve, close the valve.

11.7.18 Pressurize the ZHE to 30 psi. Allow to stand for 10 minutes, and then recheck the pressure. If the ZHE appears to be leaking, follow the corrective action protocols recommended by the manufacturer and repeat the analysis.

11.7.19. Place the ZHE in the rotary agitator. Record the initial ZHE pressure on the extraction record. Rotate at 28-32 rpm for 16-20 hours. Room temperature should be 23 ± 2 °C. The room temperature and time should be checked at both the start and end of the extraction and recorded on the extraction record.

11.7.19 Confirm that the pressure of 30 psi was maintained throughout the leaching. Record the final ZHE pressure on the extraction record. If it was NOT maintained, return to Section 11.7.1 and repeat the leachate with a new aliquot of sample.

11.7.20 Attach a syringe or Tedlar bag and open the liquid inlet/outlet valve to collect the aqueous leachate. If the filtrate is to be combined with an initial filtrate, record the volume/mass of the leachate and any oil phase.

NOTE: If the waste contained an initial liquid phase, and the leachate is miscible with the initial liquid, the liquid may be filtered directly into the same collection device holding the initial liquid phase of the waste.

11.7.20.1 A separate filtrate collection container must be used if combination would create multiple phases or there is not enough volume left within the filtrate collection container.

11.7.21 If the waste contained an initial filtrate (Section 11.7.15) that is miscible with the leachate, the leachate and the initial filtrate are directly recombined in the correct proportions. If the individual phases are NOT compatible, they are to be collected and analyzed separately.

11.7.22 Following collection, store the TCLP leachate in 2 20-mL preserved VOA vials with minimal headspace at 4 ± 2 ^{o}C and prepare for analysis as soon as possible using the appropriate organic extraction procedure.

11.7.23 If the individual phases are analyzed separately, combine the results mathematically by using the recombination calculation in Section 12.1.4.

11.8 CWET Leaching Procedure for the Solid Fraction

11.8.1 For a 100% solids sample, weigh out and quantitatively transfer a minimum of 50-grams of the sample into an extraction bottle. The extraction bottles shall be fitted with covered air scrubbers extended well into the extraction solution and flushed vigorously with nitrogen gas for 15 minutes so as to remove and exclude atmospheric oxygen from the extraction medium.

11.8.1. Secure the lid on the bottle and place the bottle in the rotator. Rotate the sample for a minimum of 48 hours at 20-40 degrees C at 30 +/- 2 rpm. Record the initial room temperature in the logbook.

NOTE: It may be necessary to vent the extraction bottle periodically throughout the extraction (samples That contain carbonates may react with the acid to yield carbon dioxide gas). It is recommended to check the bottles for built-up gas after 15-30 minutes. If a build-up was observed, the bottle should be vented occasionally. If no build-up is observed, it is safe to let it rotate without further venting. Failure to vent the bottles may result in breakage of the bottle, with subsequent loss of the sample, and possible widespread radioactivity contamination.

11.8.2. Following the rotation period, record the room temperature, then stop the rotator and remove the bottle. If using a 1-liter plastic bottle, the bottle can be centrifuged at 2300 rpm for about 10-minutes, otherwise it is recommended to stand to allow the solids to settle in order to facilitate the filtering process. The method makes no specification on the maximum amount of time the bottle can stand before beginning the filtration process.

11.8.3. Filter the leachate using disposable 0.45 um filter or vacuum filtration apparatus.

11.8.4. If the leachate is from a 100% solids, the leachate is ready for preservation. If the leachate is from a multiphasic sample, the leachate should be physically recombined with the filtrate obtained from the pre-rotation filtration if the two are miscible. If the two are not miscible, record the volumes of each liquid, and report to the analytical labs that both must be analyzed separately. The results from the analyses must then be mathematically combined. Proceed with preservation.

11.8.5. CWET Preservation

11.8.5.1. Leachates to be analyzed for the metals must be preserved with nitric acid, so as to add an equivalence of 5% by volume concentrated nitric acid (*e.g.* for 100-mls of leachate, add 5-mls of concentrated nitric acid). Matrix spiking is performed prior to acidification. Measure out the appropriate volumes of leachate. Record the standard number, volume added and standard expiration date on the extraction record.

11.8.6. Analysis of the leachate proceeds according to the standard analytical procedures. NOTE: Non-aqueous samples would normally be reported on a weight by weight basis; however, the WET regulatory limits are stated on a weight by volume basis. Therefore, aliquots on non-aqueous liquids for WET analysis should be measures by volume instead weight. For example, if the procedure calls for 1-gram of sample, measure 1-ml of sample instead.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1. Commonly used calculations (e.g. % recovery and RPD) and standard instrument software calculations are given in the TestAmerica St. Louis LQM**.**

12.1.1 Calculation of Percent Wet Solids:

$$Percent\ \ Wet\ Solids = 100\left(\frac{Mass,"solid"\ phase}{Mass, initial\ subsample}\right)$$

12.1.2 Calculation of weight of waste to charge to ZHE:

$$Weight\ of\ \ waste\ to\ add\ to\ ZHE\ = 100\left(\frac{25}{\%wet\ solids}\right)$$

12.1.3 Calculation of weight of extraction fluid to use:

$$Weight\ of\ \ Extraction\ \ fluid = \frac{20\,x\ \%\ wet\ solids\ x\ weight\ of\ \ waste\ to\ be\ extracted}{100}$$

TCLP/SPLP Calculation of volume of initial filtrate phase to recombine with solid phase leachate:

$$\text{Vol. filtrate for recombination} = \left(\frac{Wt\ \ solids\ \ leached}{Total\ \ Wt\ \ solids}\right)\left(\frac{Leachate\ \ reovered}{Fluid\ \ added}\right)\left(Vol.\,of\ \ initial\ \ aq.\ \ filtrate\right)$$

$$\text{Vol. filtrate for recombination} = \left(\frac{Wt\ \ solids\ \ leached}{Total\ \ Wt\ \ solids}\right)\left(\frac{Leachate\ \ reovered}{Fluid\ \ added}\right)\left(Vol.\,of\ \ initial\ \ aq.\ \ filtrate\right)$$

12.1.4 Mathematical recombination of analytical results:

$$Final\ Analyte\,Concentration = \frac{\left(V_1 \times C_1\right) + \left(V_2 \times C_2\right)}{V_1 + V_2}$$

V_1 = total volume of the initial filtrate phase (L).
C_1 = analyte concentration in initial filtrate phase (mg/L).
V_2 = volume of the theoretical solid phase leachate (L).
C_2 = analyte concentration in solid phase leachate (mg/L).,

12.1 For CWETs Extraction Fluid Volume Requirement:
Volume = 0.10 x *%solids* x *Wtw*
Where:
Volume = volume of the extraction fluid to be added to the extraction vessel (mls)
%solids = Percent Solids (%)
Wtw = weight the waste filtered (grams)

12.2 REPORTING REQUIREMENTS

12.2.1 Follow these reporting conventions for multi-phase samples:

12.2.2 If both phases have positive results, use the values from each phase to calculate the recombined result. Use the reporting limit for each phase to calculate the recombined reporting limit.

12.2.2.1 If both phases are “ND,” not detected, the recombined result is “ND,” and the reporting limit is calculated from the reporting limit for each phase.

12.2.2.2 If one phase is “ND” and the other phase has a positive result, use the reporting limit for the “ND” phase and the positive value for the other phase to calculate the combined result. The combined reporting limit is based on the reporting limit for both phases. If the combined result is less than the combined reporting limit, then supply a footnote to indicate that “a positive result was detected below the calculated detection limit.”

12.2.3 Units - regardless of the nature of the sample, all results are reported in units of mg/L.

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 The data assessment and corrective action process is detailed through the Clouseau Nonconformance Memorandum (NCM) process. The NCM process is described in SOP STL-QA-0036. A hardcopy of all the data assessment types and descriptions along with their associated corrective actions is included in the SOP. Below is a subset of the data assessment and QC excursion types within Clouseau which may be used with the TCLP extraction procedure:

13.2 Method Blanks: Leachate blanks which show contamination for the analytes of interest may require reextraction of the leachate batch (if positive detects were encountered), if the contamination cannot be traced to the analytical method’s preparatory procedure.

13.3 A NCM shall be generated for the following anomalies:

13.3.1 Sample weights less than the method requirement

13.3.2 Temperature excursions outside $23^oC \pm 2^oC$.

13.3.3 Multiphasic samples, single phase oils, or samples that contain liquids that didn’t filter under test conditions.

13.4 All quality control measures described in the appropriate analytical SOPs shall be followed. Sample QC requirements are found in the respective analytical SOPs: STL-MT-0003 (metals by ICP), STL-MT-0005 (mercury), STL-GC-0016 (pesticides), STL-GC-0017 (herbicides), STL-MS-0001 (Semivolatiles) and STL-MS-0002 (Volatiles).

14.0 METHOD PERFORMANCE

14.1 Method performance data, Reporting Limits, MDLs, and QC acceptance limits, are given in STL-MT-0003 (metals by ICP), ST-MT-0005 (mercury), STL-GC-0016 (pesticides), STL-GC-0017 (herbicides), STL-MS-0001 (Semivolatiles) and STL-MS-0002 (Volatiles).

14.2 Demonstration of Capability
  14.2.1 Initial and continuing demonstrations of capability requirements are established in LQM section 4.1.3.

14.3 Training Qualification
  14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.
  14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in LQM section 4.1.3.

14.4 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in LQM section 4.1.3.

15.0 VALIDATON

15.1 Laboratory SOPs are based on standard reference EPA Methods that have been validated by the EPA and the lab is not required to perform validation for these methods. The requirements for lab demonstration of capability are included in LQM. Lab validation data would be appropriate for performance based measurement systems or non-standard methods. TestAmerica St. Louis will include this information in the SOP when accreditation is sought for a performance based measurement system or non-standard method.

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”

16.2 WASTE STREAMS PRODUCED BY THE METHOD
  16.2.1 The following waste streams are produced when this method is carried out.
    16.2.1.1 Acidic sample waste generated. All acidic waste will be accumulated in the appropriate waste accumulation container, labeled as Drum Type “A” or “B”.
    16.2.1.2 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the lab ware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM meter, the lab ware will be collected in waste barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

17.1 Method 1311, Toxicity Characteristic Leaching Procedure, Revision 0, July 1992, SW-846 Final Update II. (Source method.)

17.2 Method 1312, Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, SW-846 Final Update II. (Source method.)

17.3 Related Documents

17.3.1 Toxicity Characteristic: Corrections to Final Rule. Method 1311, Federal Register, Vol. 55, No. 126, Friday, June 29, 1990.
17.3.2 Toxicity Characteristic: Final Rule. Method 1311, Federal Register, Vol. 55, No. 61, Thursday, March 29, 1990.
17.3.3 Technical Background Document and Response To Comments, Method 1311, Toxicity Characteristic Leaching Procedure, USEPA/OSW, April, 1989.
17.3.4 TestAmerica Quality Management Plan (QMP)
17.3.5 TestAmerica St. Louis Laboratory Quality Manual (LQM)
17.3.6 STL Corporate Safety Manual and St. Louis Facility Addendum (SOP STL-HS-0002), current revisions.
17.3.7 Associated SOPs
  17.3.7.1 STL-PM-0002, Sample Receipt and Chain of Custody
  17.3.7.2 STL-QA-0002, Standard and Reagent Preparation
  17.3.7.3 STL-QA-0005, Calibration and Verification Procedure for Thermometers, Balances, Weights and Pipettes
  17.3.7.4 STL-QA-0036, Non-conformance Memorandum (NCM) Process
  17.3.7.5 STL-OP-0002, Extraction and Cleanup of Organic Compounds from Water and Soils, Based on SW-846 3500 Series, 3600 Series, and 600 Series
  17.3.7.6 STL-OP-0007, Extraction and Cleanup of Herbicides from Water and Soils, Based on SW-846 8151A
  17.3.7.7 STL-IP-0013, Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by ICP Spectroscopy, and ICP/MS (Method 3010A)
  17.3.7.8 STL-MT-0003, Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis, SW-846 Method 6010B and EPA Method 200.7
  17.3.7.9 STL-MT-0005, Preparation and Analysis of Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW846 7470A and MCAWW 245.1
  17.3.7.10 STL-MS-0001, GC/MS Analysis Based on Methods 8270C and 625
  17.3.7.11 STL-MS-0002, Determination of Volatile Organics by GC/MS Based on Method 8260B, 624, and 524.2
  17.3.7.12 STL-GC-0016 , Pesticide Gas Chromatography Analysis Method SW-846 8000C/8081B and EPA 608
  17.3.7.13 STL-GC-0017 ,Herbicide Gas Chromatography Analysis Method SW-846 8000C/8151A
  17.3.7.14 STL-WC-0011, Analysis of pH in Water

17.4 Modifications/Interpretations from Reference Methods

17.4.1 Preliminary Evaluations. Section 7.1 of the source method states that the sample aliquot used for the preliminary evaluation "...may not actually undergo TCLP extraction." Section 7.1.5 of the source method indicates that the portion used for the preliminary evaluation may be used for either the ZHE or non-volatile extraction if the sample was 100% solid. Section 7.1.5 further indicates that if the sample was subjected to filtration (i.e., < 100% solid) that this aliquot may be used for the non-volatile extraction procedure only as long as sufficient sample is available (minimum 100 g). Samples which have been subjected to the oven drying step may not be used for TCLP extraction because solid phase degradation may result upon heating.

17.4.2 Percent Solids Determination. Section 7.1.2 of the source method indicates that "if the percent wet solids is ≥ 0.5% and it is noticed that a small amount of the filtrate is entrained in wetting of the filter" that the filter should be oven dried to determine percent dry solids ". Drying of oil or organic matrices can both be hazardous and inappropriate. Additionally, it may be impossible to achieve a constant weight when performing this step. Due to safety concerns, if obviously oily or heavy organic matrices are entrained on the filter, the filter is not oven dried.

17.4.3 TCLP Extraction Blanks. Section 8.1 of the source method states that a minimum of one blank for every 20 extractions "...that have been conducted in an extraction vessel." TestAmerica has interpreted this to mean one blank per twenty samples leached per TYPE of leaching vessel (i.e., Bottle or ZHE) per leach fluid used.

17.4.4 Determination of Appropriate Extraction Fluid. Method 1311 does not address the appropriate approach to take if the pH equals 5.0. This SOP requires that Fluid #1 must be used if the pH is less than or equal to 5.0.

17.4.5 QA/QC - Matrix Spikes. Section 8.2 of the source method states "A matrix spike shall be performed for each waste type..." and "A minimum of one matrix spike must be analyzed for each analytical batch." Further, Section 8.2.3 of the source method also states "The purpose of the matrix spike is to monitor the performance of the analytical methods used, and to determine whether matrix interferences exist." A minimum of one MS will be prepared for each TCLP leachate batch. The MS results are used to determine the effect of a matrix on the accuracy of the analytical process. Due to the potential variability of the matrix of each sample, the MS results have immediate bearing only on the specific sample spiked and not all samples in the batch.

18.0 CLARIFICATIONS, MODIFICATIONS TO THE REFERENCE METHOD

18.1

19.0 CHANGES FROM PREVIOUS REVISION

19.1 Update to new format.

19.2 Added ZHE leak test procedure to Section 6.

19.3 Added metals precipitate information to Section 11.

Metals Spiking for MS/MSD:

Spike Volume	Solution	Metals	Concentration
0.25 mL	ICP Spike #1	Ca, Mg, K, Na	5000 ug/mL
		Al, As, Ba, Se, Tl	200 ug/mL
		Fe, Sr	100 ug/mL
		Co, Pb, Mn, Ni, V, Zn	50 ug/mL
		Cu	25 ug/ml
		Cr (trivalent)	20 ug/mL
		Be, Cd, Ag	5 ug/mL
0.25 mL	ICP Spike #2	Mo	100 ug/mL
		Sb	50ug/mL
0.05 mL	Hg Spike	Hg	3 ug/L

Figure 1 & 2 - Rotary Agitation Apparatus and Zero Headspace Extraction Vessel (ZHE)

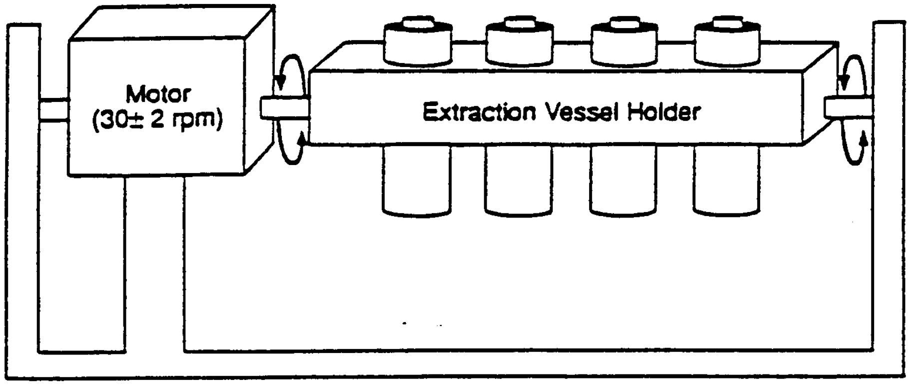


Figure 1. Rotary Agitation Apparatus

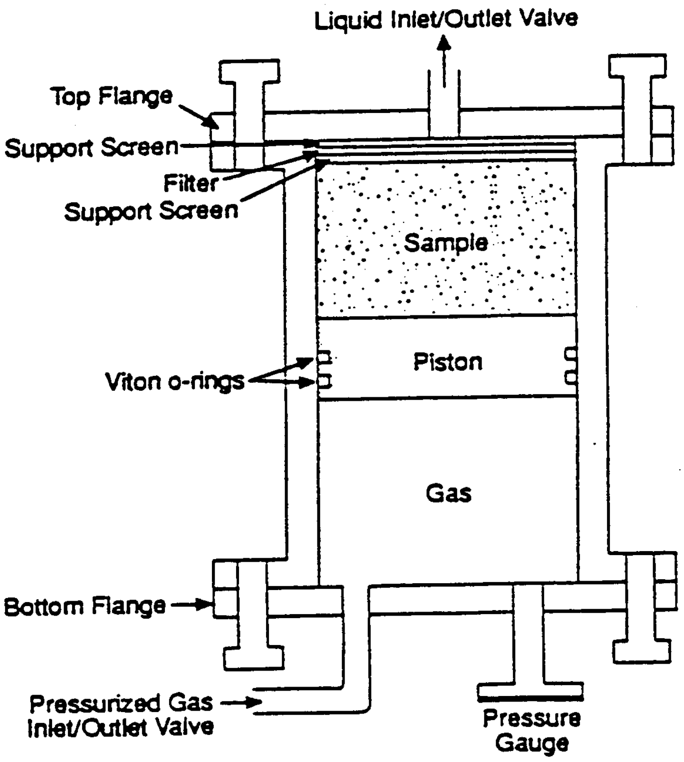
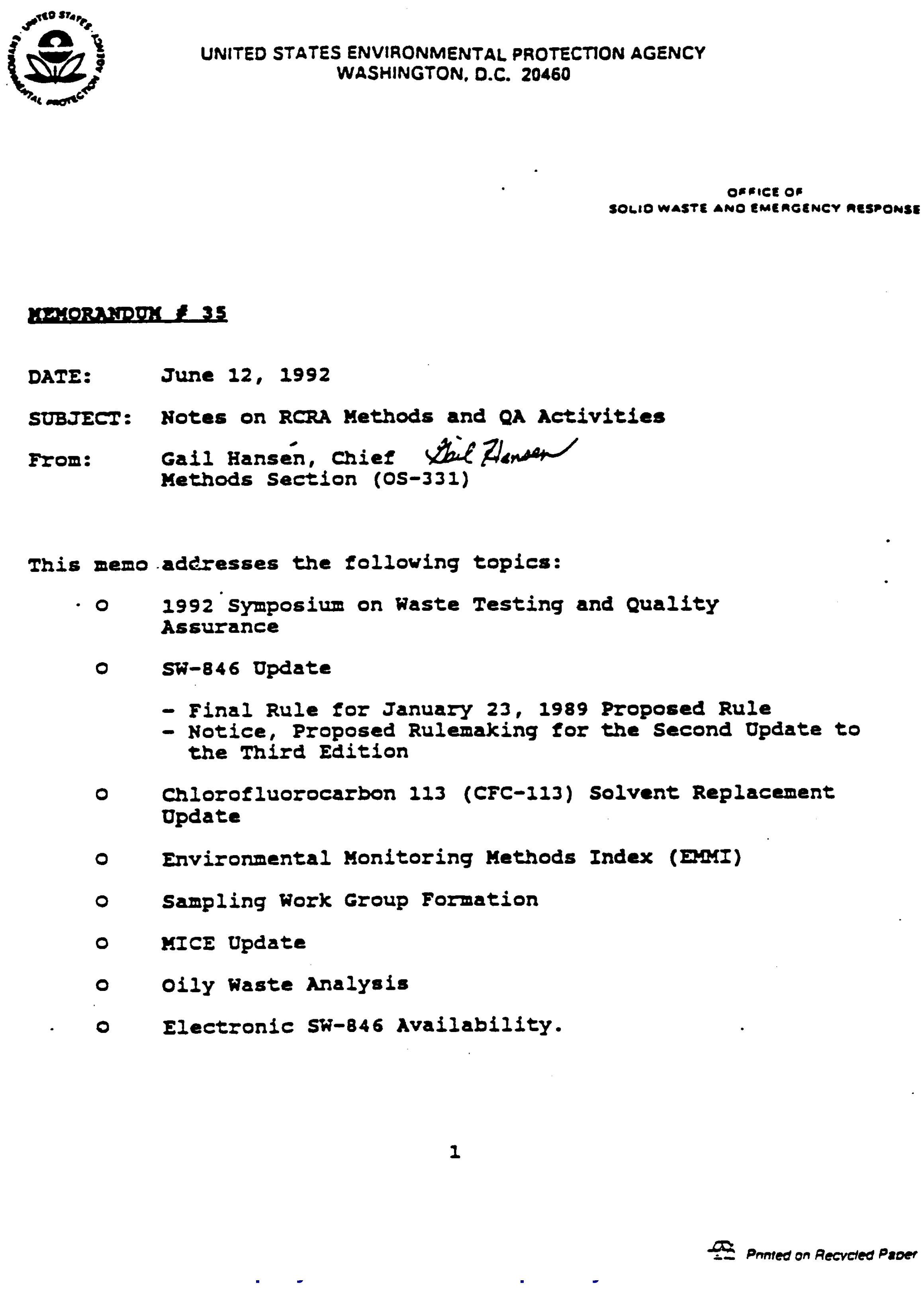


Figure 3 - US Environmental Protection Agency Memorandum #35, Page 1



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM # 35

DATE: June 12, 1992

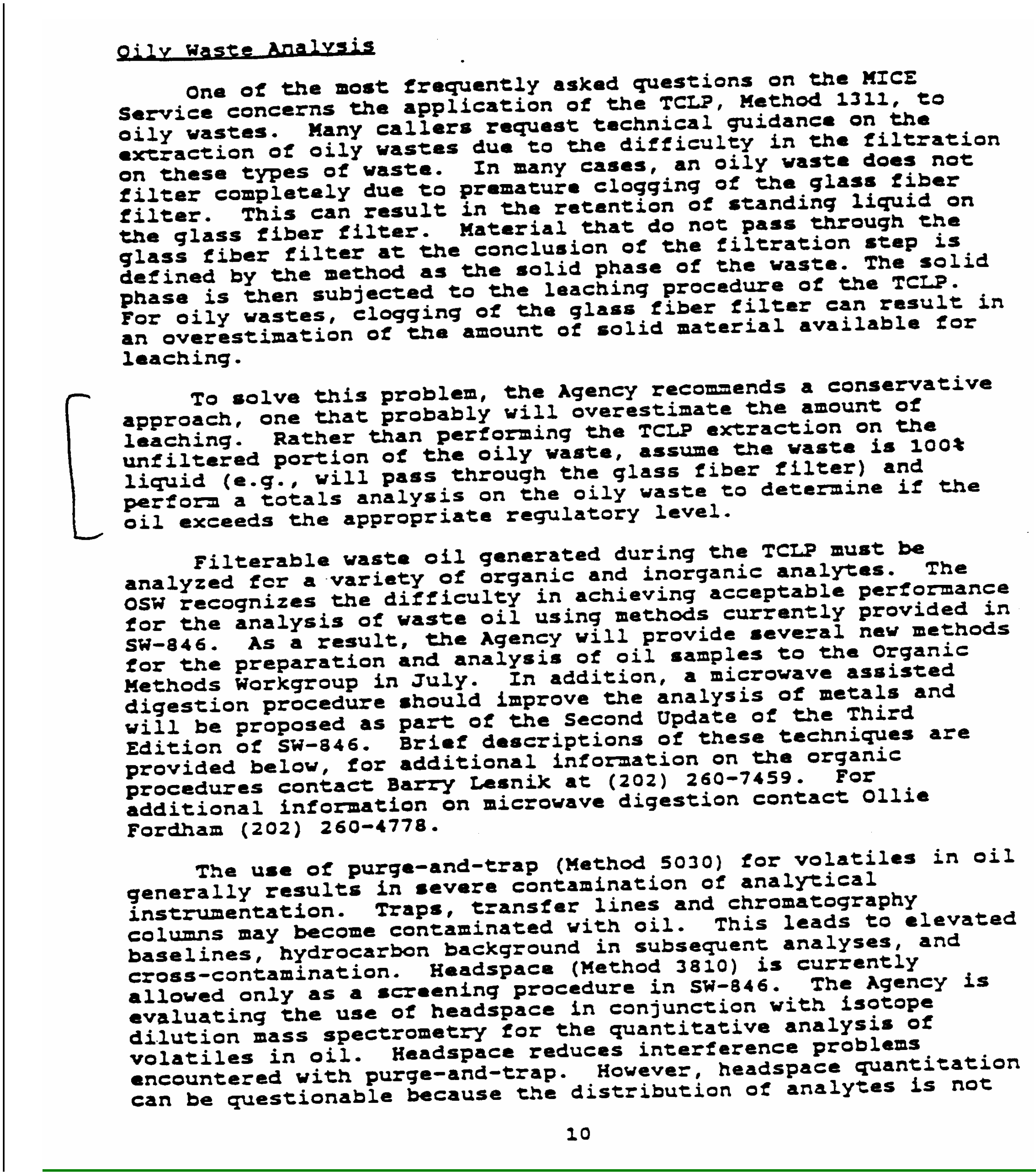
SUBJECT: Notes on RCRA Methods and QA Activities

From: Gail Hansen, Chief Gail Hansen
Methods Section (OS-331)

This memo addresses the following topics:

- 1992 Symposium on Waste Testing and Quality Assurance
- SW-846 Update
  - Final Rule for January 23, 1989 Proposed Rule
  - Notice, Proposed Rulemaking for the Second Update to the Third Edition
- Chlorofluorocarbon 113 (CFC-113) Solvent Replacement Update
- Environmental Monitoring Methods Index (EMMI)
- Sampling Work Group Formation
- MICE Update
- Oily Waste Analysis
- Electronic SW-846 Availability.

Figure 3 - US Environmental Protection Agency Memorandum #35, Page 10



Oily Waste Analysis

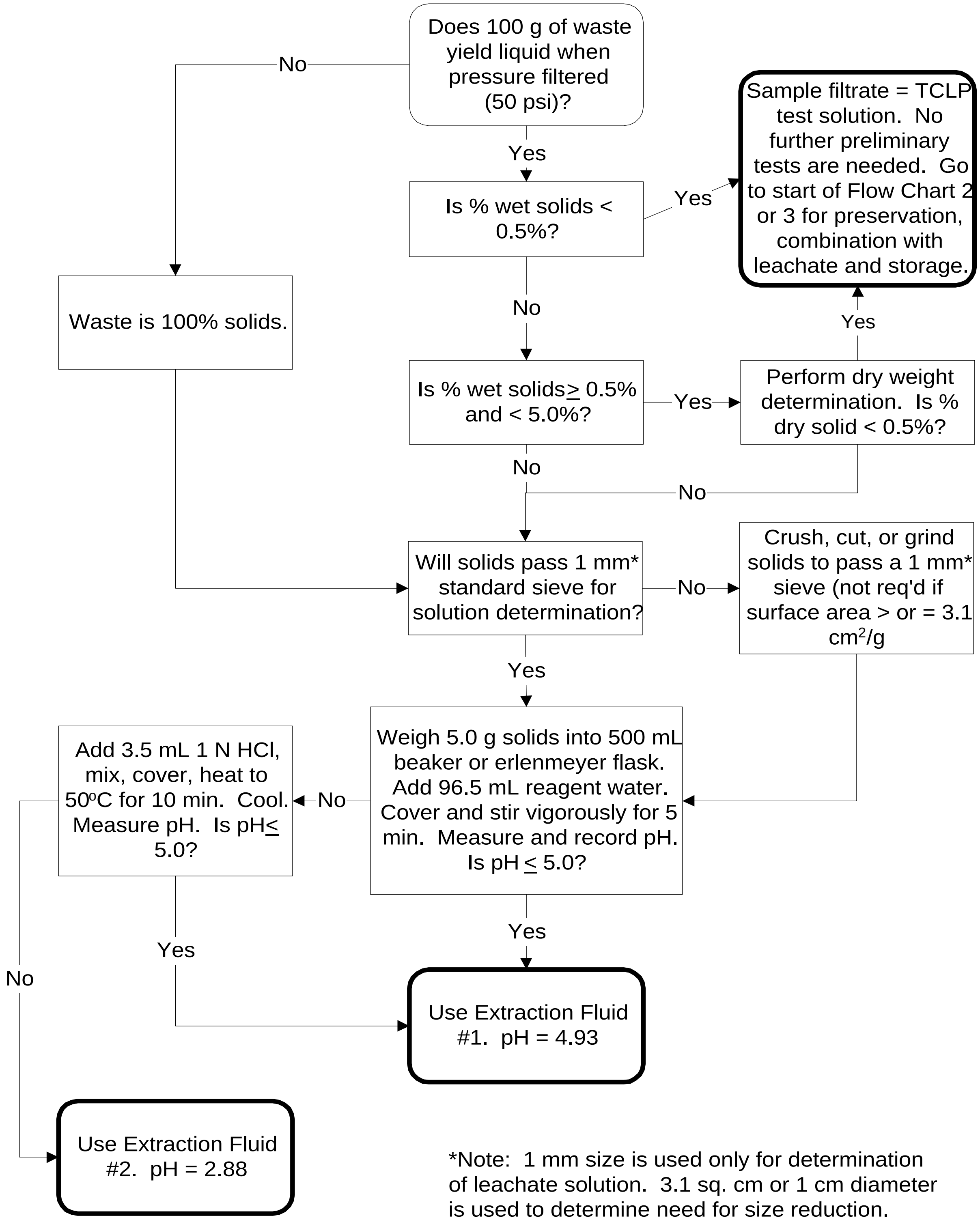
One of the most frequently asked questions on the MICE Service concerns the application of the TCLP, Method 1311, to oily wastes. Many callers request technical guidance on the extraction of oily wastes due to the difficulty in the filtration on these types of waste. In many cases, an oily waste does not filter completely due to premature clogging of the glass fiber filter. This can result in the retention of standing liquid on the glass fiber filter. Material that do not pass through the glass fiber filter at the conclusion of the filtration step is defined by the method as the solid phase of the waste. The solid phase is then subjected to the leaching procedure of the TCLP. For oily wastes, clogging of the glass fiber filter can result in an overestimation of the amount of solid material available for leaching.

To solve this problem, the Agency recommends a conservative approach, one that probably will overestimate the amount of leaching. Rather than performing the TCLP extraction on the unfiltered portion of the oily waste, assume the waste is 100% liquid (e.g., will pass through the glass fiber filter) and perform a totals analysis on the oily waste to determine if the oil exceeds the appropriate regulatory level.

Filterable waste oil generated during the TCLP must be analyzed for a variety of organic and inorganic analytes. The OSW recognizes the difficulty in achieving acceptable performance for the analysis of waste oil using methods currently provided in SW-846. As a result, the Agency will provide several new methods for the preparation and analysis of oil samples to the Organic Methods Workgroup in July. In addition, a microwave assisted digestion procedure should improve the analysis of metals and will be proposed as part of the Second Update of the Third Edition of SW-846. Brief descriptions of these techniques are provided below, for additional information on the organic procedures contact Barry Lesnik at (202) 260-7459. For additional information on microwave digestion contact Ollie Fordham (202) 260-4778.

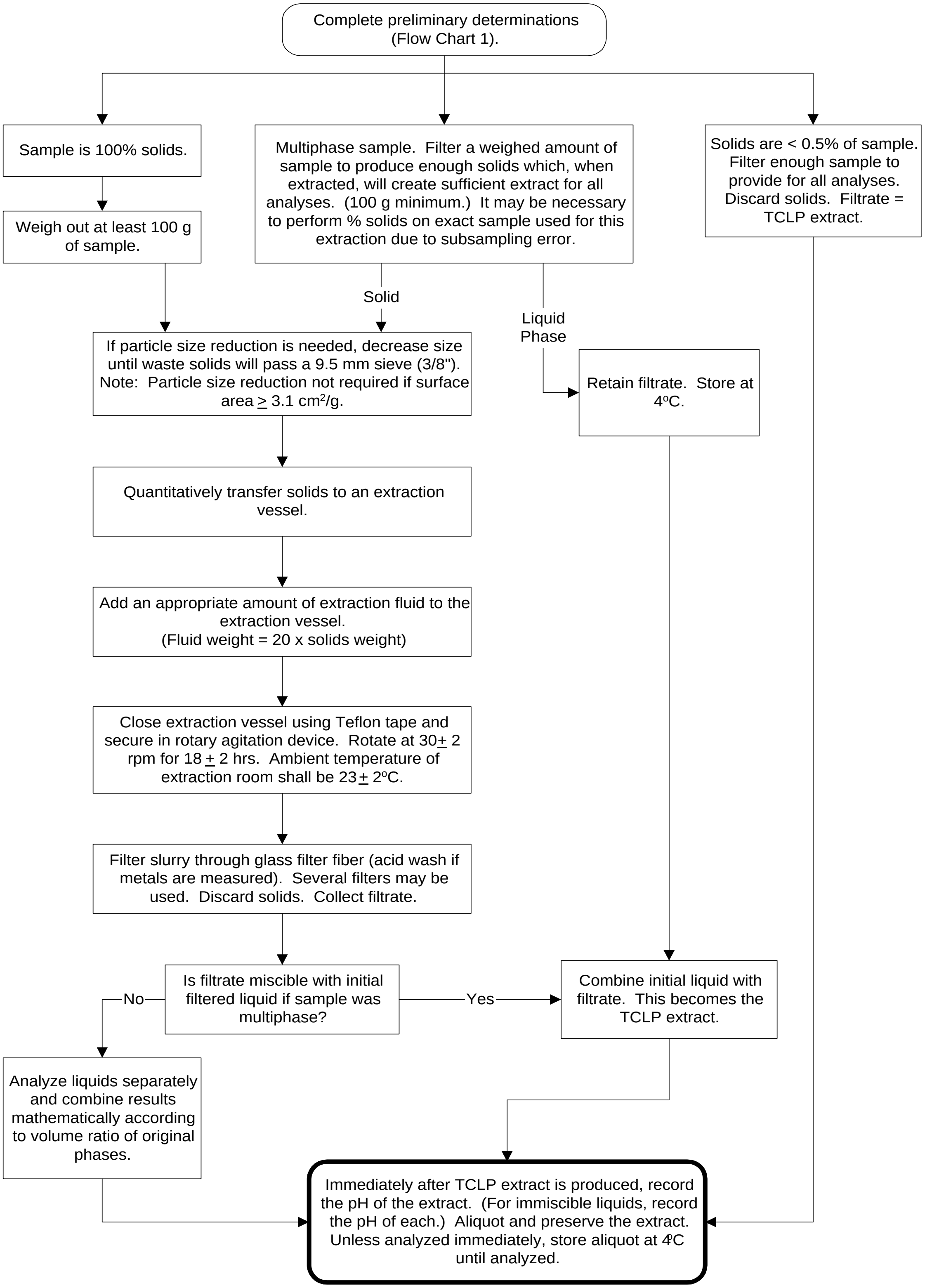
The use of purge-and-trap (Method 5030) for volatiles in oil generally results in severe contamination of analytical instrumentation. Traps, transfer lines and chromatography columns may become contaminated with oil. This leads to elevated baselines, hydrocarbon background in subsequent analyses, and cross-contamination. Headspace (Method 3810) is currently allowed only as a screening procedure in SW-846. The Agency is evaluating the use of headspace in conjunction with isotope dilution mass spectrometry for the quantitative analysis of volatiles in oil. Headspace reduces interference problems encountered with purge-and-trap. However, headspace quantitation can be questionable because the distribution of analytes is not

Flow Chart 1. Preliminary Sample Evaluation (Section 11.2)

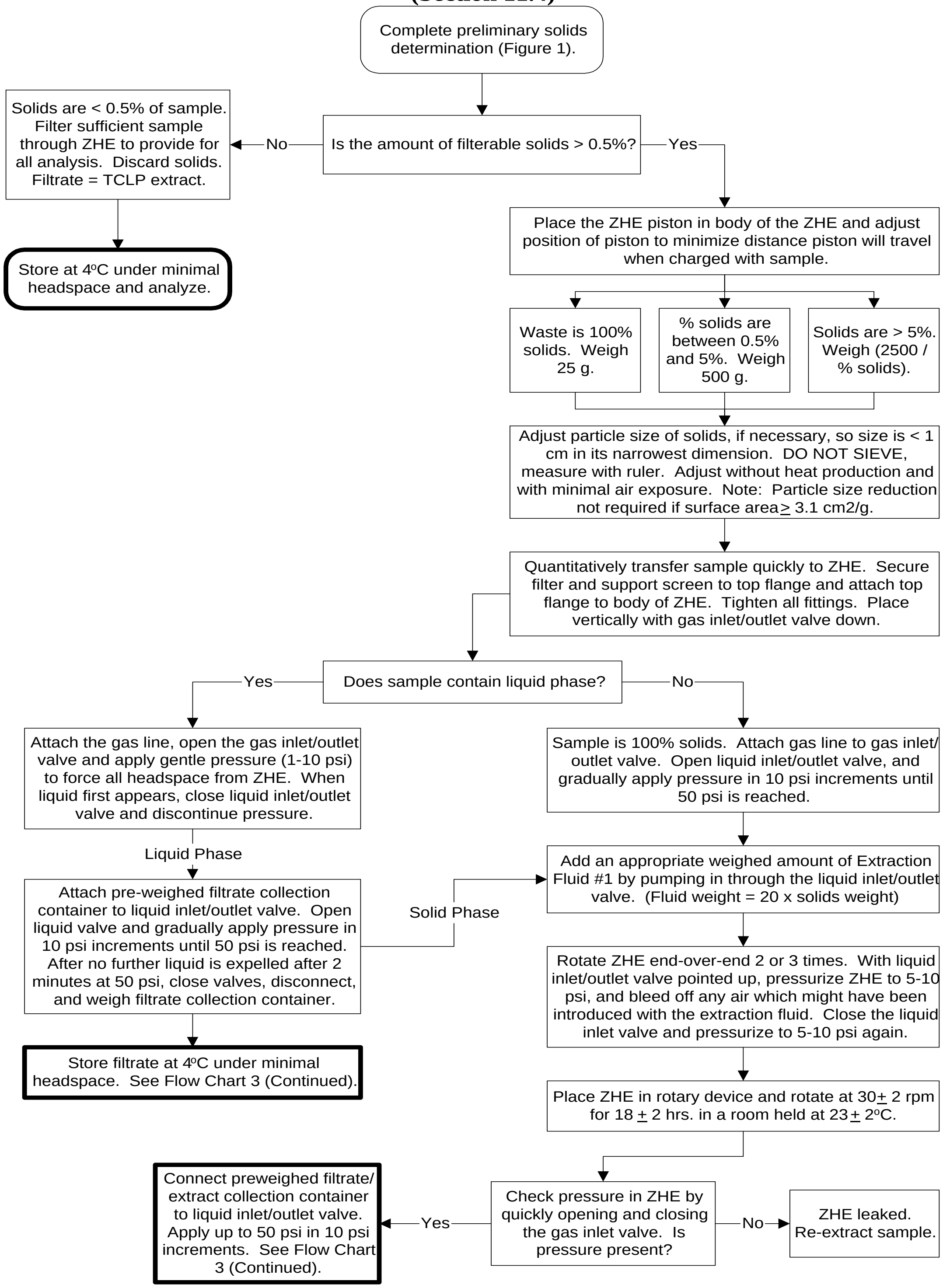


*Note: 1 mm size is used only for determination of leachate solution. 3.1 sq. cm or 1 cm diameter is used to determine need for size reduction.

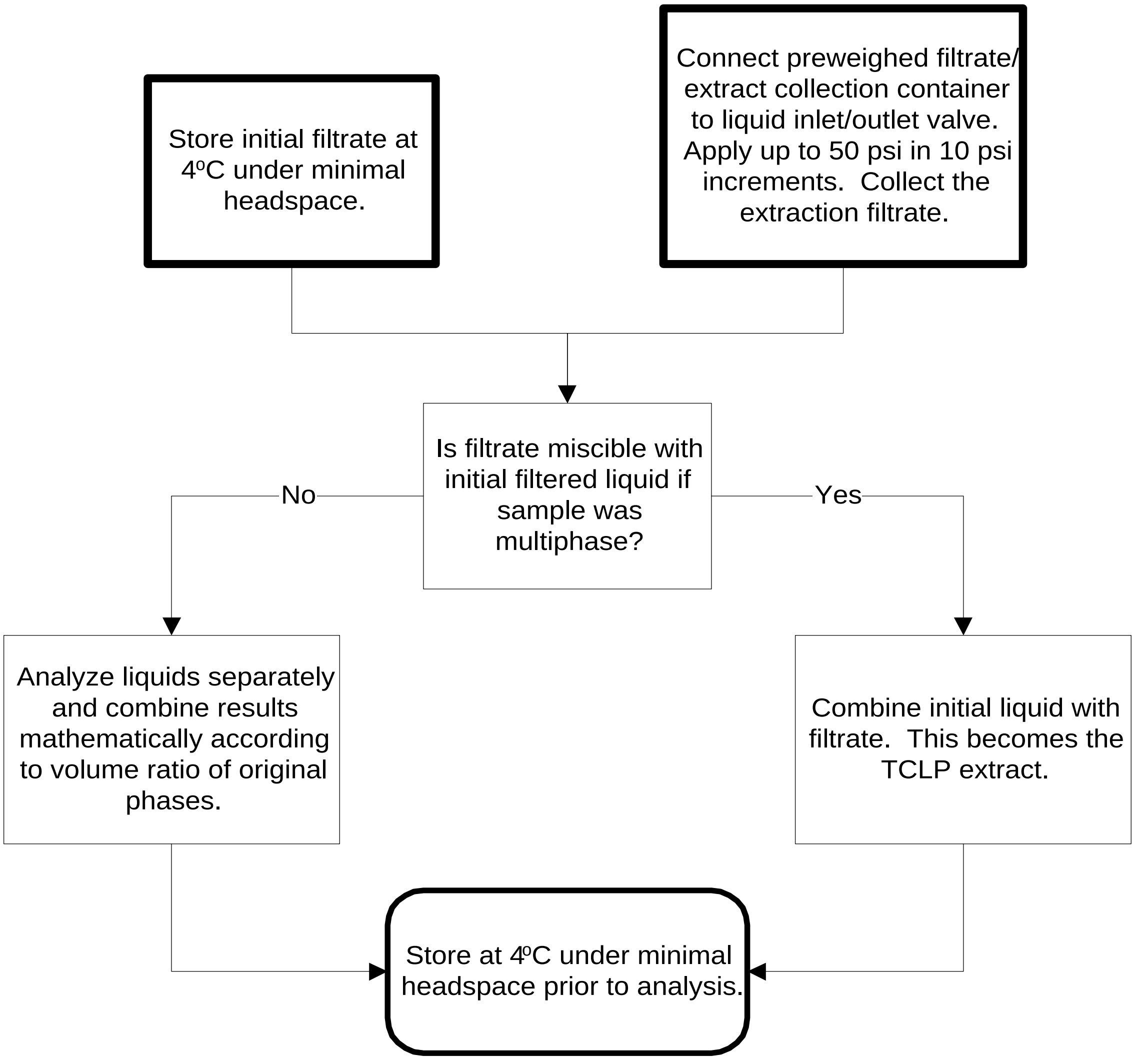
Flow Chart 2. Bottle Extraction, Non-Volatile Constituents (Section 11.3)



Flow Chart 3. ZHE Extraction, Volatile Constituents (Section 11.4)



Flow Chart 3. ZHE Extraction (Continued)



TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Title: INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROSCOPY, SPECTROMETRIC METHOD FOR TRACE ELEMENT ANALYSES
[SW-846 6010C; EPA 200.7]

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This SOP was previously identified as SOP No. STL-MT-0003 Rev. 6

Any reference within this document to Severn Trent Laboratories, Inc. or STL, should be understood to refer to TestAmerica Laboratories, Inc. (formerly known as Severn Trent Laboratories, Inc.)

Facility Distribution No.: 0 **Distributed To:** See Electronic Distribution Sheet

SOP No.: **STL-MT-0003**
Revision No.: 7
Revision Date: 05/28/07
Page: 1 of 41
Implementation Date: 05/30/07

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STL ST. LOUIS STANDARD OPERATING PROCEDURE

TITLE: INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROSCOPY, SPECTROMETRIC METHOD FOR TRACE ELEMENT ANALYSES, SW-846 METHOD 6010C AND EPA METHOD 200.7

(SUPERSEDES: STL-MT-0003 REV 6)

Approved by: ______________________
Supervisor/Lead Analyst

Approved by: Elaine Wild
Quality Assurance Manager

Approved by: ______________________
Environmental Health and Safety Coordinator

Approved by: Martha Jo Cahill
Laboratory Director

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1.0 SCOPE AND APPLICATION

1.1 This procedure describes the analysis of trace elements including metals in solution by Inductively Coupled Plasma -Atomic Emission Spectroscopy (ICP-AES) using SW-846 Method 6010C and EPA Method 200.7 .

1.2 This method is applicable to surface, and saline waters; soil and waste samples.

1.3 The aqueous sample digestion procedure is found in SOP: STL-IP-0013, Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by ICP Spectroscopy, and ICP/MS (Method 3010A, EPA 200.7 and EPA 200.8) and the soil sample digestion procedure is found in SOP: STL-IP-0002, Acid Digestion of Soils, SW846 Method 3050B for ICP, and ICP/MS.

1.4 The laboratory target analytes supported by this method, the reporting limits, method detection limits and QC limits are maintained in the Information Management System (QuantIMS). A copy of the Structure and Analysis Code (SAC), which lists this information, is included in the appendix of this SOP.

1.4.1 Additional elements may be amendable to this method provided the laboratory has established a MDL and the elements meets the QC requirements as prescribed in the associated preparation and analytical SOP.

2.0 SUMMARY OF METHOD

2.1 This method describes a technique for the determination of multi elements in solution using simultaneous optical systems and axial or radial viewing of the plasma. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the emission lines are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background must be measured adjacent to analyte lines during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interferences and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences should also be recognized and appropriate actions taken.

3.0 DEFINITIONS

3.1 See the STL Quality Management Plan (QMP) and STL St. Louis Laboratory Quality Manual (LQM) for a glossary of common laboratory terms and data reporting qualifiers.

3.2 EPA and SW methodology use different terminology. Our SOP references the SW 846 terminology:

3.2.1 The ICV satisfies the QCS requirements found in method 200.7.
3.2.2 The LCS satisfies the requirements of the LFB found in method 200.7.
3.2.3 The MS satisfies the requirements of the LFM found in method 200.7.
3.2.4 The ICS (A and/or AB) satisfies the requirements of the SIC found in method 200.7.
3.2.5 The CCV satisfies the requirements of the IPC found in method 200.7.

3.3 Linear Dynamic Range (LDR): A standard at the upper limit must be prepared, analyzed and quantitated against the normal calibration curve. The calculated value must be within 10% (±10%) of the true value. At a minimum, the range should be checked every six months. STL St. Louis uses the high point of the multi-point initial calibration as its' LDR check.

3.4 Dissolved Metals: Those elements which pass through a 0.45 um membrane filter. (Sample is acidified after filtration)

3.5 Suspended Metals: Those elements retained by a 0.45 um filter.

3.6 Total Metals: The concentration determined on an unfiltered sample following vigorous digestion.

3.7 Total Recoverable Metals: The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acid.

3.8 Dilution Test – the terminology "dilution test" found in later versions of 200.7 and 6010C is referred to as a Serial Dilution in this SOP.

4.0 INTERFERENCES

4.1 Spectral, physical and chemical interference effects may contribute to inaccuracies in the determinations of trace elements by ICP. Spectral interferences are caused by

4.1.1 Overlap of a spectral line from another element.
4.1.2 Unresolved overlap of molecular band spectra.
4.1.3 Background contribution from continuous or recombination phenomena.
4.1.4 Stray light from the line emission of high concentration elements.

4.2 A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background correction is not required in cases where a background corrective measurement would actually degrade the analytical result.

4.3 Inter-element correction factors (IECs) are necessary to compensate for spectral overlap. Inter-element interferences occur when elements in the sample emit radiation at wavelengths so close to that of the analyte that they contribute significant intensity to the analyte channel. If such conditions exist, the intensity contributed by the matrix elements will cause an excessively high (or sometimes low) concentration to be reported for the analyte. Inter-element corrections IECs must be applied to the analyte to remove the effects of these unwanted emissions.

4.4 Physical interferences are generally considered to be effects associated with sample transport, nebulization and conversion within the plasma. These interferences may result in differences between instrument responses for the sample and the calibration standards. Physical interferences may occur in the transfer of solution to the nebulizer (e.g., viscosity effects), at the point of aerosol formation and transport to the plasma (e.g., surface tension) or during excitation and ionization processes within the plasma itself. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, dilution of the sample, use of a peristaltic pump, mass flow controller, use of an internal standard and/or use of a high solids nebulizer can reduce the effect.

4.5 Chemical interferences are characterized by molecular compound formation, ionization effects and solute vaporization effects. Normally these effects are not significant with the ICP technique but if observed can be minimized by buffering the sample, matrix matching or standard addition procedures.

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

5.2.1 The ICP plasma emits strong UV light, harmful to vision. Analysts must avoid looking directly at the plasma.

5.3 PRIMARY MATERIALS USED

5.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Nitric Acid	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid	Corrosive Poison	5 ppm (Ceiling)	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrogen Peroxide 30%	Oxidizer Corrosive Fire (increases flammability of combustible, organic, and readily oxidizable materials)	1 ppm (TWA)	Irritation to respiratory tract and burning of mucous membrane of nose and throat. Pain, redness, and blurred vision in eyes.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			
TWA – Time Weighted Average			
STEL – Short Term Exposure Limit			
Ceiling – At no time should this exposure limit be exceeded.			

6.0 EQUIPMENT AND SUPPLIES

6.1 Inductively Coupled Plasma Atomic Emission Spectrometer equipped with autosampler and background correction

6.2 Radio Frequency Generator

6.3 Argon gas supply, welding grade or better

6.4 Chiller (water cooling device)

6.5 Calibrated automatic pipettes or Class A glass volumetric pipettes

6.6 Class A volumetric flasks

7.0 REAGENTS AND STANDARD

7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP STL-QA-0002, current revision.

7.2 Concentrated nitric acid (HNO3), trace metal grade

7.3 Concentrated hydrochloric acid (HCl), trace metal grade

7.4 DI water from the Millipore unit
  7.4.1 Water must be free of the analytes of interest as demonstrated through the analysis of method blanks. Water must be shown to have a resistivity greater than or equal to 16.67 Mohm-cm.

7.5 Standards, NIST traceable
  7.5.1 Purchased as custom multi-element mixes or as single-element solutions.
  7.5.2 All standards must be stored in FEP fluorocarbon or unused polyethylene or polypropylene bottles.
  7.5.3 Working calibration and calibration verification solutions may be used for up to 1 month and must be replaced sooner if verification from an independent source indicates a problem. Standards should be prepared in a matrix of 5% hydrochloric and 5% nitric acid.

7.6 Profile Standard
  7.6.1 For the Trace ICP: 5ppm Arsenic standard
  7.6.2 For the 61E ICP: A mercury lamp is used which is internal to the instrument

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 STL St. Louis supplies sample containers and chemical preservatives in accordance with the method. STL St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in STL-PM-0002.

8.2 Aqueous samples for total metals must be digested before analysis using an appropriate digestion procedure, STL-IP-0013.

8.3 Soil or waste samples are digested before analysis using an appropriate digestion procedure. Method 3050B of SW846 is the appropriate digestion procedure, STL-IP-0002.

8.4 Digestate holding time is 6 months from sample collection.

9.0 QUALITY CONTROL

9.1 **Batch**
  9.1.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents.
  9.1.2 Instrument conditions must be the same for all standards, samples and QC samples.
  9.1.3 For this analysis, batch QC consists of a method blank, a Laboratory Control Sample (LCS), and Matrix Spike (MS)/ Matrix Spike Duplicate (MSD). In the event that there is insufficient sample

to analyze a MS/MSD an LCS Duplicate (LCSD) is prepared and analyzed.

9.2 **Method Blank (MB)**

9.2.1 A method blank is a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the procedure.

9.2.2 A method blank must be prepared with every sample batch.

9.3 **Laboratory Control Sample (LCS)**

9.3.1 An LCS is a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.3.2 An LCS must be prepared with every sample batch.

9.4 **Matrix Spike (MS) /Matrix Spike Duplicate (MSD)**

9.4.1 A Matrix Spike is an aliquot of a field sample to which a known amount of target analyte(s) is added, and is processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.5 **Serial Dilution**

9.5.1 A dilution test is performed to determine whether significant physical or chemical interferences exist due to the sample matrix.

9.5.2 The test is performed by running a sample at a 5x (1:4) dilution.

9.5.3 Samples identified as field blanks cannot be used for dilution tests.

9.5.4 The serial dilution results shall agree within +\- 10% of the undiluted sample results, if the undiluted sample results are greater than 10 times the reporting limit. There is no criteria for sample results less than 10 times the reporting limit.

9.6 **Post Digestion Spike (PDS)**

9.6.1 A post digestion spike is a sample which has been fortified with target analytes of interest after the digestion process.

9.6.2 The laboratory requires the analysis of a serial dilution for all batches and thus does not perform the intermediate post digestion spike QC step.

9.6.3 The method stipulates that a PDS be performed on the sample chosen for MS/MSD and if the PDS fails to proceed to performing a serial dilution on the sample. If the PDS is acceptable, the laboratory is not required to perform a serial dilution. Since the laboratory has elected to perform the serial dilution routinely, the outcome of the PDS is not critical. There is no qualification made to the data based on the performance of the PDS.

9.6.4 For client project or programs requiring a PDS, the laboratory will include a PDS in the batch in addition to the serial dilution. This requirement is noted by the Project Manager in the client requirement sheet and/or client summary report.

9.6.4.1 For **6010C** Criteria:

9.6.4.2 If a PDS is performed, the acceptance criteria is 80%-120%, with a spike concentration between 10-100 times the MDL, UNLESS, the project/program criteria is given.

9.6.4.3 For **200.8** Criteria:

9.6.4.3.1 If a PDS is performed, the acceptance criteria is 85%-115%, with a spike concentration between 10-100 times the MDL, UNLESS, the project/program criteria is given.

9.7 **Method of Standard Addition** (MSA)

9.7.1 This technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample interferent that may enhance or depress the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences which cause a baseline shift.

9.7.2 MSA are not required by the method.

9.7.3 MSAs are not considered normal batch QC and if required by the client, must appear on the client requirement sheet or client summary report.

9.8 **Procedural Variations/ Nonconformance and Corrective Action**

9.8.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. See SOP STL-QA-0036 for details regarding the NCM process.

9.8.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA Manager. See SOP STL-QA-0036 for details regarding the NCM process.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Set up the instrument with the operating parameters recommended by the manufacturer. Allow the instrument to become thermally stable before beginning calibration (minimum 30 minutes of warm-up is required).

10.2 Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures. Flush the system with the calibration blank between each standard. Refer to each ICP instrument manual for a detailed set up and operation protocols.

10.2.1 Profile standard is 5ppm Arsenic for Trace ICP.

10.2.2 Profile standard is internal Mercury Lamp for 61E ICP

10.3 A minimum of <u>two</u> <u>exposures</u> for each standard, field sample and QC sample is required. The average of the exposures is reported.

10.3.1 For Trace ICP analyses, the result of the sum channel is used for reporting.

10.4 Rinse Time Determination

10.4.1 Prior to calibration and between each sample/standard the system is rinsed with the calibration blank solution. The minimum rinse time between analytical samples is 60 seconds unless following the protocol outlined in this SOP it can be demonstrated that a shorter rinse time may be used.

10.4.1.1 To determine the appropriate rinse time for a particular ICP system, a linear range verification standard should be aspirated as a regular sample followed by the analysis of a series of rinse blanks. The length of time required to reduce the analyte signals to < RL will define the rinse time for a particular ICP system. For some analytes it may be impractical to set the rinse time based on the linear range standard result (i.e., analyte not typically detected in environmental samples at that level and an excessive rinse time would be required at the linear range level). The concentration levels used to establish the rinse time must be taken into consideration when reviewing the data.

10.5 **Background Correction Points**

10.5.1 A background correction technique is applied to compensate for variable background contribution. This is performed by setting background points during initials instrument set up and matrix matching.

10.6 **Inter-element Corrections** (IECs)

10.6.1 The IECs are verified on a daily basis by analyzing the ICSA and ICSAB solutions at the beginning of every analytical run. An IEC must be established to compensate for any interelement interference which results in a false analyte signal greater than ± the RL. To determine IECs, run a single element standard at the high level calibration standard.. To calculate an IEC, divide the observed concentration of the analyte by the observed concentration of the "interfering element."

10.6.2 IEC factors are updated every 6 months.

10.7 Profile

10.7.1 To monitor and prevent instrument spectral drift, a profile is performed on a daily basis.

10.7.2 For the Trace ICP, a 5pmm Arsenic standard is apirated. When 0 +/- 0.05 has been achieved, a calibration can begin.

10.7.3 For the 61E ICP, a Mercury lamp is contained within the instrument and is used as the profile reference source. When 0 +/- 0.05 has been achieved, a calibration can begin.

10.8 Initial Calibration

10.8.1 Multi-point Calibration:

10.8.1.1 A calibration curve, consisting of 3 standards and a blank, must be analyzed daily.

10.8.1.2 Calibration criteria:

10.8.1.2.1 Correlation Coefficient of > 0.995

10.8.1.2.2 The low level standard in the curve must be at or below the laboratory's routine reporting limit. See structure and analysis code (SAC) information appended to this SOP.

10.8.1.2.2.1 If a client requested reporting limit is below the laboratory's routine reporting limit and thus below the low level verification standard, the laboratory will discuss with the client, prior to sample analysis, how to proceed with this requirement.

10.8.2 Single point Calibration (Alternative)

10.8.2.1 The single point calibration is an alternative calibration process within 6010C. See manager or supervisor to determine if this technique may be appropriate.

10.8.2.2 Instrument calibration consists of a minimum of high level standard plus a method blank.

10.8.2.3 Calibration criteria:

10.8.2.3.1 The resulting curve must be verified by a low level and mid-level verification standard

10.8.2.3.2 Both the low level and mid level verification standards must be within 80%-120% of its' true value.

10.8.2.3.3 The low level verification standard must be at or below the laboratory's routine reporting limit. See structure and analysis code (SAC) information appended to this SOP.

10.9 Initial Calibration Verification/Initial Calibration Blank (ICV/ICB)

10.9.1 The initial calibration accuracy is verified by analyzing a second source standard (ICV).

10.9.2 ICV Frequency:

10.9.2.1 Perform with each initial calibration

10.9.3 ICV Criteria:

10.9.3.1 **Method 200.7**, the ICV result must fall within 5% of the true value for that solution with relative standard deviation <3% from replicate (minimum of two) exposures.

10.9.3.2 **Method 6010C**, the ICV must fall within 10% of the true value for that solution with relative standard deviation <5% from replicate (minimum of two) exposures.

10.9.4 ICB Frequency:

10.9.4.1 An ICB is analyzed immediately following the ICV to monitor low level accuracy and system cleanliness.

10.9.5 ICB Criteria:

10.9.5.1 The ICB result must fall within +/- the RL from zero.

10.9.6 If either the ICV or ICB fail to meet criteria, the analysis should be terminated, the problem corrected, the instrument recalibrated and the calibration reverified.

10.9.6.1 Not meeting this requirement may be indicative of serious system malfunction or inaccuracies in the standards used for the initial calibration curve or ICV standard. Corrective action must be taken (including reanalysis of the ICV, or analysis of a different ICV). Any decision to proceed with analysis of samples when the ICV is out-of-control must be taken with great care and in consultation with the QA department and the laboratory director. Any such action must be documented in an NCM.

10.10 **Continuing Calibration Verification/Continuing Calibration Blank (CCV/CCB)**

- 10.10.1 Calibration is monitored throughout the analytical run through the analysis of a known standard.
- 10.10.2 A CCV may be a second source or the same source as the calibration
- 10.10.3 CCV Frequency:
  - 10.10.3.1 Analyte response factors must be verified at the beginning of each analytical run (by either an ICV or a CCV), after every 10 samples and at the end of the analysis run through the analysis of a mid-level calibration standard.
- 10.10.4 CCV Criteria:
  - 10.10.4.1 The CCV must fall within 10% of the true value for that solution with relative standard deviation <5% from replicate (minimum of two) exposures.
  - 10.10.4.2 If a CCV has failed and the analyst can document the reason for failure (e.g mis-injection, etc.) then a second CCV may be analyzed without any adjustments to the instrument. If this CCV meets criteria then sample analysis may continue; however the preceding 10 samples must be reanalyzed. If this second CCV does not meet criteria, the analysis run is terminated. Instrument maintenance is performed and the instrument may require re-calibration (ie initial calibration). Samples after the last acceptable CCV require re-analysis.
- 10.10.5 CCB Frequency:
  - 10.10.5.1 A CCB is analyzed immediately following each CCV.
- 10.10.6 CCB Criteria:
  - 10.10.6.1 The CCB result must fall within +/- RL from zero.

10.11 **Interference Check Analysis** (ICSA/ICSAB)

- 10.11.1 The validity of the interelement correction factors is demonstrated through the successful analysis of interference check solutions.
- 10.11.2 **ICSA**:
  - 10.11.2.1 The ICSA contains only interfering elements. Refer to Table II for the details of ICSA composition.
  - 10.11.2.2 Custom multielement ICS solutions must be used.
  - 10.11.2.3 Elements known to be interferents on a required analyte must be included in the ICP run when that analyte is determined. Aluminum, iron, calcium and magnesium must always be included in all ICP runs.
- 10.11.3 **ICSAB**:
  - 10.11.3.1 The ICSAB contains analytes and interferents.
  - 10.11.3.2 Refer to Table II for the details of ICSAB composition.
  - 10.11.3.3 Custom multielement ICS solutions must be used.
- 10.11.4 ICSA/ICSAB Frequency:
  - 10.11.4.1 For **6010C**: The ICSA and ICSAB must run with each initial calibration or every 12 hours whichever is shorter.
  - 10.11.4.2 For **200.7**: The ICSA and ICSAB must run at the beginning and the end of the run.
- 10.11.5 ICSA/ICSAB Criteria:
  - 10.11.5.1 The ICSAB results for interferents must fall within 80 – 120% of the true value.
  - 10.11.5.2 ICSA results for the non-interfering elements with RLs < 10 µg/L must fall within ± 2x RL from zero. ICSA results for the non-interfering elements with RLs > 10 µg/L must fall within ± 1xRL from zero.

10.12 Calibration Sequence

Profile Standard
Initial Calibration (3 standards plus a blank)
ICV
ICB

ICSA*
ICSAB*
CCV
CCB
10 samples (analysis runs)
CCV
CCB
10 samples (repeat every 10 analysis runs)
CCV
CCB
8 samples (CCV/CCB pairs as required to complete run)
ICSA (200.7 only)
ICSAB (200.7)
CCV
CCB
End

* If sequence time is longer than 12 hours, the ICSA and ICSAB standard must be re-analyzed.

10.13 **Linear Dynamic Range Verification** (LDR)

- 10.13.1 The linear range is determined for each element on the standard list.
- 10.13.2 LDR Frequency:
  - 10.13.2.1 Check is performed using the high level standard of each initial calibration.
    - 10.13.2.1.1 Method 6010C stipulates LDR check every 6 months by using the high level standard from each ICAL this frequency is met.
- 10.13.3 LDR Criteria:
  - 10.13.3.1 Recovery within 10% of the true concentration.

11.0 PROCEDURE

11.1 The aqueous sample digestion procedure is found in SOP: STL-IP-0013, Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by ICP Spectroscopy, and ICP/MS (Method 3010A, EPA 200.7 and EPA 200.8)

- 11.1.4 For 200.7 analyses, dissolved samples must be digested

11.2 The soil sample digestion procedure is found in SOP: STL-IP-0002, Acid Digestion of Soils, SW846 Method 3050B for ICP, and ICP/MS.

11.3 The use of a high solids nebulizer and mass flow controller is utilized and the calibration and QC standards are matrix matched.

- 11.3.4 Normal acid concentrations are 5% HCl and 5% HNO3

11.4 Instrument conditions, including rinse times, must be the same for all standards and samples.

11.5 Load autosampler with standards and digestates in accordance with the sequence given in section 10.

11.6 Analyze samples.

11.7 When analysis is completed, return unused digestate to proper storage area.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Commonly used calculations (e.g. % recovery and RPD) and standard instrument software calculations are given in the STL St. Louis LQM.

12.2 A minimum of <u>two exposures</u> for each standard, field sample and QC sample is required. The average of the exposures is reported.

12.3 For Trace ICP analyses, the result of the sum channel is used for reporting.
All measurements must fall within the defined linear range where spectral interference correction factors are valid.
12.3.1 Dilute and reanalyze all samples for required analytes that exceed the linear range.
12.3.2 Acid strength must be maintained in the dilution of samples.

12.4 If an interelement correction exists for an analyte which exceeds the linear range, the IEC may be inaccurately applied. Normally the inability to accurately correct for an interference is denoted by a "K" on the instrument printout. Therefore, even if an overrange analyte may not be required to be reported for a sample, if that analyte is a interferent for any requested analyte in that sample, the sample must be diluted.

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 The data assessment and corrective action process is detailed through the Clouseau Nonconformance Memorandum (NCM) process. The NCM process is described in SOP: STL-QA-0036. Below is a subset of the data assessment and QC excursion types within Clouseau; the text in underline is the exact "type" line in Clouseau. For a complete and current listing, please access the software program.

13.2 Method Blank
13.2.1 Acceptance Criteria:
13.2.1.1 No target analytes may be present in the method blank above the reporting limit.
13.2.1.2 Project specific requirements if more stringent than our routine procedure (e.g. no target analytes present above ½ RL), will be noted on the client requirements sheet.
13.2.2 Corrective Action for Method Blanks not meeting acceptance criteria:
13.2.2.1 <u>Method Blank Contamination</u> – See Clouseau NCM for corrective action (e.g. reprep/reanalysis, narration). Note certain analytes are common laboratory contaminants which require special narrative comment. These compounds are so designated in Clouseau.

13.3 Laboratory Control Sample (LCS)
13.3.1 Acceptance Criteria:
13.3.1.1 All control analytes should be within established control limits for accuracy (%Recovery) and precision (RPD).
13.3.1.1.1 For long analyte spike list, marginal exceedances (ME) are allowed as follows:
13.3.1.1.2 < 11 analytes in LCS, no analytes allowed in ME of the LCS control limit.
13.3.1.1.3 11-30 analytes in LCS, 1 analytes allowed in ME of the LCS control limit.
13.3.1.1.4 31-50 analytes in LCS, 2 analytes allowed in ME of the LCS control limit.
13.3.1.1.5 51-70 analytes in LCS, 3 analytes allowed in ME of the LCS control limit.
13.3.1.1.6 71-90 analytes in LCS, 4 analytes allowed in ME of the LCS control limit.
13.3.1.1.7 > 90 analytes in LCS, 5 analytes allowed in ME of the LCS control limit.
13.3.1.1.8 No LCS recoveries may be outside the Marginal Exceedance limit.
13.3.1.1.9 Marginal exceedances must be random. If the same LCS analyte exceeds the control limit repeatedly, it is an indication of a systemic problem. The source of the error must be located and corrective action taken.

13.3.1.2 Note: Not all regulatory programs allow the use of marginal exceedances for Metals analyses (e.g. DOE QSAS). Please check program requirements.

13.3.2 Corrective Action for LCS not meeting acceptance criteria:
13.3.2.1 LCS Spike Recovery excursion (high) – See Clouseau NCM for corrective action (e.g. , reanalysis, narration).
13.3.2.2 LCS Spike Recovery excursion (low) – See Clouseau NCM for corrective action (e.g. , reanalysis, narration).
13.3.2.3 RPD Duplicate excursion – See Clouseau NCM for corrective action (e.g. , reanalysis, narration).

13.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)
13.4.1 Analytes should be within control limits for accuracy (%Recovery) and precision (RPD).
13.4.2 Corrective Action for MS/MSD not meeting acceptance criteria:
13.4.2.1 MS/MSD Spike Rec. excursion may not necessarily warrant corrective action other than narration. See Clouseau NCM to determine if re-preparation re-analysis is required.

13.5 Sample result evaluation
13.5.1 Dilutions
13.5.1.1 If the response for any compound exceeds the working range of the analytical system, a dilution of the extract is prepared and analyzed. An appropriate dilution should be in the upper half of the calibration range.
13.5.1.2 Dilution: Sample– See Clouseau NCM for corrective action.

13.5.2 Insufficient Sample
13.5.2.1 For any prescribed re-preparation corrective action, if there is insufficient sample to repeat the analysis, a narrative comment stating such is included in the report narrative. The insufficient sample description is included in the Clouseau NCM within the type defining the excursion.

14.0 METHOD PERFORMANCE

14.1 Method performance data, Reporting Limits, and QC acceptance limits, are given in the appendix of this SOP.

14.2 Demonstration of Capability
14.2.1 Initial and continuing demonstrations of capability requirements are established in LQM section 4.1.3.
14.3 Training Qualification
14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.
14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in LQM section 4.1.3.
14.3.3 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in LQM section 4.1.3.

15.0 VALIDATION

15.1 Laboratory SOPs are based on standard reference EPA Methods that have been validated by the EPA and the lab is not required to perform validation for these methods. The requirements for lab demonstration of capability are included in LQM. Lab validation data would be appropriate for performance based measurement systems or non-standard methods. STL ST Louis will include this information in the SOP when accreditation is sought for a performance based measurement system or non-standard method.

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

16.2 Waste Streams Produced by the Method
- 16.2.1 The following waste streams are produced when this method is carried out.
  - 16.2.1.1 Acidic sample waste generated. All acidic waste will be accumulated in the appropriate waste accumulation container, labeled as Drum Type "A" or "B."
  - 16.2.1.2 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the lab ware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM meter, the lab ware will be collected in waste barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

17.1 Test Methods for Evaluating Solid Waste , Physical/Chemical Methods, SW-846, Method 6010C.

17.2 Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry, Method 200.7.

17.3 Thermo Jarrell Ash Corporation Customer Training Manual, ICAP 61/91E Course

17.4 STL Quality Management Plan (QMP), current revision

17.5 STL St. Louis Laboratory Quality Manual (LQM), current revision

17.6 STL Corporate Safety Manual and St. Louis Facility Addendum (SOP STL-HS-0002), current revisions.

17.7 Associated SOPs, current revisions
- 17.7.1 STL-IP-0002, Acid Digestion of Soils, SW846 Method 3050B for ICP, ICP/MS, and GFAA
- 17.7.2 STL-IP-0013, Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by ICP Spectroscopy, and ICP/MS (Method 3010A, EPA 200.7 and EPA 200.8)
- 17.7.3 STL-QA-0002, Standard and Reagent Preparation
- 17.7.4 STL-PM-0002, Sample Receipt and Chain of Custody
- 17.7.5 STL-QA-0014, Evaluation of Analytical Accuracy and Precision Through the Use of Control Charts
- 17.7.6 STL-QA-0016, IDL/MDL Determination
- 17.7.7 STL-QA-0036, Non-conformance Memorandum (NCM) Process

18.0 CLARIFICATIONS, MODIFICATIONS TO THE REFERENCE METHOD

18.1 Modifications/interpretations from both Methods 6010C and 200.7.
- 18.1.1 Section 8.5 of Method 6010C and Section 9.5 of Method 200.7 recommend that whenever a new or unusual matrix is encountered, a series of tests be performed prior to reporting concentration data for that analyte. The dilution test helps determine if a chemical or physical interference exists. Because STL laboratories receive no prior information from clients regarding when to expect a new or unusual matrix, STL may select to perform a dilution test on one sample in each prep batch. According to the method, the post digestion spike (PDS) determines any potential

matrix interferences. At STL labs, matrix interference is determined by evaluating data for the LCS and MS/MSD. STL requires documented, clear guidance when a new or unusual matrix will be received for a project and a request to perform the dilution test or PDS on a client-identified sample.

18.2 Modifications from Method 200.7.

18.2.1 STL St. Louis digests all aqueous samples. Method 200.7 allows for the digestion step to be omitted under certain conditions.

18.2.2 Method 200.7 defines the IDL as the concentration equivalent to a signal, due to the analyte, which is equal to three times the standard deviation of a series of ten replicate measurements of the calibration blank signal at the same wavelength. STL labs utilize the CLP IDL definition.

18.2.3 The calibration blank is prepared in an acid matrix of 5% HNO_3/5% HCl instead of the specified 2% HNO_3/10% HCl matrix as the former matrix provides for improved performance relative to the wide variety of digestate acid matrices which result from the various EPA preparation protocols applied.

18.2.4 Method section 9.3.4 specifies that "Analysis of the IPC (ICSA/AB) solution immediately following calibration must verify that the instrument is within ± 5% of calibration with a relative standard deviation <3% from replicate integrations ≥ 4." STL uses a minimum of two exposures.

18.2.5 Section 7.12 of 200.7 indicates that the QCS (ICV) should be prepared at a concentration near 1 ppm. The ICV specified in this SOP deviates from the 1 ppm criteria . For the analytes, this SOP specifies ICV concentrations which are appropriate to the range of calibration. The intent of the ICV, verification of calibration standard accuracy, is independent of the ICV concentration used.

18.2.6 The ICS criteria applied by this SOP differ from those stated in the method. Method 200.7 section 10.4 states that results should fall within the established control limits of 3 times the standard deviation of the calibration blank for that analyte. The control limits listed in this SOP are those applicable to the EPA designed solution.

18.2.7 Method 200.7 section 9.3.4 states the CCB should be less than the IDL, but > the lower 3-sigma control limit of the calibration blank. The intent of this requirement is to ensure that the calibration is not drifting at the low end. STL has adopted an absolute control limit of +/- RL from zero for calibration blank criteria.

18.3 Modifications from Method 6010C.

18.3.1 Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit. Common lab contaminants are allowed up to two times the reporting limit in the blank following consultation with the client.

18.3.2 Method 6010C section 8.6.1.3 states that the results of the calibration blank are to agree within 3x the MDL. If not, repeat the analysis two or more times and average the results. If the average is not within three standard deviation of the background mean, terminate the analysis, correct the problem, recalibrate, and reanalyze the previous 10 samples. The intent of this requirement is to ensure that the calibration is not drifting at the low end. STL has adopted an absolute control limit of +/- RL from zero for calibration blank criteria.

19.0 CHANGES TO PREVIOUS REVISION

19.1 Sections 9, 12, 13 and 14 were replaced with new text.

19.2 Section 18 was added.

19.3 Documentations of changes to the previous version of the SOP were moved to newly created Section 19.

TABLE I. ICP Calibration and Calibration Verification Standards

Element	Calibration Level	ICV (ug/L)	CCV (ug/L)
Aluminum	100000	40000	40000
Antimony	10000	4000	4000
Arsenic	10000	4000	4000
Barium	10000	4000	4000
Bismuth	10000	4000	4000
Beryllium	10000	4000	4000
Boron	10000	4000	4000
Cadmium	10000	4000	4000
Calcium	50000	20000	20000
Chromium	10000	4000	4000
Cobalt	10000	4000	4000
Copper	10000	4000	4000
Iron	100000	40000	40000
Lead	10000	4000	4000
Lithium	10000	4000	4000
Magnesium	50000	20000	20000
Manganese	10000	4000	4000
Molybdenum	10000	4000	4000
Nickel	10000	4000	4000
Phosphorous	10000	4000	4000
Potassium	100000	40000	40000
Selenium	10000	4000	4000
Silicon	10000	4000	4000
Silver	2000	1000	1000
Sodium	100000	40000	40000
Strontium	10000	4000	4000
Tellurium	10000	4000	4000
Thallium	10000	4000	4000
Tin	10000	4000	4000
Titanium	10000	4000	4000
Thorium	10000	4000	4000
Uranium	10000	4000	4000
Vanadium	10000	4000	4000
Zinc	10000	4000	4000
Zirconium	10000	4000	4000

TABLE II. Interference Check Sample Concentrations

Element	ICSA (ug/L)	ICSAB (ug/L)
Aluminum	500000	500000
Antimony	-	1000
Arsenic	-	1000
Barium	-	500
Beryllium	-	500
Bismuth	-	1000
Boron	-	1000
Cadmium	-	1000
Calcium	500000	500000
Chromium	-	500
Cobalt	-	500
Copper	-	500
Iron	200000	200000
Lead	-	1000
Lithium	-	1000
Magnesium	500000	500000
Manganese	-	500
Molybdenum	-	1000
Nickel	-	1000
Phosphorus	-	500
Potassium	-	20000
Selenium	-	1000
Silicon	-	1000
Silver	-	1000
Sodium	-	20000
Strontium	-	1000
Sulfur	-	20000
Thallium	-	1000
Thorium	-	1000
Tin	-	1000
Titanium	-	500
Uranium	-	1000
Vanadium	-	500
Zinc	-	1000
Zirconium	-	1000

STL Reference Data Summary

Structured Analysis Code: **A-GK-QO-01-06**
Target Analyte List: All Analytes

Matrix: SOLID
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6428							Spike List 6225						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	20	mg/kg	5.072	mg/kg	20070125	C	Y	6320	mg/kg	58	142	20	C	Y	100	mg/kg	75	125	30
128	Antimony	6	mg/kg	3.542	mg/kg	20070117	C	Y	60.9	mg/kg	10	150	20	C	Y	25	mg/kg	75	125	30
140	Arsenic	20	mg/kg	9.001	mg/kg	20070117	C	Y	161	mg/kg	80	120	20	C	Y	100	mg/kg	75	125	30
194	Barium	5	mg/kg	0.2303	mg/kg	20070111	C	Y	252	mg/kg	82	118	20	C	Y	100	mg/kg	75	125	30
222	Beryllium	0.5	mg/kg	0.07	mg/kg	20051222	C	Y	94.4	mg/kg	82	118	20	C	Y	2.5	mg/kg	75	125	30
307	Bismuth	20	mg/kg	6.255	mg/kg	20070117	C	Y	100	mg/kg	80	120	20							
313	Boron	10	mg/kg	1.5	mg/kg	20051222	C	Y	97.4	mg/kg	56	144	20	C	Y	100	mg/kg	75	125	30
411	Cadmium	0.5	mg/kg	0.314	mg/kg	20070117	C	Y	128	mg/kg	81	119	20	C	Y	2.5	mg/kg	75	125	30
413	Calcium	250	mg/kg	8.5	mg/kg	20051222	C	Y	3320	mg/kg	79	121	20	C	Y	2500	mg/kg	75	125	30
2952	Chromium	1	mg/kg	0.2264	mg/kg	20070111	C	Y	69.5	mg/kg	78	121	20	C	Y	10.0	mg/kg	75	125	30
637	Cobalt	5	mg/kg	0.5	mg/kg	20051222	C	Y	35.2	mg/kg	73	127	20	C	Y	25.0	mg/kg	75	125	30
643	Copper	5.0	mg/kg	0.3008	mg/kg	20051222	C	Y	148	mg/kg	82	118	20	C	Y	12.5	mg/kg	75	125	30
1539	Iron	10	mg/kg	3.744	mg/kg	20070111	C	Y	11200	mg/kg	57	143	20	C	Y	50.0	mg/kg	75	125	30
1605	Lead	10	mg/kg	2.557	mg/kg	20070111	C	Y	142	mg/kg	80	120	20	C	Y	25.0	mg/kg	75	125	30
1616	Lithium	5	mg/kg	0.7314	mg/kg	20070111	C	Y	100	mg/kg	80	120	0	C	Y	50	mg/kg	75	125	20
1618	Magnesium	100	mg/kg	8.956	mg/kg	20070111	C	Y	2040	mg/kg	77	123	20	C	Y	2500	mg/kg	75	125	30
1659	Manganese	1.0	mg/kg	0.2177	mg/kg	20070111	C	Y	408	mg/kg	80	120	20	C	Y	25.0	mg/kg	75	125	30
1906	Molybdenum	4	mg/kg	0.892	mg/kg	20070117	C	Y	84.1	mg/kg	79	120	20	C	Y	100	mg/kg	75	125	30
1956	Nickel	4	mg/kg	1.140	mg/kg	20070111	C	Y	147	mg/kg	82	118	20	C	Y	25.0	mg/kg	75	125	30
2200	Phosphorus	25	mg/kg	3.719	mg/kg	20070111	C	Y	500	mg/kg	80	120	20	C	Y	500	mg/kg	75	125	30
2214	Potassium	500	mg/kg	91.54	mg/kg	20070302	C	Y	1920	mg/kg	71	129	20	C	Y	2500	mg/kg	75	125	30
2281	Selenium	20	mg/kg	8.973	mg/kg	20070117	C	Y	64.2	mg/kg	76	124	20	C	Y	100	mg/kg	75	125	30
2283	Silicon	40	mg/kg	4.0	mg/kg	20051222	C	Y	754	mg/kg	10	150	20	C	Y	500	mg/kg	75	125	30
2285	Silver	1	mg/kg	0.3644	mg/kg	20070117	C	Y	130	mg/kg	53	147	20	C	Y	2.5	mg/kg	75	125	30
2315	Sodium	100	mg/kg	5.741	mg/kg	20070111	C	Y	445	mg/kg	56	144	20	C	Y	2500	mg/kg	75	125	30
2353	Strontium	1	mg/kg	0.1	mg/kg	20051222	C	Y	84.0	mg/kg	80	120	20	C	Y	50.0	mg/kg	75	125	30
2876	Sulfur	500	mg/kg	210.7	mg/kg	20060303	C	Y	2000	mg/kg	80	120	20	C	Y	2000	mg/kg	75	125	30
2477	Thallium	20	mg/kg	3.866	mg/kg	20070111	C	Y	84	mg/kg	76	125	20	C	Y	100	mg/kg	75	125	30
3935	Thorium	20	mg/kg	1.917	mg/kg	20070111	C	Y	100	mg/kg	80	120	20	C	Y	10.0	mg/kg	75	125	30
2479	Tin	10	mg/kg	2.788	mg/kg	20051229	C	Y	61.0	mg/kg	58	142	20	C	Y	50.0	mg/kg	75	125	30
2482	Titanium	2	mg/kg	0.2	mg/kg	20060104	C	Y	310	mg/kg	40	150	20	C	Y	50.0	mg/kg	75	125	30
3827	Uranium	50	mg/kg	8.208	mg/kg	20070111	C	Y	100	mg/kg	80	120	20	C	Y	100	mg/kg	75	125	30
2607	Vanadium	2	mg/kg	0.5348	mg/kg	20070111	C	Y	97.3	mg/kg	75	125	20	C	Y	25.0	mg/kg	75	125	30
2649	Zinc	5	mg/kg	0.5348	mg/kg	20051222	C	Y	165	mg/kg	79	121	20	C	Y	25.0	mg/kg	75	125	30
2651	Zirconium	10	mg/kg	2.973	mg/kg	20060228	C	Y	100	mg/kg	80	120	20	C	Y	50.0	mg/kg	75	125	30

STL Reference Data Summary

Structured Analysis Code: **A-29-QO-01-06**
Target Analyte List: All Analytes

Matrix: SOLID
Extraction: SPLP-E(1312) -> METALS, TOTAL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6038							Spike List 6039						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	500	ug/L	135.8	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
128	Antimony	150	ug/L	112.1	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
140	Arsenic	500	ug/L	4.792	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
194	Barium	125	ug/L	12.50	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
222	Beryllium	12.50	ug/L	1.429	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
307	Bismuth	500	ug/L	94.48	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
313	Boron	250	ug/L	6.272	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
411	Cadmium	12.5	ug/L	8.865	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
413	Calcium	6250	ug/L	45.11	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2952	Chromium	62.5	ug/L	6.165	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
637	Cobalt	125	ug/L	4.985	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
643	Copper	62.5	ug/L	4.612	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	312.5	ug/L	75	125	20
1539	Iron	250	ug/L	46.525	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1605	Lead	250	ug/L	50.48	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1616	Lithium	125	ug/L	25.78	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1618	Magnesium	2500	ug/L	320.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
1659	Manganese	37.5	ug/L	2.148	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1906	Molybdenum	100	ug/L	21.11	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1956	Nickel	100	ug/L	11.41	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2200	Phosphorus	625	ug/L	104.1	ug/L	20070111	C	Y	12500	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2214	Potassium	12500	ug/L	4082	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2281	Selenium	500	ug/L	234.9	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2283	Silicon	1000	ug/L	11.66	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2285	Silver	25	ug/L	4.198	ug/L	20070111	C	Y	312.5	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
2315	Sodium	2500	ug/L	196.3	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2353	Strontium	125	ug/L	1.403	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
3742	Tellurium	1250	ug/L	302.5	ug/L	20020121	C	N	1250	ug/L	80	120	20	C	N	5000	ug/L	75	125	20
2477	Thallium	500	ug/L	104	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3935	Thorium	500	ug/L	33.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2479	Tin	250	ug/L	72.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2482	Titanium	50	ug/L	5.00	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3827	Uranium	1250	ug/L	137.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2607	Vanadium	125	ug/L	15.16	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2649	Zinc	50	ug/L	24.08	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	30
2651	Zirconium	250	ug/L	81.35	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **A-34-QO-01-06**
Target Analyte List: All Analytes

Matrix: SOLID
Extraction: TCLP(1311) -> METALS, TOTAL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6038							Spike List 6039						
Syn	**Compound**	**RL**	**Units**	**MDL**	**Units**	**Run Date**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**
88	Aluminum	500	ug/L	135.8	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
128	Antimony	150	ug/L	112.1	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
140	Arsenic	500	ug/L	4.792	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
194	Barium	125	ug/L	12.50	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
222	Beryllium	12.50	ug/L	1.429	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
307	Bismuth	500	ug/L	94.48	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
313	Boron	250	ug/L	6.272	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
411	Cadmium	12.5	ug/L	8.865	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
413	Calcium	6250	ug/L	45.11	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2952	Chromium	62.5	ug/L	6.165	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
637	Cobalt	125	ug/L	4.985	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
643	Copper	62.5	ug/L	4.612	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	312.5	ug/L	75	125	20
1539	Iron	250	ug/L	46.525	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1605	Lead	250	ug/L	50.48	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1616	Lithium	125	ug/L	25.78	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1618	Magnesium	2500	ug/L	320.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
1659	Manganese	37.5	ug/L	2.148	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1906	Molybdenum	100	ug/L	21.11	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1956	Nickel	100	ug/L	11.41	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2200	Phosphorus	625	ug/L	104.1	ug/L	20070111	C	Y	12500	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2214	Potassium	12500	ug/L	4082	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2281	Selenium	500	ug/L	234.9	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2283	Silicon	1000	ug/L	11.66	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2285	Silver	25	ug/L	4.198	ug/L	20070111	C	Y	312.5	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
2315	Sodium	2500	ug/L	196.3	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2353	Strontium	125	ug/L	1.403	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
3742	Tellurium	1250	ug/L	302.5	ug/L	20020121	C	N	1250	ug/L	80	120	20	C	N	5000	ug/L	75	125	20
2477	Thallium	500	ug/L	104	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3935	Thorium	500	ug/L	33.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2479	Tin	250	ug/L	72.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2482	Titanium	50	ug/L	5.00	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3827	Uranium	1250	ug/L	137.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2607	Vanadium	125	ug/L	15.16	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2649	Zinc	50	ug/L	24.08	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	30
2651	Zirconium	250	ug/L	81.35	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: A-38-QO-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: SPLP-W(1312) -> METALS, TOTAL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6038							Spike List 6039						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	500	ug/L	135.8	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
128	Antimony	150	ug/L	112.1	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
140	Arsenic	500	ug/L	4.792	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
194	Barium	125	ug/L	12.50	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
222	Beryllium	12.50	ug/L	1.429	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
307	Bismuth	500	ug/L	94.48	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
313	Boron	250	ug/L	6.272	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
411	Cadmium	12.5	ug/L	8.865	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
413	Calcium	6250	ug/L	45.11	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2952	Chromium	62.5	ug/L	6.165	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
637	Cobalt	125	ug/L	4.985	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
643	Copper	62.5	ug/L	4.612	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	312.5	ug/L	75	125	20
1539	Iron	250	ug/L	46.525	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1605	Lead	250	ug/L	50.48	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1616	Lithium	125	ug/L	25.78	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1618	Magnesium	2500	ug/L	320.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
1659	Manganese	37.5	ug/L	2.148	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1906	Molybdenum	100	ug/L	21.11	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1956	Nickel	100	ug/L	11.41	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2200	Phosphorus	625	ug/L	104.1	ug/L	20070111	C	Y	12500	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2214	Potassium	12500	ug/L	4082	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2281	Selenium	500	ug/L	234.9	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2283	Silicon	1000	ug/L	11.66	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2285	Silver	25	ug/L	4.198	ug/L	20070111	C	Y	312.5	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
2315	Sodium	2500	ug/L	196.3	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2353	Strontium	125	ug/L	1.403	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
3742	Tellurium	1250	ug/L	302.5	ug/L	20020121	C	N	1250	ug/L	80	120	20	C	N	5000	ug/L	75	125	20
2477	Thallium	500	ug/L	104	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3935	Thorium	500	ug/L	33.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2479	Tin	250	ug/L	72.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2482	Titanium	50	ug/L	5.00	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3827	Uranium	1250	ug/L	137.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2607	Vanadium	125	ug/L	15.16	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2649	Zinc	50	ug/L	24.08	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	30
2651	Zirconium	250	ug/L	81.35	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: A-5E-QO-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: LEACHATE,Citrate Buffer,CA Title 22 WET -> DIGESTION
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6058							Spike List 6059						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	1000	ug/L	271.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
128	Antimony	300	ug/L	224.2	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
140	Arsenic	1000	ug/L	9.585	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
194	Barium	250	ug/L	25	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
222	Beryllium	25	ug/L	2.859	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
307	Bismuth	1000	ug/L	188.9	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
313	Boron	500	ug/L	12.54	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
411	Cadmium	25	ug/L	17.73	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
413	Calcium	12500	ug/L	90.22	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2952	Chromium	125	ug/L	12.33	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
637	Cobalt	250	ug/L	9.97	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
643	Copper	125	ug/L	9.225	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1539	Iron	500	ug/L	93.05	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1605	Lead	500	ug/L	100.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1616	Lithium	250	ug/L	51.55	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
1618	Magnesium	5000	ug/L	640.5	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
1659	Manganese	75	ug/L	4.295	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1906	Molybdenum	250	ug/L	42.22	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1956	Nickel	250	ug/L	22.82	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2200	Phosphorus	1250	ug/L	208.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2214	Potassium	25000	ug/L	8165	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2281	Selenium	1000	ug/L	469.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2283	Silicon	2000	ug/L	23.32	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2285	Silver	50	ug/L	8.395	ug/L	20070111	C	Y	625	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
2315	Sodium	5000	ug/L	3926	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2353	Strontium	250	ug/L	2.806	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2477	Thallium	1000	ug/L	208.1	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3935	Thorium	1000	ug/L	67.6	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2479	Tin	500	ug/L	145.8	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2482	Titanium	100	ug/L	10	ug/L	20051222	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3827	Uranium	2500	ug/L	275.1	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2607	Vanadium	250	ug/L	30.31	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2649	Zinc	100	ug/L	48.15	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2651	Zirconium	500	ug/L	162.7	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: I-GJ-QO-01-06
Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6609							Spike List 6225						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	200	ug/L	54.33	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
128	Antimony	60	ug/L	44.83	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
140	Arsenic	200	ug/L	1.917	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
194	Barium	50	ug/L	5.0	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
222	Beryllium	5	ug/L	0.5718	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
307	Bismuth	200	ug/L	37.79	ug/L	20070117	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
313	Boron	100	ug/L	2.509	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
411	Cadmium	5	ug/L	3.546	ug/L	20070117	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
413	Calcium	1000	ug/L	18.045	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2952	Chromium	10	ug/L	2.466	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	100	ug/L	75	125	20
637	Cobalt	50	ug/L	1.994	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
643	Copper	25	ug/L	1.845	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
1539	Iron	100	ug/L	18.61	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1605	Lead	100	ug/L	20.19	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1616	Lithium	50	ug/L	10.31	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
1618	Magnesium	1000	ug/L	128.1	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
1659	Manganese	15	ug/L	0.859	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1906	Molybdenum	40	ug/L	8.444	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1956	Nickel	40	ug/L	4.564	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2200	Phosphorus	250	ug/L	41.65	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2214	Potassium	5000	ug/L	1633	ug/L	20070302	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2281	Selenium	200	ug/L	93.96	ug/L	20070117	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2283	Silicon	400	ug/L	4.665	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2285	Silver	10	ug/L	1.679	ug/L	20070111	C	Y	125	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
2315	Sodium	1000	ug/L	78.53	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2353	Strontium	5	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2876	Sulfur	5000	ug/L	1218	ug/L	20060303	C	Y	20000	ug/L	80	120	20	C	Y	20000	ug/L	75	125	20
2477	Thallium	200	ug/L	41.62	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3935	Thorium	200	ug/L	13.52	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2479	Tin	100	ug/L	29.16	ug/L	20060111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2482	Titanium	20	ug/L	2.000	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3827	Uranium	500	ug/L	55.02	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2607	Vanadium	50	ug/L	6.062	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2649	Zinc	20	ug/L	9.63	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2651	Zirconium	100	ug/L	32.54	ug/L	20060228	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **I-JX-QO-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, FILTERED 2% HCL, DISSOLVED
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6609							Spike List 6225						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	200	ug/L	54.33	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
128	Antimony	60	ug/L	44.83	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
140	Arsenic	200	ug/L	1.917	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
194	Barium	50	ug/L	5.0	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
222	Beryllium	5	ug/L	0.5718	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
307	Bismuth	200	ug/L	37.79	ug/L	20070117	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
313	Boron	100	ug/L	2.509	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
411	Cadmium	5	ug/L	3.546	ug/L	20070117	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
413	Calcium	1000	ug/L	18.045	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2952	Chromium	10	ug/L	2.466	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	100	ug/L	75	125	20
637	Cobalt	50	ug/L	1.994	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
643	Copper	25	ug/L	1.845	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
1539	Iron	100	ug/L	18.61	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1605	Lead	100	ug/L	20.19	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1616	Lithium	50	ug/L	10.31	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
1618	Magnesium	1000	ug/L	128.1	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
1659	Manganese	15	ug/L	0.859	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1906	Molybdenum	40	ug/L	8.444	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1956	Nickel	40	ug/L	4.564	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2200	Phosphorus	250	ug/L	41.65	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2214	Potassium	5000	ug/L	1633	ug/L	20070302	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2281	Selenium	200	ug/L	93.96	ug/L	20070117	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2283	Silicon	400	ug/L	4.665	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2285	Silver	10	ug/L	1.679	ug/L	20070111	C	Y	125	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
2315	Sodium	1000	ug/L	78.53	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2353	Strontium	5	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2876	Sulfur	5000	ug/L	1218	ug/L	20060303	C	Y	20000	ug/L	80	120	20	C	Y	20000	ug/L	75	125	20
2477	Thallium	200	ug/L	41.62	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3935	Thorium	200	ug/L	13.52	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2479	Tin	100	ug/L	29.16	ug/L	20060111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2482	Titanium	20	ug/L	2.000	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3827	Uranium	500	ug/L	55.02	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2607	Vanadium	50	ug/L	6.062	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2649	Zinc	20	ug/L	9.63	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2651	Zirconium	100	ug/L	32.54	ug/L	20060228	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: I-29-QO-01-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: SPLP-E(1312) -> METALS, TOTAL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6038							Spike List 6039						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	500	ug/L	135.8	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
128	Antimony	150	ug/L	112.1	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
140	Arsenic	500	ug/L	4.792	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
194	Barium	125	ug/L	12.50	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
222	Beryllium	12.50	ug/L	1.429	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
307	Bismuth	500	ug/L	94.48	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
313	Boron	250	ug/L	6.272	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
411	Cadmium	12.5	ug/L	8.865	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
413	Calcium	6250	ug/L	45.11	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2952	Chromium	62.5	ug/L	6.165	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
637	Cobalt	125	ug/L	4.985	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
643	Copper	62.5	ug/L	4.612	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	312.5	ug/L	75	125	20
1539	Iron	250	ug/L	46.525	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1605	Lead	250	ug/L	50.48	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1616	Lithium	125	ug/L	25.78	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1618	Magnesium	2500	ug/L	320.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
1659	Manganese	37.5	ug/L	2.148	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1906	Molybdenum	100	ug/L	21.11	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1956	Nickel	100	ug/L	11.41	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2200	Phosphorus	625	ug/L	104.1	ug/L	20070111	C	Y	12500	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2214	Potassium	12500	ug/L	4082	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2281	Selenium	500	ug/L	234.9	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2283	Silicon	1000	ug/L	11.66	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2285	Silver	25	ug/L	4.198	ug/L	20070111	C	Y	312.5	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
2315	Sodium	2500	ug/L	196.3	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2353	Strontium	125	ug/L	1.403	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2477	Thallium	500	ug/L	104	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3935	Thorium	500	ug/L	33.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2479	Tin	250	ug/L	72.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2482	Titanium	50	ug/L	5.00	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3827	Uranium	1250	ug/L	137.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2607	Vanadium	125	ug/L	15.16	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2649	Zinc	50	ug/L	24.08	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2651	Zirconium	250	ug/L	81.35	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: I-34-QO-01-06
Target Analyte List: All Analytes

Matrix: WATER
Extraction: TCLP(1311) -> METALS, TOTAL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6038							Spike List 6039						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	500	ug/L	135.8	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
128	Antimony	150	ug/L	112.1	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
140	Arsenic	500	ug/L	4.792	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
194	Barium	125	ug/L	12.50	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
222	Beryllium	12.50	ug/L	1.429	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
307	Bismuth	500	ug/L	94.48	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
313	Boron	250	ug/L	6.272	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
411	Cadmium	12.5	ug/L	8.865	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
413	Calcium	6250	ug/L	45.11	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2952	Chromium	62.5	ug/L	6.165	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
637	Cobalt	125	ug/L	4.985	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
643	Copper	62.5	ug/L	4.612	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	312.5	ug/L	75	125	20
1539	Iron	250	ug/L	46.525	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1605	Lead	250	ug/L	50.48	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1616	Lithium	125	ug/L	25.78	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1618	Magnesium	2500	ug/L	320.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
1659	Manganese	37.5	ug/L	2.148	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1906	Molybdenum	100	ug/L	21.11	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1956	Nickel	100	ug/L	11.41	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2200	Phosphorus	625	ug/L	104.1	ug/L	20070111	C	Y	12500	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2214	Potassium	12500	ug/L	4082	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2281	Selenium	500	ug/L	234.9	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2283	Silicon	1000	ug/L	11.66	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2285	Silver	25	ug/L	4.198	ug/L	20070111	C	Y	312.5	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
2315	Sodium	2500	ug/L	196.3	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2353	Strontium	125	ug/L	1.403	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2477	Thallium	500	ug/L	104	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3935	Thorium	500	ug/L	33.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2479	Tin	250	ug/L	72.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2482	Titanium	50	ug/L	5.00	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3827	Uranium	1250	ug/L	137.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2607	Vanadium	125	ug/L	15.16	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2649	Zinc	50	ug/L	24.08	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2651	Zirconium	250	ug/L	81.35	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **I-38-QO-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: SPLP-W(1312) -> METALS, TOTAL
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6038							Spike List 6039						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	500	ug/L	135.8	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
128	Antimony	150	ug/L	112.1	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
140	Arsenic	500	ug/L	4.792	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
194	Barium	500	ug/L	12.50	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
222	Beryllium	25	ug/L	1.429	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
307	Bismuth	500	ug/L	94.48	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
313	Boron	500	ug/L	6.272	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
411	Cadmium	15	ug/L	8.865	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
413	Calcium	12500	ug/L	45.11	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2952	Chromium	25	ug/L	6.165	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
637	Cobalt	125	ug/L	4.985	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
643	Copper	65	ug/L	4.612	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	312.5	ug/L	75	125	20
1539	Iron	250	ug/L	46.525	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1605	Lead	250	ug/L	50.48	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1616	Lithium	125	ug/L	25.78	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1618	Magnesium	12500	ug/L	320.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
1659	Manganese	50	ug/L	2.148	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1906	Molybdenum	100	ug/L	21.11	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1956	Nickel	100	ug/L	11.41	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2200	Phosphorus	625	ug/L	104.1	ug/L	20070111	C	Y	12500	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2214	Potassium	12500	ug/L	4082	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2281	Selenium	500	ug/L	234.9	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2283	Silicon	1250	ug/L	11.66	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2285	Silver	25	ug/L	4.198	ug/L	20070111	C	Y	312.5	ug/L	80	120	20	C	Y	62.5	ug/L	75	125	20
2315	Sodium	1250	ug/L	196.3	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	62500	ug/L	75	125	20
2353	Strontium	125	ug/L	1.403	ug/L	20051222	C	Y	1250	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2477	Thallium	500	ug/L	104	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3935	Thorium	1250	ug/L	33.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2479	Tin	250	ug/L	72.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2482	Titanium	125	ug/L	5.00	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
3827	Uranium	1250	ug/L	137.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2607	Vanadium	125	ug/L	15.16	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2649	Zinc	100	ug/L	24.08	ug/L	20070111	C	Y	1250	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
2651	Zirconium	250	ug/L	81.35	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **I-5E-QO-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: LEACHATE,Citrate Buffer,CA Title 22 WET -> DIGESTION
Method: Inductively Coupled Plasma (6010B)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6058							Spike List 6059						
Syn	**Compound**	**RL**	**Units**	**MDL**	**Units**	**Run Date**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**
88	Aluminum	1000	ug/L	271.6	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
128	Antimony	300	ug/L	224.2	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
140	Arsenic	1000	ug/L	9.585	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
194	Barium	250	ug/L	25	ug/L	20051222	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
222	Beryllium	25	ug/L	2.859	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
307	Bismuth	1000	ug/L	188.9	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
313	Boron	500	ug/L	12.54	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
411	Cadmium	25	ug/L	17.73	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
413	Calcium	12500	ug/L	90.22	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2952	Chromium	125	ug/L	12.33	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
637	Cobalt	250	ug/L	9.97	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
643	Copper	125	ug/L	9.225	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	625	ug/L	75	125	20
1539	Iron	500	ug/L	93.05	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1605	Lead	500	ug/L	100.9	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1616	Lithium	250	ug/L	51.55	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
1618	Magnesium	5000	ug/L	640.5	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
1659	Manganese	75	ug/L	4.295	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
1906	Molybdenum	250	ug/L	42.22	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
1956	Nickel	250	ug/L	22.82	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2200	Phosphorus	1250	ug/L	208.2	ug/L	20070111	C	Y	25000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2214	Potassium	25000	ug/L	8165	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2281	Selenium	1000	ug/L	469.8	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2283	Silicon	2000	ug/L	23.32	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2285	Silver	50	ug/L	8.395	ug/L	20070111	C	Y	625	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
2315	Sodium	5000	ug/L	3926	ug/L	20070111	C	Y	50000	ug/L	80	120	20	C	Y	12500	ug/L	75	125	20
2353	Strontium	250	ug/L	2.806	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	2500	ug/L	75	125	20
2477	Thallium	1000	ug/L	208.1	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3935	Thorium	1000	ug/L	67.6	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2479	Tin	500	ug/L	145.8	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2482	Titanium	100	ug/L	10	ug/L	20051222	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3827	Uranium	2500	ug/L	275.1	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2607	Vanadium	250	ug/L	30.31	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2649	Zinc	100	ug/L	48.15	ug/L	20070111	C	Y	2500	ug/L	80	120	20	C	Y	1250	ug/L	75	125	20
2651	Zirconium	500	ug/L	162.7	ug/L	20070111	C	Y	5000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: A-GK-QM-01-06
Target Analyte List: All Analytes

Matrix: SOLID
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6428							Spike List 6225						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	20	mg/kg	5.072	mg/kg	20070125	C	Y	6320	mg/kg	58	142	20	C	Y	100	mg/kg	75	125	30
128	Antimony	1	mg/kg	0.5087	mg/kg	20070111	C	Y	60.9	mg/kg	10	150	20	C	Y	25	mg/kg	75	125	30
140	Arsenic	1	mg/kg	0.2388	mg/kg	20070111	C	Y	161	mg/kg	80	120	20	C	Y	100	mg/kg	75	125	30
194	Barium	5	mg/kg	0.2303	mg/kg	20070111	C	Y	252	mg/kg	82	118	20	C	Y	100	mg/kg	75	125	30
222	Beryllium	0.5	mg/kg	0.07	mg/kg	20051222	C	Y	94.4	mg/kg	82	118	20	C	Y	2.5	mg/kg	75	125	30
307	Bismuth	20	mg/kg	6.2554	mg/kg	20070117	C	Y	100	mg/kg	80	120	20							
313	Boron	10	mg/kg	1.5	mg/kg	20051222	C	Y	97.4	mg/kg	56	144	20	C	Y	100	mg/kg	75	125	30
411	Cadmium	0.5	mg/kg	0.0611	mg/kg	20070111	C	Y	128	mg/kg	81	119	20	C	Y	2.5	mg/kg	75	125	30
413	Calcium	250	mg/kg	8.5	mg/kg	20051222	C	Y	3320	mg/kg	79	121	20	C	Y	2500	mg/kg	75	125	30
2952	Chromium	1	mg/kg	0.2264	mg/kg	20070111	C	Y	69.5	mg/kg	78	121	20	C	Y	10.0	mg/kg	75	125	30
637	Cobalt	5	mg/kg	0.2308	mg/kg	20070111	C	Y	35.2	mg/kg	73	127	20	C	Y	25.0	mg/kg	75	125	30
643	Copper	2.5	mg/kg	0.1557	mg/kg	20070111	C	Y	148	mg/kg	82	118	20	C	Y	12.5	mg/kg	75	125	30
1539	Iron	10	mg/kg	3.744	mg/kg	20070111	C	Y	11200	mg/kg	57	143	20	C	Y	50.0	mg/kg	75	125	30
1605	Lead	1.0	mg/kg	0.0969	mg/kg	20070111	C	Y	142	mg/kg	80	120	20	C	Y	25.0	mg/kg	75	125	30
1616	Lithium	5	mg/kg	0.7314	mg/kg	20070111	C	Y	100	mg/kg	80	120	0	C	Y	50	mg/kg	75	125	20
1618	Magnesium	100	mg/kg	8.956	mg/kg	20070111	C	Y	2040	mg/kg	77	123	20	C	Y	2500	mg/kg	75	125	30
1659	Manganese	1.0	mg/kg	0.2177	mg/kg	20070111	C	Y	408	mg/kg	80	120	20	C	Y	25.0	mg/kg	75	125	30
1906	Molybdenum	4	mg/kg	0.892	mg/kg	20070111	C	Y	84.1	mg/kg	79	120	20	C	Y	100	mg/kg	75	125	30
1956	Nickel	4	mg/kg	1.1399	mg/kg	20070111	C	Y	147	mg/kg	82	118	20	C	Y	25.0	mg/kg	75	125	30
2214	Potassium	500	mg/kg	91.54	mg/kg	20070302	C	Y	1920	mg/kg	71	129	20	C	Y	2500	mg/kg	75	125	30
2281	Selenium	1.5	mg/kg	0.4407	mg/kg	20070111	C	Y	64.2	mg/kg	76	124	20	C	Y	100	mg/kg	75	125	30
2283	Silicon	40	mg/kg	4.0	mg/kg	20051222	C	Y	754	mg/kg	10	150	20	C	Y	500	mg/kg	75	125	30
2285	Silver	1	mg/kg	0.3644	mg/kg	20070117	C	Y	130	mg/kg	53	147	20	C	Y	2.5	mg/kg	75	125	30
2315	Sodium	100	mg/kg	5.7414	mg/kg	20070111	C	Y	445	mg/kg	56	144	20	C	Y	2500	mg/kg	75	125	30
2353	Strontium	1	mg/kg	0.1266	mg/kg	20070111	C	Y	84.0	mg/kg	80	120	20	C	Y	50.0	mg/kg	75	125	30
2876	Sulfur	500	mg/kg	210.7	mg/kg	20060303	C	Y	2000	mg/kg	80	120	20	C	Y	2000	mg/kg	75	125	30
2477	Thallium	20	mg/kg	3.8659	mg/kg	20070111	C	Y	84	mg/kg	76	125	20	C	Y	100	mg/kg	75	125	30
3935	Thorium	20	mg/kg	1.9172	mg/kg	20070111	C	Y	100	mg/kg	80	120	20	C	Y	10.0	mg/kg	75	125	30
2479	Tin	10	mg/kg	0.2244	mg/kg	20070111	C	Y	61.0	mg/kg	58	142	20	C	Y	50.0	mg/kg	75	125	30
2482	Titanium	2.0	mg/kg	0.1523	mg/kg	20070111	C	Y	310	mg/kg	40	150	20	C	Y	50.0	mg/kg	75	125	30
3827	Uranium	50	mg/kg	8.2077	mg/kg	20070111	C	Y	100	mg/kg	80	120	20	C	Y	100	mg/kg	75	125	30
2607	Vanadium	5	mg/kg	0.5348	mg/kg	20070111	C	Y	97.3	mg/kg	75	125	20	C	Y	25.0	mg/kg	75	125	30
2649	Zinc	5	mg/kg	1.4	mg/kg	20051222	C	Y	165	mg/kg	79	121	20	C	Y	25.0	mg/kg	75	125	30
2651	Zirconium	10	mg/kg	2.972	mg/kg	20060228	C	Y	100	mg/kg	80	120	20	C	Y	50.0	mg/kg	75	125	30

STL Reference Data Summary

Structured Analysis Code: **A-JV-QM-01-06**

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: SPLP-E -> LOW LEVEL, 2% HCL
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6222							Spike List 6223						
Syn	**Compound**	**RL**	**Units**	**MDL**	**Units**	**Run Date**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	20	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.046	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	N	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	6.558	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	100	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **A-KL-QM-01-06**

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: TCLP(1311) -> LOW LEVEL METALS, 2% HCl
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6222							Spike List 6223						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	40	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.046	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	N	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	6.558	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	100	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **A-KN-QM-01-06**
Target Analyte List: All Analytes

Matrix: SOLID
Extraction: SPLP-W(1312) -> LOW LEVEL METALS, 2% HCl
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6222							Spike List 6223						
Syn	**Compound**	**RL**	**Units**	**MDL**	**Units**	**Run Date**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	40	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.046	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	N	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	6.558	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	100	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **I-GJ-QM-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6609							Spike List 6225						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	200	ug/L	94.80	ug/L	20051230	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
128	Antimony	10	ug/L	4.664	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
140	Arsenic	10	ug/L	1.917	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
194	Barium	50	ug/L	1.045	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
222	Beryllium	5	ug/L	0.5106	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
307	Bismuth	200	ug/L	21.88	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
313	Boron	100	ug/L	10.00	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
411	Cadmium	5	ug/L	0.1775	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
413	Calcium	1000	ug/L	18.045	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2952	Chromium	10	ug/L	2.466	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	100	ug/L	75	125	20
637	Cobalt	50	ug/L	5.00	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
643	Copper	25	ug/L	1.845	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
1539	Iron	100	ug/L	18.61	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1605	Lead	10	ug/L	1.923	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1616	Lithium	50	ug/L	10.31	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
1618	Magnesium	1000	ug/L	108.2	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
1659	Manganese	15	ug/L	2.458	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1906	Molybdenum	40	ug/L	8.444	ug/L	20070117	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1956	Nickel	40	ug/L	4.564	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2200	Phosphorus	250	ug/L	50.00	ug/L	20051222	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2214	Potassium	5000	ug/L	1633	ug/L	20070302	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2281	Selenium	15	ug/L	3.712	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2283	Silicon	400	ug/L	40	ug/L	20060103	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2285	Silver	10	ug/L	1.679	ug/L	20070111	C	Y	125	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
2315	Sodium	1000	ug/L	78.53	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2353	Strontium	5	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2876	Sulfur	5000	ug/L	1218	ug/L	20060303	C	Y	20000	ug/L	80	120	20	C	Y	20000	ug/L	75	125	20
2477	Thallium	20	ug/L	5.188	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3935	Thorium	200	ug/L	13.52	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2479	Tin	100	ug/L	3.247	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2482	Titanium	20	ug/L	0.5231	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3827	Uranium	500	ug/L	55.02	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2607	Vanadium	50	ug/L	5.905	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2649	Zinc	20	ug/L	3.279	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2651	Zirconium	100	ug/L	32.54	ug/L	20060228	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: I-JV-QM-01-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: SPLP-E -> LOW LEVEL, 2% HCL
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6222							Spike List 6223						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	20	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.046	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	6.558	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	200	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **I-JX-QM-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, FILTERED 2% HCL, DISSOLVED
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6609							Spike List 6225						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	200	ug/L	94.80	ug/L	20051230	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
128	Antimony	10	ug/L	4.664	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
140	Arsenic	10	ug/L	1.917	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
194	Barium	50	ug/L	1.045	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
222	Beryllium	5	ug/L	0.5106	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
307	Bismuth	200	ug/L	21.88	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
313	Boron	100	ug/L	10.00	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
411	Cadmium	5	ug/L	0.1775	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
413	Calcium	1000	ug/L	18.045	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2952	Chromium	10	ug/L	2.466	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	100	ug/L	75	125	20
637	Cobalt	50	ug/L	5.00	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
643	Copper	25	ug/L	1.845	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	125	ug/L	75	125	20
1539	Iron	100	ug/L	18.61	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1605	Lead	10	ug/L	1.923	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1616	Lithium	50	ug/L	10.31	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	85	115	20
1618	Magnesium	1000	ug/L	108.2	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
1659	Manganese	15	ug/L	2.458	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1906	Molybdenum	40	ug/L	8.444	ug/L	20070117	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1956	Nickel	40	ug/L	4.564	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2200	Phosphorus	250	ug/L	50.00	ug/L	20051222	C	Y	5000	ug/L	80	120	20	C	Y	5000	ug/L	75	125	20
2214	Potassium	5000	ug/L	1633	ug/L	20070302	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2281	Selenium	15	ug/L	3.712	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2283	Silicon	400	ug/L	40	ug/L	20060103	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2285	Silver	10	ug/L	1.679	ug/L	20070111	C	Y	125	ug/L	80	120	20	C	Y	25	ug/L	75	125	20
2315	Sodium	1000	ug/L	78.53	ug/L	20070111	C	Y	10000	ug/L	80	120	20	C	Y	25000	ug/L	75	125	20
2353	Strontium	5	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2876	Sulfur	5000	ug/L	1218	ug/L	20060303	C	Y	20000	ug/L	80	120	20	C	Y	20000	ug/L	75	125	20
2477	Thallium	20	ug/L	5.188	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3935	Thorium	200	ug/L	13.52	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2479	Tin	100	ug/L	3.247	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2482	Titanium	20	ug/L	0.5231	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
3827	Uranium	500	ug/L	55.02	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2607	Vanadium	50	ug/L	5.905	ug/L	20051222	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2649	Zinc	20	ug/L	3.279	ug/L	20070111	C	Y	500	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
2651	Zirconium	100	ug/L	32.54	ug/L	20060228	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: I-KL-QM-01-06
Target Analyte List: All Analytes

Matrix: WATER
Extraction: TCLP(1311) -> LOW LEVEL METALS, 2% HCl
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6222							Spike List 6223						
Syn	**Compound**	**RL**	**Units**	**MDL**	**Units**	**Run Date**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	40	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.046	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	6.558	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	200	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: I-KN-QM-01-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: SPLP-W(1312) -> LOW LEVEL METALS, 2% HCl
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6222							Spike List 6223						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	40	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.046	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	6.558	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	200	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: A-GK-AS-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (200.7)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6224							Spike List 6227						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	20	mg/kg	6.197	mg/kg	20060104	C	N	6320	mg/kg	58	142	20	C	Y	8830	mg/kg	42.8	157	20
128	Antimony	6	mg/kg	2.942	mg/kg	20051222	C	N	60.9	mg/kg	10	150	20	C	Y	68.9	mg/kg	27.3	173	20
140	Arsenic	20	mg/kg	2.000	mg/kg	20051222	C	N	161	mg/kg	80	120	20	C	Y	136	mg/kg	74.3	126	20
194	Barium	5	mg/kg	0.500	mg/kg	20051222	C	N	252	mg/kg	82	118	20	C	Y	124	mg/kg	76.9	123	20
222	Beryllium	0.5	mg/kg	0.07	mg/kg	20051222	C	N	94.4	mg/kg	82	118	20	C	Y	95.3	mg/kg	78.4	122	20
307	Bismuth	20	mg/kg	5.000	mg/kg	20051222														
313	Boron	10	mg/kg	1.5	mg/kg	20051222	C	N	97.4	mg/kg	56	144	20	C	Y	115	mg/kg	68.9	131	20
411	Cadmium	0.5	mg/kg	0.1345	mg/kg	20051222	C	N	128	mg/kg	81	119	20	C	Y	118	mg/kg	76.6	123	20
413	Calcium	250	mg/kg	8.5	mg/kg	20051222	C	N	3320	mg/kg	79	121	20	C	Y	11500	mg/kg	74.7	125	20
2952	Chromium	1	mg/kg	0.3552	mg/kg	20051222	C	N	69.5	mg/kg	78	121	20	C	Y	89.3	mg/kg	79.8	120	20
637	Cobalt	5	mg/kg	0.5	mg/kg	20051222	C	N	35.2	mg/kg	73	127	20	C	Y	110	mg/kg	79.3	120	20
643	Copper	5.0	mg/kg	0.3008	mg/kg	20051222	C	N	148	mg/kg	82	118	20	C	Y	117	mg/kg	81.8	118	20
1539	Iron	10	mg/kg	2.4	mg/kg	20051222	C	N	11200	mg/kg	57	143	20	C	Y	13700	mg/kg	60.9	139	20
1605	Lead	10	mg/kg	1.1	mg/kg	20051222	C	N	142	mg/kg	80	120	20	C	Y	138	mg/kg	76.1	123	20
1616	Lithium	5	mg/kg	1.327	mg/kg	20051222	C	N	200	mg/kg	80	120	20							
1618	Magnesium	100	mg/kg	12.13	mg/kg	20051222	C	N	2040	mg/kg	77	123	20	C	Y	3040	mg/kg	70.1	129	20
1659	Manganese	1.0	mg/kg	0.1	mg/kg	20051222	C	N	408	mg/kg	80	120	20	C	Y	341	mg/kg	79.8	120	20
1906	Molybdenum	4	mg/kg	1.161	mg/kg	20051222	C	N	84.1	mg/kg	79	120	20	C	Y	94.1	mg/kg	76.5	123	20
1956	Nickel	4	mg/kg	0.7542	mg/kg	20051222	C	N	147	mg/kg	82	118	20	C	Y	156	mg/kg	78.2	122	20
2200	Phosphorus	25	mg/kg	5.00	mg/kg	20051222	C	Y	500	mg/kg	85	115	30							
2214	Potassium	500	mg/kg	50.00	mg/kg	20051222	C	N	1920	mg/kg	71	129	20	C	Y	3430	mg/kg	77.8	122	20
2281	Selenium	20	mg/kg	5.034	mg/kg	20051222	C	N	64.2	mg/kg	76	124	20	C	Y	87.6	mg/kg	74.1	126	20
2283	Silicon	40	mg/kg	4.0	mg/kg	20051222	C	N	754	mg/kg	10	150	20	C	Y	200	mg/kg	80	120	20
2285	Silver	1	mg/kg	0.1950	mg/kg	20051222	C	N	130	mg/kg	53	147	20	C	Y	119	mg/kg	74.6	126	20
2315	Sodium	100	mg/kg	10.00	mg/kg	20051222	C	N	445	mg/kg	56	144	20	C	Y	853	mg/kg	67.8	132	20
2353	Strontium	1	mg/kg	0.1	mg/kg	20051222	C	N	84.0	mg/kg	80	120	20	C	Y	83.4	mg/kg	72.5	127	20
2876	Sulfur	500	mg/kg	210.7	mg/kg	20060303														
2477	Thallium	20	mg/kg	3.289	mg/kg	20051222	C	N	84	mg/kg	76	125	20	C	Y	139	mg/kg	57.3	143	20
3935	Thorium	20	mg/kg	2.0	mg/kg	20051222	C	N	100	mg/kg	80	120	20	C	Y	100	mg/kg	80	120	20
2479	Tin	10	mg/kg	2.788	mg/kg	20051229	C	N	61.0	mg/kg	58	142	20	C	Y	96.3	mg/kg	74.9	126	20
2482	Titanium	2	mg/kg	0.2	mg/kg	20060104	C	N	310	mg/kg	40	150	20							
3827	Uranium	50	mg/kg	20.00	mg/kg	20060104	C	N	100	mg/kg	80	120	20	C	Y	200	mg/kg	80	120	20
2607	Vanadium	2	mg/kg	0.6748	mg/kg	20051222	C	N	97.3	mg/kg	75	125	20	C	Y	79.1	mg/kg	68.3	131	20
2649	Zinc	5	mg/kg	1.4	mg/kg	20051222	C	N	165	mg/kg	79	120	20	C	Y	66.0	mg/kg	65	135	20
2651	Zirconium	10	mg/kg	2.973	mg/kg	20060228	C	N	100	mg/kg	80	120	20							

STL Reference Data Summary

Structured Analysis Code: **A-KQ-AS-01-06**
Target Analyte List: All Analytes

Matrix: SOLID
Extraction: METALS, TOTAL RECOVERABLE (200.7)
Method: Inductively Coupled Plasma (200.7)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6224							Spike List 6227						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	20	mg/kg	1.97	mg/kg	19990723	C	N	6320	mg/kg	58	142	20	C	Y	8830	mg/kg	42.8	157	20
128	Antimony	6	mg/kg	4.09	mg/kg	19990723	C	N	60.9	mg/kg	10	150	20	C	Y	68.9	mg/kg	27.3	173	20
140	Arsenic	30	mg/kg	17.11	mg/kg	19990723	C	N	161	mg/kg	80	120	20	C	Y	136	mg/kg	74.3	126	20
194	Barium	20	mg/kg	0.67	mg/kg	19990723	C	N	252	mg/kg	82	118	20	C	Y	124	mg/kg	76.9	123	20
222	Beryllium	0.5	mg/kg	0.05	mg/kg	19990723	C	N	94.4	mg/kg	82	118	20	C	Y	95.3	mg/kg	78.4	122	20
307	Bismuth	20	mg/kg	5.6	mg/kg	19990723														
313	Boron	20	mg/kg	1.69	mg/kg	19990723	C	N	97.4	mg/kg	56	144	20	C	Y	115	mg/kg	68.9	131	20
411	Cadmium	0.5	mg/kg	0.33	mg/kg	19990723	C	N	128	mg/kg	81	119	20	C	Y	118	mg/kg	76.6	123	20
413	Calcium	500	mg/kg	10.28	mg/kg	19990723	C	N	3320	mg/kg	79	121	20	C	Y	11500	mg/kg	74.7	125	20
2952	Chromium	1	mg/kg	0.3	mg/kg	19990723	C	N	69.5	mg/kg	78	121	20	C	Y	89.3	mg/kg	79.8	120	20
637	Cobalt	5	mg/kg	0.28	mg/kg	19990723	C	N	35.2	mg/kg	73	127	20	C	Y	110	mg/kg	79.3	120	20
643	Copper	2.5	mg/kg	0.64	mg/kg	19990723	C	N	148	mg/kg	82	118	20	C	Y	117	mg/kg	81.8	118	20
1539	Iron	10	mg/kg	0.86	mg/kg	19990723	C	N	11200	mg/kg	57	143	20	C	Y	13700	mg/kg	60.9	139	20
1605	Lead	10	mg/kg	4.13	mg/kg	19990723	C	N	142	mg/kg	80	120	20	C	Y	138	mg/kg	76.1	123	20
1616	Lithium	5	mg/kg	0.5	mg/kg	19990723	C	N	200	mg/kg	80	120	20							
1618	Magnesium	500	mg/kg	9.92	mg/kg	19990723	C	N	2040	mg/kg	77	123	20	C	Y	3040	mg/kg	70.1	129	20
1659	Manganese	1.5	mg/kg	0.11	mg/kg	19990723	C	N	408	mg/kg	80	120	20	C	Y	341	mg/kg	79.8	120	20
1906	Molybdenum	4	mg/kg	2.26	mg/kg	19990723	C	N	84.1	mg/kg	79	120	20	C	Y	94.1	mg/kg	76.5	123	20
1956	Nickel	4	mg/kg	1.28	mg/kg	19990723	C	N	147	mg/kg	82	118	20	C	Y	156	mg/kg	78.2	122	20
2214	Potassium	500	mg/kg	170	mg/kg	19990723	C	N	1920	mg/kg	71	129	20	C	Y	3430	mg/kg	77.8	122	20
2281	Selenium	25	mg/kg	10.09	mg/kg	19990723	C	N	64.2	mg/kg	76	124	20	C	Y	87.6	mg/kg	74.1	126	20
2283	Silicon	50	mg/kg	2.4	mg/kg	19990723	C	N	754	mg/kg	10	150	20	C	Y	200	mg/kg	80	120	20
2285	Silver	1	mg/kg	0.55	mg/kg	19990723	C	N	130	mg/kg	53	147	20	C	Y	119	mg/kg	74.6	126	20
2315	Sodium	500	mg/kg	10.17	mg/kg	19990723	C	N	445	mg/kg	56	144	20	C	Y	853	mg/kg	67.8	132	20
2353	Strontium	5	mg/kg	0.31	mg/kg	19990723	C	N	84.0	mg/kg	80	120	20	C	Y	83.4	mg/kg	72.5	127	20
3742	Tellurium	50	mg/kg	9.26	mg/kg	19990723														
2477	Thallium	200	mg/kg	11.58	mg/kg	19990723	C	N	84	mg/kg	76	125	20	C	Y	139	mg/kg	57.3	143	20
3935	Thorium	50	mg/kg	1.71	mg/kg	19990723	C	N	100	mg/kg	80	120	20	C	Y	100	mg/kg	80	120	20
2479	Tin	10	mg/kg	6.88	mg/kg	19990723	C	N	61.0	mg/kg	58	142	20	C	Y	96.3	mg/kg	74.9	126	20
2482	Titanium	5	mg/kg			0	C	N	310	mg/kg	40	150	20							
3827	Uranium	50	mg/kg	10.88	mg/kg	19990723	C	N	100	mg/kg	80	120	20	C	Y	200	mg/kg	80	120	20
2607	Vanadium	2	mg/kg	0.3	mg/kg	19990723	C	N	97.3	mg/kg	75	125	20	C	Y	79.1	mg/kg	68.3	131	20
2649	Zinc	2	mg/kg	0.3	mg/kg	19990723	C	N	165	mg/kg	79	120	20	C	Y	66.0	mg/kg	65	135	20
2651	Zirconium	10	mg/kg			0	C	N	100	mg/kg	80	120	20							

STL Reference Data Summary

Structured Analysis Code: **I-GJ-AS-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (200.7)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List			Detection Limits				Check List 6224							Spike List 6227						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	200	ug/L	54.33	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
128	Antimony	60	ug/L	44.83	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
140	Arsenic	200	ug/L	1.917	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
194	Barium	50	ug/L	5.0	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
222	Beryllium	5	ug/L	0.5718	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
307	Bismuth	200	ug/L	37.79	ug/L	20070117	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
313	Boron	100	ug/L	2.509	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
411	Cadmium	5	ug/L	3.546	ug/L	20070117	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
413	Calcium	1000	ug/L	18.045	ug/L	20070111	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2952	Chromium	10	ug/L	2.466	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	100	ug/L	70	130	20
637	Cobalt	50	ug/L	1.994	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
643	Copper	25	ug/L	1.845	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	125	ug/L	70	130	20
1539	Iron	100	ug/L	18.61	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1605	Lead	100	ug/L	20.19	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1616	Lithium	50	ug/L	10.31	ug/L	20070111	C	N	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
1618	Magnesium	1000	ug/L	128.1	ug/L	20070111	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
1659	Manganese	15	ug/L	0.859	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1906	Molybdenum	40	ug/L	8.444	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1956	Nickel	40	ug/L	4.564	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2200	Phosphorus	250	ug/L	41.65	ug/L	20070111	C	Y	5000	ug/L	85	115	20	C	Y	5000	ug/L	70	130	20
2214	Potassium	5000	ug/L	1633	ug/L	20070302	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2281	Selenium	200	ug/L	93.96	ug/L	20070117	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2283	Silicon	400	ug/L	4.665	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2285	Silver	10	ug/L	1.679	ug/L	20070111	C	Y	125	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
2315	Sodium	1000	ug/L	78.53	ug/L	20070111	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2353	Strontium	5	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
2876	Sulfur	5000	ug/L	1218	ug/L	20060303														
2477	Thallium	200	ug/L	41.62	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3935	Thorium	200	ug/L	13.52	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2479	Tin	100	ug/L	29.16	ug/L	20060111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2482	Titanium	20	ug/L	2.000	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3827	Uranium	500	ug/L	55.02	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2607	Vanadium	50	ug/L	6.062	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2649	Zinc	20	ug/L	9.63	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2651	Zirconium	100	ug/L	32.54	ug/L	20060228	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20

STL Reference Data Summary

Structured Analysis Code: **I-KQ-AS-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, TOTAL RECOVERABLE (200.7)
Method: Inductively Coupled Plasma (200.7)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6224							Spike List 6227						
Syn	**Compound**	**RL**	**Units**	**MDL**	**Units**	**Run Date**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**
88	Aluminum	200	ug/L	94.80	ug/L	20051230	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
128	Antimony	60	ug/L	44.83	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
140	Arsenic	200	ug/L	29.71	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
194	Barium	50	ug/L	5.0	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
222	Beryllium	5	ug/L	0.5106	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
307	Bismuth	200	ug/L	21.88	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
313	Boron	100	ug/L	10.00	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
411	Cadmium	5	ug/L	2.276	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
413	Calcium	2500	ug/L	25.00	ug/L	20051222	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2952	Chromium	10	ug/L	3.092	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	100	ug/L	70	130	20
637	Cobalt	50	ug/L	5.000	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
643	Copper	25	ug/L	2.787	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	125	ug/L	70	130	20
1539	Iron	100	ug/L	25.00	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1605	Lead	100	ug/L	28.17	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1616	Lithium	50	ug/L	8.705	ug/L	20051222	C	N	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
1618	Magnesium	1000	ug/L	108.2	ug/L	20051222	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
1659	Manganese	15	ug/L	2.458	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1906	Molybdenum	40	ug/L	10.00	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1956	Nickel	40	ug/L	7.488	ug/L	20051229	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2200	Phosphorus	250	ug/L	50.00	ug/L	20051222	C	Y	5000	ug/L	85	115	20	C	Y	5000	ug/L	70	130	20
2214	Potassium	5000	ug/L	1500	ug/L	20051222	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2281	Selenium	200	ug/L	41.53	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2283	Silicon	400	ug/L	40	ug/L	20060103	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2285	Silver	10	ug/L	5.209	ug/L	20051222	C	Y	125	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
2315	Sodium	1000	ug/L	110.4	ug/L	20051222	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2353	Strontium	50	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
2477	Thallium	200	ug/L	50.00	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3935	Thorium	200	ug/L	20.00	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2479	Tin	100	ug/L	29.16	ug/L	20060111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2482	Titanium	20	ug/L	2.000	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3827	Uranium	500	ug/L	170.2	ug/L	20060103	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2607	Vanadium	50	ug/L	5.905	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2649	Zinc	20	ug/L	5.569	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2651	Zirconium	100	ug/L	1.382	ug/L	20040209	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20

STL Reference Data Summary

Structured Analysis Code: **I-GJ-JI-01-06**
Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (200.7 Trace)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 6224							Spike List 6227						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	200	ug/L	94.80	ug/L	20051230	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
128	Antimony	10	ug/L	4.664	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
140	Arsenic	10	ug/L	1.917	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
194	Barium	50	ug/L	1.045	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
222	Beryllium	5	ug/L	0.5106	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
307	Bismuth	200	ug/L	21.88	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
313	Boron	100	ug/L	10.00	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
411	Cadmium	5	ug/L	0.1775	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
413	Calcium	1000	ug/L	18.045	ug/L	20070111	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2952	Chromium	10	ug/L	2.466	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	100	ug/L	70	130	20
637	Cobalt	50	ug/L	5.00	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
643	Copper	25	ug/L	1.845	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	125	ug/L	70	130	20
1539	Iron	100	ug/L	18.61	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1605	Lead	10	ug/L	1.923	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1616	Lithium	50	ug/L	10.31	ug/L	20070111	C	N	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
1618	Magnesium	1000	ug/L	108.2	ug/L	20051222	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
1659	Manganese	15	ug/L	2.458	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1906	Molybdenum	40	ug/L	8.444	ug/L	20070117	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1956	Nickel	40	ug/L	4.564	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2200	Phosphorus	250	ug/L	50.00	ug/L	20051222	C	Y	5000	ug/L	85	115	20	C	Y	5000	ug/L	70	130	20
2214	Potassium	5000	ug/L	1633	ug/L	20070302	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2281	Selenium	15	ug/L	3.712	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2283	Silicon	400	ug/L	40	ug/L	20060103	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2285	Silver	10	ug/L	1.679	ug/L	20070111	C	Y	125	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
2315	Sodium	1000	ug/L	78.53	ug/L	20070111	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2353	Strontium	5	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
2876	Sulfur	5000	ug/L	1218	ug/L	20060303														
2477	Thallium	20	ug/L	5.188	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3935	Thorium	200	ug/L	13.52	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2479	Tin	100	ug/L	3.247	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2482	Titanium	20	ug/L	0.5231	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3827	Uranium	500	ug/L	55.02	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2607	Vanadium	50	ug/L	5.905	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2649	Zinc	20	ug/L	3.279	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2651	Zirconium	100	ug/L	32.54	ug/L	20060228	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20

STL Reference Data Summary

Structured Analysis Code: **I-GJ-JI-01-06**

Target Analyte List: All Analytes

Matrix: WATER
Extraction: METALS, TOTAL - 2% HCL
Method: Inductively Coupled Plasma (200.7 Trace)
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List			Detection Limits				Check List 6224							Spike List 6227						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	200	ug/L	94.80	ug/L	20051230	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
128	Antimony	10	ug/L	4.664	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
140	Arsenic	10	ug/L	1.917	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
194	Barium	50	ug/L	1.045	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
222	Beryllium	5	ug/L	0.5106	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
307	Bismuth	200	ug/L	21.88	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
313	Boron	100	ug/L	10.00	ug/L	20051222	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
411	Cadmium	5	ug/L	0.1775	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
413	Calcium	1000	ug/L	18.045	ug/L	20070111	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2952	Chromium	10	ug/L	2.466	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	100	ug/L	70	130	20
637	Cobalt	50	ug/L	5.00	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
643	Copper	25	ug/L	1.845	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	125	ug/L	70	130	20
1539	Iron	100	ug/L	18.61	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1605	Lead	10	ug/L	1.923	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1616	Lithium	50	ug/L	10.31	ug/L	20070111	C	N	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
1618	Magnesium	1000	ug/L	108.2	ug/L	20051222	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
1659	Manganese	15	ug/L	2.458	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
1906	Molybdenum	40	ug/L	8.444	ug/L	20070117	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
1956	Nickel	40	ug/L	4.564	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2200	Phosphorus	250	ug/L	50.00	ug/L	20051222	C	Y	5000	ug/L	85	115	20	C	Y	5000	ug/L	70	130	20
2214	Potassium	5000	ug/L	1633	ug/L	20070302	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2281	Selenium	15	ug/L	3.712	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2283	Silicon	400	ug/L	40	ug/L	20060103	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2285	Silver	10	ug/L	1.679	ug/L	20070111	C	Y	125	ug/L	85	115	20	C	Y	25	ug/L	70	130	20
2315	Sodium	1000	ug/L	78.53	ug/L	20070111	C	Y	10000	ug/L	85	115	20	C	Y	25000	ug/L	70	130	20
2353	Strontium	5	ug/L	0.5611	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	500	ug/L	70	130	20
2876	Sulfur	5000	ug/L	1218	ug/L	20060303														
2477	Thallium	20	ug/L	5.188	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3935	Thorium	200	ug/L	13.52	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2479	Tin	100	ug/L	3.247	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2482	Titanium	20	ug/L	0.5231	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
3827	Uranium	500	ug/L	55.02	ug/L	20070111	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20
2607	Vanadium	50	ug/L	5.905	ug/L	20051222	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2649	Zinc	20	ug/L	3.279	ug/L	20070111	C	Y	500	ug/L	85	115	20	C	Y	250	ug/L	70	130	20
2651	Zirconium	100	ug/L	32.54	ug/L	20060228	C	Y	1000	ug/L	85	115	20	C	Y	1000	ug/L	70	130	20

STL Reference Data Summary

Structured Analysis Code: **I-88-EA-01-06**

Target Analyte List: All Analytes

Matrix: WATER
Extraction: NO SAMPLE PREPARATION PERFORMED / DIRECT INJ
Method: Chromium, Hexavalent (7196A)
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List			Detection Limits				Check List 6046							Spike List 6047						
Syn	**Compound**	**RL**	**Units**	**MDL**	**Units**	**Run Date**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**	**T**	**A**	**Amt**	**Units**	**LCL**	**UCL**	**RPD**
630	CR, Hexavalent	10	ug/L	2.985	ug/L	20070320	C	Y			85	115	20	C	Y			85	115	20

STL Reference Data Summary

Structured Analysis Code: I-KL-QM-01-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: TCLP(1311) -> LOW LEVEL METALS, 2% HCl
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List			Detection Limits				Check List 6222							Spike List 6223						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	40	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.914	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	10.54	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	200	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

STL Reference Data Summary

Structured Analysis Code: **I-KN-QM-01-06**

Target Analyte List: All Analytes

Matrix: WATER
Extraction: SPLP-W(1312) -> LOW LEVEL METALS, 2% HCl
Method: Inductively Coupled Plasma (6010B Trace)
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		Detection Limits					Check List 6222							Spike List 6223						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
88	Aluminum	400	ug/L	189.6	ug/L	20051230	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
128	Antimony	20	ug/L	9.328	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
140	Arsenic	20	ug/L	3.834	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
194	Barium	100	ug/L	2.09	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
222	Beryllium	10	ug/L	1.021	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
307	Bismuth	400	ug/L	43.76	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
313	Boron	200	ug/L	20.00	ug/L	20051222	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
411	Cadmium	10	ug/L	0.355	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
413	Calcium	5000	ug/L	36.09	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2952	Chromium	20	ug/L	4.932	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	200	ug/L	75	125	20
637	Cobalt	100	ug/L	10	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
643	Copper	50	ug/L	3.69	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	250	ug/L	75	125	20
1539	Iron	200	ug/L	37.22	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1605	Lead	40	ug/L	3.846	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1616	Lithium	100	ug/L	20.62	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
1618	Magnesium	2000	ug/L	216.4	ug/L	20051222	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
1659	Manganese	30	ug/L	4.916	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
1906	Molybdenum	80	ug/L	16.89	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
1956	Nickel	80	ug/L	9.128	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2200	Phosphorus	500	ug/L	100	ug/L	20051222	C	Y	10000	ug/L	80	120	20	C	Y	10000	ug/L	75	125	20
2214	Potassium	10000	ug/L	3266	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2281	Selenium	30	ug/L	7.424	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2283	Silicon	800	ug/L	80	ug/L	20060103	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2285	Silver	20	ug/L	3.358	ug/L	20070111	C	Y	250	ug/L	80	120	20	C	Y	50	ug/L	75	125	20
2315	Sodium	2000	ug/L	157.1	ug/L	20070111	C	Y	20000	ug/L	80	120	20	C	Y	50000	ug/L	75	125	20
2353	Strontium	100	ug/L	1.12	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	1000	ug/L	75	125	20
2477	Thallium	40	ug/L	10.376	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3935	Thorium	200	ug/L	27.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2479	Tin	200	ug/L	6.494	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2482	Titanium	40	ug/L	1.914	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
3827	Uranium	1000	ug/L	110.04	ug/L	20070111	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20
2607	Vanadium	100	ug/L	11.81	ug/L	20051222	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2649	Zinc	40	ug/L	10.54	ug/L	20070111	C	Y	1000	ug/L	80	120	20	C	Y	500	ug/L	75	125	20
2651	Zirconium	200	ug/L	65.09	ug/L	20060228	C	Y	2000	ug/L	80	120	20	C	Y	2000	ug/L	75	125	20

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Title: PERCENTS SOLIDS DETERMINATION

Approvals (Signature/Date):

Chris Hough 12/3/07
Chris Hough Date
Wet Chemistry Supervisor

12/3/07
Michael Ridenhower Date
Health & Safety Manager / Coordinator

12-3-07
Marti Ward Date
Quality Assurance Manager

Elaine Wild 12/3/07
Elaine Wild Date
Laboratory Director

This SOP was previously identified as SOP No. STL-WC-0005 Rev. 5

Any reference within this document to Severn Trent Laboratories, Inc. or STL, should be understood to refer to TestAmerica Laboratories, Inc. (formerly known as Severn Trent Laboratories, Inc.)

Facility Distribution No.: 0 **Distributed To:** **See Electronic Distribution Sheet**

SOP No.: **STL-WC-0005**
Revision No.: 6
Revision Date: 06/11/07
Page: 1 of 9
Implementation Date: 06/15/07

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STL ST. LOUIS STANDARD OPERATING PROCEDURE

TITLE: PERCENT SOLIDS DETERMINATION

(SUPERSEDES: STL-WC-0005 REV. 5)

Approved by: Chris Hough
Supervisor/Lead Analyst

Approved by: Elaine Wild
Quality Assurance Manager

Approved by:
Environmental Health and Safety Coordinator

Approved by: Martha Jo Cahill
Laboratory Director

1.0 SCOPE AND APPLICATION

1.1 The purpose of this standard operating procedure is to define the method used at STL St. Louis for determination of percent solids of an environmental sample.

1.2 This SOP is based on the Percent Solids Determination Procedure for EPA CLP SOW ILM05.3.

1.3 This procedure is applicable to solid samples (soil, sand, clay, etc.) which are received for analysis. The determination is performed when client requested and for the purpose of correcting concentrations of compounds found in organic and inorganic analyses to reflect the amount present in dry weight of samples.

1.4 This SOP is not intended to be used for solid determination methodologies (TSS, TDS, TVS, TS). These method procedures are found in SOP, STL-WC-0036.

1.5 Due to the potential of explosion, this procedure is not to be performed on samples submitted for nitroaromatic analysis when there is the possibility that the samples contain a high level of explosives. If samples are identified as having the potential of containing a high level of explosives, sample drying must follow the procedure described in SOP STL-LC-0002.

1.6 The laboratory target analytes supported by this method, the reporting limits, method detection limits and QC limits are maintained in the Information Management System (QuantIMS). A copy of the Structure and Analysis Code (SAC), which lists this information, is included in the appendix of this SOP.

2.0 SUMMARY OF METHOD

2.1 A weighed amount of a solid sample is dried overnight in an oven at 105 °C to drive off water. The cooled sample is reweighed to determine the percent moisture or percent solid of the sample as received.

3.0 DEFINITIONS

3.1 See the STL Quality Management Plan (QMP) and STL St. Louis Laboratory Quality Manual (LQM) for a glossary of common laboratory terms and data reporting qualifiers.

4.0 INTERFERENCES

4.1 None

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

5.2.1 Due to the potential of **explosion**, this procedure is not to be performed on samples submitted for nitroaromatic analysis when there is the possibility that the samples contain a high level of explosives. If samples are identified as having the potential of containing a high level of explosives, the procedure for sample drying must follow the procedure described in SOP STL-LC-0002.

5.3 PRIMARY MATERIALS USED

5.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

5.3.2 There are no hazardous reagents used in this procedure.

6.0 EQUIPMENT AND SUPPLIES

6.1 Analytical balance capable of weighing accurately to the nearest 0.0001 g.

6.2 Aluminum pans capable of holding approximately 10 g of solid samples for drying.

6.3 Desiccator

6.4 Oven, capable of maintaining a temperature from 103° to 105°C.

7.0 REAGENTS AND STANDARDS

7.1 None

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 STL St. Louis supplies sample containers and chemical preservatives in accordance with the method. STL St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in STL-PM-0002.

8.2 No specific holding time is required for this procedure.

9.0 QUALITY CONTROL

9.1 Batch

9.1.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents. Where no preparation method exists (e.g. water sample volatile organics, water sample anion analysis) the batch is comprised of a maximum of 20 environmental samples which are analyzed together with the same process, lots of reagents and personnel.

9.1.2 Instrument conditions must be the same for all standards, samples and QC samples.

9.1.3 For this analysis, batch QC consists of a Sample Duplicate (SD).

9.1.4 Samples having different QC codes, due to non-standard client specific QC requirements, must be batched separately in the LIMS.

9.2 Sample Duplicate

9.2.1 A Sample Duplicate is an additional aliquot of a field sample taken through the entire analytical process to demonstrate precision.

9.2.2 If there is insufficient sample to perform a Sample Duplicate an NCM is written to document the insufficient volume.

9.3 Procedural Variations/ Nonconformance and Corrective Action

9.3.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. See SOP STL-QA-0036 for details regarding the NCM process.

9.3.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA Manager. See SOP STL-QA-0036 for details regarding the NCM process.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Balance calibration must be checked daily when used. Refer to SOP STL-QA-0005, "Calibration and Verification Procedure for Thermometers, Balances, Weights and Pipettes."

11.0 PROCEDURE

11.1 Weigh a clean labeled aluminum pan on a calibrated analytical balance. Record the weight to 0.01 g. as the "pan weight" on the appropriate spreadsheet. Record the number of the balance used on the data spreadsheet.

11.2 Add approximately 10 g. of solid sample to the pan, and record the weight to 0.01 g. as the "Wet Soil + Pan" on the spreadsheet.

11.2.1 Samples with a standing water layer should be homogenized as much as possible before removing the aliquot for % solid determination.

11.3 Place the pan containing the sample in an oven heated to 103 - 105°C for at least 12 hours, or overnight, (but no more than 24 hours). Monitor the temperature at beginning and end of drying time, to assure that the sample was dried at the correct temperature for the required length of time.

11.4 Remove sample from oven and place in a desiccator for cooling to room temperature.

11.5 Reweigh cooled sample and pan after zeroing balance and record as "dry soil plus pan" weight to the nearest 0.01g.

11.5.1 If a drying time of less than 12 hours is required by contractual data delivery restraints, constant weight must be demonstrated in the following manner:

11.5.1.1 Perform steps 11.3 through 11.5 with a drying time no less than one hour.

11.5.1.2 Repeat the drying cycle at least once.

11.5.1.3 Constant weight is achieved when there is a loss in weight of no greater than 0.01 g between the start and final weights of the last cycle.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Commonly used calculations (e.g. % recovery and RPD) and standard instrument software calculations are given in the STL St. Louis LQM.

12.2 Enter the sample weights into the Percent Total Solid/Percent Moisture Logsheet for upload into QuantIMS.

12.3 Calculation of percent solid of the sample is as follows:

$$\% \text{ solid} = \frac{\text{dry soil plus pan - pan}}{\text{wet soil plus pan - pan}} \times 100$$

12.4 Percent moisture is calculated as follows:

$$\% \text{ Moisture} = 100 - \% \text{ Solid}$$

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 The data assessment and corrective action process is detailed through the Clouseau Nonconformance Memorandum (NCM) process. The NCM process is described in SOP: STL-QA-0036. A hardcopy of all the data assessment types and descriptions along with their associated corrective actions is included in the SOP. Below is a subset of the data assessment and QC excursion types within Clouseau; the text in underline is the exact "type" line in Clouseau. For a complete and current listing, please access the software program.

13.2 Sample Duplicates

13.2.1 Sample duplicate criteria is 30% RPD.

13.2.1.1 <u>% D excursion for sample/sample duplicate</u> – See Clouseau NCM for corrective action.

13.3 Insufficient Sample

13.3.1 For each prescribed re-preparation corrective action, if there is insufficient sample to repeat the analysis, a narrative comment stating such is included in the report case narrative. The insufficient sample description is included in the Clouseau NCM within the type defining the excursion.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1 Method performance data, reporting limits, and qc acceptance limits, are given in the appendix of this SOP.

14.2 Demonstration of Capability

14.2.1 Initial and continuing demonstrations of capability requirements are established in LQM section 4.1.3.

14.3 Training Qualification

14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in LQM section 4.1.3.

15.0 VALIDATION

15.1 Laboratory SOPs are based on standard reference EPA Methods that have been validated by the EPA and the lab is not required to perform validation for these methods. The requirements for lab demonstration of capability are included in LQM. Lab validation data would be appropriate for performance based measurement systems or non-standard methods. STL ST Louis will include this information in the SOP when accreditation is sought for a performance based measurement system or non-standard method

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

16.2 Waste Streams Produced by the Method

16.2.1 The following waste streams are produced when this method is carried out.

16.2.1.1 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the labware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM meter, the labware will be collected in waste barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

17.1 EPA CLP Program SOW ILM05.3, Exhibit D, Section 1.6

17.2 STL Quality Management Plan (QMP), current revision

17.3 STL St. Louis Laboratory Quality Manual (LQM), current revision

17.4 STL Corporate Safety Manual and St. Louis Facility Addendum (SOP STL-HS-0002), current revision

17.5 Associated SOPs, current revisions:

17.5.1 STL-QA-0002, Standard and Reagent Preparation
17.5.2 STL-QA-0005, Calibration and Verification Procedure for Thermometers, Balances, Weights and Pipettes.
17.5.3 STL-PM-0002, Sample Receipt and Chain of Custody
17.5.4 STL-QA-0036, Non-conformance Memorandum (NCM) Process.
17.5.5 STL-IP-0004, Labware Preparation for Inorganic and Trace Metal Analysis.
17.5.6 STL-WC-0036, Determination of Solids in Water and Wastes
17.5.7 STL-LC-0002, Analysis of Nitroaromatic and Nitroamine Explosives by HPLC.

18.0 MODIFICATIONS TO CITED METHOD

18.1 The method calls for the weighing dishes to be processed with "the cover tipped to allow for moisture escape". The laboratory does not cover the aluminum weighing dishes.

19.0 CHANGES TO PREVIOUS REVISION

19.1 Update SOP reference in 17.

19.2 Added Method reference to Section 1.

19.3 Updated temperature criteria in Sections 6 and 11.

19.4 Replaced text in Sections 9 and 14.

19.5 Updated Section 11 to include temperature criteria, weight criteria, constant weight criteria.

19.6 Formatting and general grammatical edits.

19.7 Added a copy of the spreadsheet to the appendix of the SOP.

19.8 Added Section 18 for modifications.

19.9 Moved "Changes to Previous Revision" to Section 19.

STL St. Louis Laboratory
Percent Total Solid/Percent Moisture Logsheet

Analysis: %Moisture Time In: ____________ Temp:________ Batch: ____________________

Prep Date: __________ Time Out:* ____________ Temp:________ Analyst: ____________________

Anal Date: __________ * if less than 12 hours, complete page 2 of this spreadsheet Reviewed By: ____________________

Balance 1 SN: __________

SOP	Rev.	Date
STL-WC-0005	5	2/14/2006

Pan Number	Sample Id	Pan wt	Wet Sam + Pan g	Dry Sam + Pan wt	Results % Solids	Results % Moisture	Comments
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
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16							
17							
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26							
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29							
30							
31							
32							
33							
34							
35							
36							

STL St. Louis Laboratory
Constant Weight Determination Form

to be used when drying time is less than 12 hours.
drying cylcles must be at least one hour

ite: ________

ne in: ________ Temp in: ________
ne out: ________ Temp out: ________ Analyst ____________

ne in: ________ Temp in: ________ Batch ____________
ne out: ________ Temp out: ________

ne in: ________ Temp in: ________
ne out: ________ Temp out: ________

Pan lumber	Sample Id	pan weight g	wet + pan g	dry + pan g	2nd cycle final Dry+Sam+Pan g	3rd Cycle final Dry+Sam+Pan wt	Constant Weight Achieved (for 2nd cycle)	Constant Weight Achieved (for 3rd cycle)	Results % Solids	Results % Moisture
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										

File: Slsvr01\Public\INORGANICS\Wet Chemistry\spreadsheets\Percent Solids.xls, modified 06/14/07

STL Reference Data Summary

Structured Analysis Code: **A-88-WM-01-06**
Target Analyte List: All Analytes

Matrix: SOLID
Extraction: NO SAMPLE PREPARATION PERFORMED / DIRECT INJ
Method: Moisture, Percent (160.3)
QC Program: STANDARD TEST SET
Location: STL St. Louis

Analyte List		Detection Limits					Check List 0							Spike List 6014						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
3203	Percent Moisture	0.1	%			0								C	Y			0	0	30