Appendix E

Quality Assurance and Quality Control

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Appendix E – Quality Assurance and Quality Control

H. L. Anastos

This appendix presents quality assurance/quality control (QA/QC) information for groundwater monitoring at the Hanford Site. Information in this chapter covers the period from October 1, 2008, through December 31, 2009. As a result of changing from a fiscal year (FY) to a calendar year (CY) reporting period, the following date conventions are used throughout this report.

- FY 2009: Refers to the fiscal year named (i.e., October 1, 2008, to September 30, 2009).
- CY 2009: Refers to the calendar year named (i.e., January 1, 2009, to December 31, 2009).
- Reporting period: Refers to the entire 15-month reporting period covered for this report (i.e., October 1, 2008, to December 31 2009).

Due to the change in reporting period this report covers a 15-month period. Comparisons to FY 2008 are made throughout this report and it should be noted that the data set for this reporting period is larger than that used in FY 2008. However, these comparisons are provided because they provide a useful indication of relative quality trends.

Groundwater monitoring activities were managed by the Soil and Groundwater Remediation Project (Groundwater Project) during the reporting period. This includes monitoring performed to meet the requirements of the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954* (AEA); and *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The QA/QC practices used by the Groundwater Project assess and enhance the reliability and validity of field and laboratory measurements conducted to support these programs. Accuracy, precision, and detection are the primary parameters used to assess data quality ("Determination of Measurement Data Quality and Establishment of Achievable Goals for Environmental Measurements" [Mitchell et al. 1985]). Representativeness, completeness, and comparability can also be evaluated for overall quality; however, representativeness and comparability are considered qualitative and do not have specific evaluation criteria in this report. These six parameters are evaluated through laboratory QC checks (e.g., matrix spikes and laboratory blanks), replicate sampling and analysis, analysis of blind standards and field blanks, and interlaboratory comparisons. Acceptance criteria have been established for each of these QC checks. When QC is outside the criteria, groundwater analytical support staff review the data and ensure that appropriate data qualifying flags are entered in the Hanford Environmental Information System (HEIS) database. When a recurring problem is identified, corrective actions are taken.

This appendix is intended to evaluate the overall QA/QC program for the Groundwater Project. Through the comprehensive review provided in this appendix, the Groundwater Project identifies and resolves issues with data quality and initiates process improvements. The annual QA/QC appendix can be a tool for data users in determining usability of specific data sets for decision-making purposes.

The QA/QC practices for RCRA samples are based on guidance from the U.S. Environmental Protection Agency (EPA) (EPA 2008; SW-846). The U.S. Department of Energy (DOE) orders and internal requirements provide the guidance for the collection and analysis of samples for other long-term monitoring. The QA/QC practices for the Groundwater Project are described in the CH2M HILL Plateau Remediation Company (CHPRC) QA plan (CHPRC-00189, *CH2M HILL Plateau Remediation Company Quality Assurance Program Plan*). A glossary of QA/QC terms is provided in Section E.9. Additional information about the QA/QC program and data from this reporting period (e.g., results of individual QC samples and/or associated groundwater samples) are available upon request. The FY 2008 data referenced in this report can be found in *Hanford Site Groundwater Monitoring for Fiscal Year 2008* (DOE/RL-2008-66).

E.1. Sample Collection and Analysis

H. L. Anastos

The Groundwater Project staff collected groundwater samples during the reporting period. Tasks related to sampling included bottle preparation, sample set coordination, measurement of field parameters, sample collection, sample shipping, well pumping, and coordination of purge water containment and disposal.

The Waste Sampling and Characterization Facility (WSCF) is an onsite laboratory managed by Mission Support Alliance. The WSCF was the primary analytical laboratory supporting the Groundwater Project during the reporting period. Excluding field measurements, WSCF performed 84% of the analytical services for groundwater monitoring during the reporting period; the percentage performed by WSCF is 75% when field measurements are included.

WSCF and Test America St. Louis (St. Louis, Missouri) (TA St. Louis) performed most of the routine analyses of Hanford Site groundwater samples for hazardous and non-hazardous chemicals. Lionville Laboratory, Inc. (Lionville, Pennsylvania) (Lionville Laboratory), performed less than 1% of the chemical analyses. Test America Knoxville (Knoxville, Tennessee) (TA Knoxville) performed polychlorinated biphenyl (PCB) congener and dioxin analysis. WSCF and Test America Richland (Richland, Washington) (TA Richland) performed the majority of radiological analyses on Hanford Site groundwater samples. Eberline Services (Richmond, California) (Eberline) analyzed less than 1% of the samples for radiological constituents. In addition, the Environmental Sciences Laboratory (ESL) at Pacific Northwest National Laboratory analyzed a select number of samples for iodine-129 as split samples. Section E.6.4 provides additional information.

Standard methods from EPA, the American Society for Testing and Materials (ASTM), and the *Standard Methods for the Examination of Water and Wastewater* (APHA et al. 1998) were used for the analysis of chemical constituents. Methods employed for radiological constituents were developed by the analyzing laboratories and are recognized as acceptable within the radiochemical industry. Descriptions of the analytical methods used are available upon request.

E.2. Data Review and Validation

H. Hampt

Groundwater staff review and validate groundwater data according to an established process. Validation produces an electronic data set, with suspect or erroneous data corrected or flagged. The validation process includes the following activities:

- Review of sampling documents and analytical data verification
- QC evaluation
- Project scientists' evaluations
- Resolution of data issues identified during the evaluation.

E.2.1 Review of Sampling Documents and Data Verification

Sampling documents include the groundwater sampling record, chain-of-custody forms, field logbook pages, and other paperwork associated with sampling and shipping. Groundwater staff review these forms to determine if the documents are filled out completely, signed appropriately, and legible, as well as to determine if problems arose during sampling that may impact the data. Staff also verify that analytical data from the laboratories are complete and reported correctly. Moreover, staff review laboratory documents to check the condition of the samples upon receipt at the laboratory and determine if problems arose during analysis that may have affected the data. Identified issues are documented, investigated, and resolved (Section E.2.4 and E.6.3.1).

E.2.2 Quality Control Evaluation

A quarterly evaluation of field and laboratory QC data is conducted as part of the validation process. Groundwater analytical support staff assess the laboratories' internal QC practices and submit field QC samples and blind standards to the laboratories on a regular basis.

E.2.3 Project Scientists' Evaluation

Data management staff generate routine data reports for project scientists' review. These reports include biweekly data reports and include analytical data loaded into the HEIS database since the previous reporting period. The tables are organized by groundwater interest area, RCRA site, or special project (e.g., confined aquifer data). As soon as practical after receiving a report, the project scientists review the data, typically by viewing trend plots, to determine the following:

- Any significant changes in contaminant concentrations or distribution
- If there are data points that appear erroneous (e.g., significantly out of trend).

Project scientists also review quarterly compilations of the data. The quarterly review provides a method for groundwater staff to check whether there were problems with sampling, all requested analyses were received, and that the data seem to represent actual groundwater quality. Unlike biweekly reports, the quarterly reports usually include a full data set (i.e., all data from the wells sampled during the previous quarter that have been received and loaded into the HEIS database). This review also includes water-level data, preliminary maps of selected constituent distribution (plume maps), and a partial listing of sampling comments. When specific questions arise regarding field measurements, analytical results, dates of analysis or sampling, or sample or well numbers, the project scientist requests a formal data review. Section E.2.4 describes the process for data reviews.

E.2.4 Resolution of Data Issues

Requests for data reviews are the formal mechanism used by the Groundwater Project to resolve specific issues with data. When potential anomalies are encountered during a review of analytical data or water-level measurements, the Groundwater Project Support staff or the project scientist reviewing the data will initiate a request for data review. Depending on the type of data issue identified, groundwater analytical support staff resolve the request for data review through some or all of the following actions:

- Request a laboratory recheck, recount, or re-analysis
- Review laboratory hardcopy data
- Review sampling documents for data entry errors or other problems.
- Flag the affected data with one of the flags described in Table E-1.

A review of the sampling documents and/or hardcopy data from the laboratory can sometimes provide an explanation for unusual results (e.g., data entry errors or samples swapped in the field). Laboratory rechecks involve an internal laboratory review of the data. When discrepancies are discovered by the laboratory, the data are re-reported. The original data are removed from the HEIS database, the corrected data are loaded into HEIS, and the data are flagged appropriately. However, when a laboratory re-analysis or recount is requested, the laboratory re-analyzes or recounts the original sample and reports the new results. If a discrepancy occurs between the original and new results, groundwater staff determine which results appear to be more representative and assign an appropriate review code to the results loaded into the HEIS database.

Requests for data reviews are most commonly resolved by assigning "Y," "G," or "R" flags to the HEIS data. If a review determines that the result is valid, the result is flagged with a "G." If clear, documented evidence exists that a result is erroneous, the result is flagged with an "R." If a review was unable to determine the validity of the result, the result is considered suspect and flagged as "Y." Data flagged with a "Y" or "R" are typically excluded from statistical evaluations, maps, and other interpretations, but the data are not deleted from the HEIS database. Occasionally, a request for data review is submitted on data that are not managed by the Groundwater Project. In those cases, the data owner is notified, but no further action is taken by the Groundwater Project.

Table E-2 lists the number of analytical and water-level results that were flagged during the reporting period as a result of the request for data review process. As of March 24, 2010, requests for data reviews have been filed on 1,659 of ~206,000 analytical results (less than 1%). Requests for data reviews of water-level measurements have been filed on 73 of 4,314 measurements (1.7%). The resolution of 258 analytical requests for review and 13 water-level measurements is pending, and additional requests may yet be filed on data from the reporting period. During the reporting period, WSCF performed ~75% of the analytical (laboratory and field) measurements for groundwater monitoring and WSCF data received 82% of the requests for data review. The bulk of the requests for data review (72%) were filed on metals results. Requests for data review also were filed on WSCF results from wet chemistry methods (10%), organic methods (6%), and radiological methods (12%). Requests for data review to the field and other laboratories were scattered among a varied group of methods and issues. Approximately 17% of the requests for data review from the other laboratories were for iodine-129 analysis. These requests were filed as part of an evaluation of method improvements at the TA and Eberline laboratories. Section E.6.4 provides additional information about this evaluation. No other trends in data review requests from the field or other laboratories were identified.

E.3. Data Completeness

H. L. Anastos

Data judged to be complete are data that are not suspect, rejected, associated with a missed holding time, out-of-limit field duplicate, or qualified to indicate laboratory blank contamination. Table E-3 provides a summary of data completeness. During the reporting period, 97% of the groundwater data were considered complete. The percentages of potentially invalid data were 1.8% for field QC problems, 0.2% for exceeding holding times, 0.3% for suspect values, and 0.5% for laboratory blank contamination. These values are similar to the percentages observed in FY 2008 for field QC problems, rejected and suspect data; however, improvement is noted in the areas of missed holding times and laboratory blank contamination. In particular, method blank contamination affected 0.5% of the data during this reporting period, which is significantly less than the 3% reported for FY 2008.

E.4. Field Quality Control Samples

H. L. Anastos

Field QC samples include field duplicates, split samples, and three types of field blanks: full trip, field transfer, and equipment blanks. Section E.9 provides definitions for these QC samples. Field QC samples are used to assess precision, repeatability, and potential contamination related to both sampling and laboratory activities. Tables E-4 through E-8 summarize the field QC results that exceeded QC limits. Constituents not listed in the tables had 100% acceptable field QC. The tables are divided into the following categories, where applicable: general chemistry parameters, ammonia and anions, metals, volatile organic compounds, semivolatile organic compounds, and radiological parameters. Table E-9 provides additional information on the method categories.

E.4.1 Field Blanks

Field blanks are used to assess potential contamination associated with sampling and laboratory activities. Field blank results above two times the method detection limit are identified as suspected contamination; however, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit. For radiological data, blank results are identified as potentially contaminated if they are greater than two times the total minimum detectable activity.

Results associated with field blanks that are above these criteria are flagged with a “Q” in the HEIS database to indicate potential contamination issues. For full trip and field transfer blanks, an associated sample is one that was collected on the same day and analyzed by the same method as a full trip or field transfer blank. For equipment blanks, an associated sample is one that has the same collection date, collection method/sampling equipment, and analysis method as the equipment blank.

The percentage of acceptable field blank results (18,636 of 19,175, or 97%) evaluated during the reporting period was high, indicating little problem with contamination and good precision overall. Semivolatile organic compounds had 100% acceptable field blanks and therefore are not listed in Tables E-4 through E-6. All of the constituents in the tables had results that were flagged as "Q" in the HEIS database as potentially contaminated due to out-of-limit field blank results. Data users must evaluate the usability of data associated with quality issues based on the data quality objective requirements established for the specific monitoring campaign.

Compared to FY 2008, out-of-limit blank results decreased from 4% to 3%. Similar to FY 2008, the highest numbers of out-of-limit results were associated with metals analysis; however, the number decreased from 2.7% to 1.8% during the reporting period. While field blank concentrations of calcium, potassium, magnesium, and sodium were frequently above QC limits, the levels detected in QC were 10 to 100 times lower than the average concentration of these constituents in Hanford Site groundwater. One metals field blank sample (B23066) had four of the highest out-of-limit results; this is currently under investigation. For several other metals (aluminum, arsenic, barium, cobalt, copper, iron, manganese, nickel, silver, strontium, uranium, vanadium, and zinc), the levels detected in the blank are similar or higher than those typically found in groundwater, which could result in false-positive detections. Several of these metals (copper, calcium, iron, nickel, silver, and sodium) were also identified in laboratory method blanks at similar levels (Table E-10).

A total of 173 field blank results for volatile organic compounds (1%) exceeded the QC limits, which is less than the percentages in FY 2008 (1.7%) and FY 2007 (2.1%). The overall percentages are decreasing; however, methylene chloride continues to be the predominant volatile organic contaminant, accounting for 65% of the volatile organic compound out-of-limit results. Similar concentrations of methylene chloride were measured in method blanks, therefore laboratory contamination is suspected. In addition, 79 field blanks had concentrations of methylene chloride greater than the drinking water standard (DWS) of 5 µg/L. This limits the usability of data with low-level detections for methylene chloride in groundwater monitoring samples. Affected results were flagged as "Q" (quality failures) and/or "Y" (data are suspect) in the HEIS database. Groundwater analytical support staff continue to work with the laboratories to decrease both the frequency and magnitude of methylene chloride contamination.

Twelve percent (41 of 342) field blank results for carbon tetrachloride exceeded the QC limits. This is higher than in FY 2008 (8%; 19 of 235). Ten of the 41 results were greater than the DWS of 5 µg/L. Trace levels of several other volatile organic compounds were also measured in field blanks (Tables E-2 through E-6). The frequencies of detection for these compounds were low (less than 1%) and the impact on the data is minor.

One result for chloride and one result for tritium are still under investigation. A small number of other chemical and radiological constituents were detected at levels that exceeded blank QC limits (Tables E-4 through E-6). However, the frequency and magnitude of detections for these compounds were low (less than 1%) and no trends were identified.

E.4.2 Field Duplicates

Field duplicates are used to assess field sampling and measurement precision. Results of field duplicates must have precision within ±20%, as measured by the relative percent difference. Only field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated. Results associated with field duplicates that have greater than ±20% relative percent difference are flagged as "Q" in the HEIS database to indicate potential precision issues.

The percentage of acceptable duplicate results (11,309 of 11,424, or 99%) evaluated during the reporting period was high, indicating little problem with contamination and good precision overall. Note that the number and percentage of duplicate results were incorrectly reported in FY 2008; the correct data are 6,486 of 6,589 = 98%; thus, the relative number of unacceptable duplicates decreased compared to FY 2008. Duplicate results were flagged for all constituent classes (Table E-7). The majority of out-of-limit duplicates (46%) were associated with metal results from WSCF. The number of out-of-limit metal duplicates decreased from 62 failures in FY 2008 to 53 for this reporting period. Thirty-five of the duplicates that exceeded QC limits were from unfiltered samples. Suspended solids in heterogeneous sample fractions may have caused some of the discrepancies in the results. Likewise, all of the associated samples in the radiological parameters category were unfiltered, which may explain some of the out-of-limit results.

The majority of the out-of-limit duplicate results appear to be anomalous instances of poor precision based on other QC indicators, such as the results from the laboratory duplicates. In several cases, the laboratory was asked to re-analyze or investigate duplicate results with a very high relative percent difference, but the source of the problem was not discovered. Some of these investigations are underway during the writing of this report.

E.4.3 Field Splits

Split samples are used to confirm out-of-trend results and for interlaboratory comparisons. Results must have a relative percent difference less than or equal to 20% (less than or equal to 20%). Only those results that are greater than five times the method detection limit or minimum detectable activity at both laboratories are evaluated.

In the reporting period, 212 split samples were analyzed for 87 different analytes, generating 2,593 field split pairs of data. The split sample data were used to evaluate the performance of the laboratories and to troubleshoot analytical problems with chromium and hexavalent chromium. Section E.6.5 discusses the observations related to these constituents. The results for field splits that exceeded QC limits are summarized in Table E-8. The percent of evaluated pairs outside the acceptance limits of ≤20% relative percent difference decreased from 25% in FY 2008 to 23% in this reporting period; however, the failures are predominantly associated with metals splits; 62% of the split failures were associated with metals analyses. Additional testing for metals is planned for FY 2010.

In addition to the issues noted with metals analysis, fluoride results continue to demonstrate poor precision. Based on past review of raw data, it is likely that one or more of the laboratories is/are experiencing interferences from small organic acids, which can interfere with the analysis of fluoride by ion chromatography. Carbon-14 and technecium-99 results also appear to have a potential bias between laboratories. Eberline and TA Richland perform carbon-14 analysis, while WSCF and TA Richland analyze groundwater samples for technetium-99. Additional testing is planned for FY 2010.

Previous studies have identified precision issues with gross-beta results from various laboratories, which are suspected to be due to differing calibration strategies used by the laboratories. Two out of the seven evaluated gross-beta split samples failed to meet the acceptance criteria during this reporting period.

E.5. Holding Times

H. Hampt

Holding time is the elapsed time period between sample collection and analysis. Samples are required to be analyzed within recommended holding times to minimize the possibility of changes in constituent concentrations caused by volatilization, decomposition, or other chemical processes. Samples are also refrigerated to slow potential chemical reactions within the sample matrix. Maximum recommended holding times for constituents frequently analyzed for the Groundwater Project are listed in Table E-11. Radiological constituents do not have recommended maximum holding times because these constituents are not typically lost under ambient temperatures when appropriate preservatives are used. The results of radionuclide analysis are corrected for decay from the sampling date to analysis date.

During the reporting period, recommended holding times were met for over 99% of non-radiological results (Table E-3). Holding times were exceeded for 403 non-radiological results produced by WSCF, TA St. Louis, and the Lionville Laboratory. Approximately 70% of the missed holding times at WSCF were associated with anions by EPA Method 300.0 (134 results). A few of these missed holding times (eleven results) were due to late delivery to the laboratory. The others were due to high sample load at the laboratory or other laboratory issues. Holding times were missed for 206 sample results sent to TA St. Louis. Over 58% of those missed holding times were due to late delivery to the laboratory. Few samples were sent to the Lionville Laboratory during the reporting period; however, seven were not analyzed before the holding time had lapsed. Results for samples with missed holding times are flagged as “H” in the HEIS database.

E.6. Laboratory Performance

H. L. Anastos, C. J. Thompson, H. Hampt, S. J. Champoux, and J. A. Sanford

Laboratory performance is measured by several indicators, including national performance evaluation studies, double-blind standard analyses, laboratory audits, and internal laboratory QA/QC programs. This section provides a detailed discussion of the performance indicators for WSCF, TA St. Louis, and TA Richland. Brief summaries of performance measures for Lionville and Eberline are also presented throughout this section.

E.6.1 National Performance Evaluation Studies

During the reporting period, Environmental Resources Associates and DOE conducted national studies to evaluate laboratory performance for chemical and radiological constituents. TA St. Louis and WSCF participated in the EPA-sanctioned Water Pollution Performance Evaluation studies conducted by Environmental Resources Associates. WSCF and Eberline participated in the Environmental Resources Associates' InterLaB RadCheM Proficiency Testing Program. All five laboratories supporting the Groundwater Project (WSCF, TA St. Louis, TA Richland, Lionville, and Eberline) took part in DOE's Mixed Analyte Performance Evaluation Program (MAPEP). Lionville participates in EPA-sanctioned water supply/water pollution performance evaluation studies conducted by Wibby Environmental (Wibby). The results of those studies related to groundwater monitoring at the Hanford Site are described in the following section.

E.6.1.1 Water Pollution Performance Evaluation Studies

The purpose of water pollution performance evaluation studies is to evaluate the performance of laboratories in analyzing selected organic and inorganic compounds in water matrices. An accredited agency (e.g., Environmental Resource Associates) distributes standard water samples to participating laboratories. These samples contain specific organic and inorganic analytes at concentrations unknown to the participating laboratories. After analysis, the laboratories submit their results to the accredited agency, which uses regression equations to determine acceptance and warning limits for the study participants. The results of these studies are expressed in the following section as a percentage of the results that the accredited agency found acceptable and independently verify the level of laboratory performance. In the event of an unacceptable result, the laboratories may order an ERA QuiK Response® sample to verify successful corrective action. The QuiK Response samples are similar to water pollution/water supply samples, and results are reported in a comparable fashion.

For the three water pollution performance evaluation studies in which TA St. Louis participated during the reporting period (ERA WP-168, WP-173, and WP-174), the percentage of results within the acceptance limits was 98% (Table E-12). Twenty-one different constituents had unacceptable results, none of which were repeated across studies.

For the two water pollution performance evaluation studies (ERA WP-168 and WP-174) in which WSCF participated during the reporting period, the percentage of results was 100% (Table E-13). As shown in Tables E-12 and E-13, the number of constituents reported by WSCF in the water pollution studies was considerably less than those reported by TA St. Louis; thus, the percentages from the two laboratories are not directly comparable.

E.6.1.2 InterLaB RadCheM Proficiency Testing Program Studies

The purpose of the InterLaB RadCheM Proficiency Testing Program (also conducted by Environmental Resources Associates) is to evaluate the performance of laboratories in the analysis of selected radionuclides. This program provides blind standards that contain specific amounts of one or more radionuclides in a water matrix to participating laboratories. After sample analysis, the results are forwarded to Environmental Resources Associates for comparison with the known values and with results from other laboratories. Environmental Resources Associates bases its control limits on EPA's *National Standards for Water Proficiency Testing Studies Criteria Document* (NERL-Ci-0045).

During the reporting period, WSCF participated in two studies, RAD-75 and RAD-76. WSCF (Table E-13) performed well on RAD-75, acceptably quantifying eight of the nine constituents; only radium-228 was missed with a high bias. In the second study, RAD-76, WSCF performance improved with 100% acceptable results.

Eberline participated in five studies (RAD-75, RAD-76, RAD-77, RAD-78, and RAD-79), and analyzed a total of thirty-five constituents. Only one result was unacceptable, radium-226 with a low bias (Table E-14).

E.6.1.3 DOE Mixed Analyte Performance Evaluation Program

The DOE's Mixed Analyte Performance Evaluation Program examines laboratory performance in the analysis of soil and water samples containing metals, volatile and semivolatile organic compounds, and radionuclides. This appendix considers only the results from water samples. The program is conducted through the DOE's Radiological and Environmental Sciences Laboratory in Idaho Falls, Idaho. The DOE evaluates the accuracy of the Mixed Analyte Performance Evaluation Program results for radiological and inorganic samples by determining if the results are within a 30% bias of the reference value. Two studies were available for all of the laboratories during the reporting period (MAPEP-08-19 [MAPEP 19] and MAPEP-09-20 [MAPEP 20]). Eberline and WSCF also participated in MAPEP-09-21 [MAPEP 21].

For the semivolatile organics in water portion (OrW), TA St. Louis (Table E-12) missed gamma-BHC in study MAPEP 19 and benzo(a)anthrcene, chrysene, and hexachlorobenzene in MAPEP 20. TA St. Louis acceptably identified and quantified 72% of the analytes for the organics in water. TA St. Louis' performance on the radiological water section (MaW) was very good. Only one constituent was missed (nickel-63) and one constituent received a warning status (technetitum-99). Both constituents were within limits on the next study (MAPEP 20). The last portion of the studies concerning gross alpha and beta (GrW) received 100% acceptance.

TA Richland (Table E-12) performed well on the gross-alpha and gross-beta portion (GrW) of both studies but received a warning status for tritium (reported as hydrogen-3) and technetium-99 for the MAPEP 19 MaW section. These two constituents were acceptable in the next study.

Lionville (Table E-14) performed well on both of the studies, missing three constituents and receiving one warning. The missed constituents included 4-bromophenyl-phenylether, phenathrene, and hexachlorocyclopentadiene. The constituent receiving a warning was bis(2-ethylhexyl)phthalate. The radiological analytes were all correctly quantified.

Eberline (Table E-14) received one warning and missed two constituents for the MAPEP 19 study. The missed analytes were americium-241 and plutonium-239/240; both of these analytes were within limits for the MAPEP 20 study. Iron-55 received a warning status in both studies. Eberline did not perform analyses for this constituent on Hanford Site groundwater samples. All analytes were acceptable for MAPEP 21.

For the MAPEP 19 study, WSCF (Table E-13) also performed well, missing only two analytes and receiving three warnings, resulting in 98% acceptable results. The two missed analytes include technetium-99 and 2,4,6-trichlorophenol. In response, WSCF performed a quick-turn supplementary study (MaWR1). In this study, technetium-99 was within the acceptance limits. The three analytes that were placed on a warning status were copper, selenium, and zinc; all of these were found acceptable in the MAPEP 20 study. The only constituent that was outside the acceptance limits in the MAPEP 20 study was thallium, which received a warning. On the following study, MAPEP 21, thallium was within limits, but strontium-90 and indeno(1,2,3-c,d)pyrene received a warning status.

E.6.1.4 Wibby Environmental Water Supply and Water Pollution Performance Evaluation Study

Lionville participates in the EPA-sanctioned water supply/water pollution performance evaluation studies conducted by Wibby. Periodically, standard water samples are distributed as blind standards to participating laboratories. These samples contain specific organic and inorganic analytes at concentrations unknown to the participating laboratories. After analysis, the laboratories submit their results to the Wibby study administrator. Regression equations are used to determine acceptance and warning limits for the study participants. The results of these studies (expressed in this section as a percentage of the results that the performance evaluation provider found acceptable) independently verify the level of laboratory performance. In the event of an unacceptable result, the laboratories may order a Wibby rapid return sample to verify that successful corrective action has been taken. Rapid return samples are similar to water supply/water pollution samples, and the results are reported in a comparable fashion.

Lionville (Table E-14) participated in two new Wibby studies in the past year. The first was a rapid return proficiency (RR-04955), in which they correctly quantified 22 of the 23 analytes, missing only thallium. The second was a water pollution proficiency study (WP0209), in which the laboratory received a 94% correct quantification of analytes (566 of 605).

E.6.2 Double-Blind Standard Evaluation

Double-blind standards provide a measure of both interlaboratory and intralaboratory precision and accuracy. These studies also help groundwater staff troubleshoot analytical problems identified during data reviews and QC evaluations. The double-blind standards also may be used to confirm the adequacy of corrective actions performed to resolve analytical problems. During the reporting period, the Groundwater Project forwarded double-blind QC standards to TA Richland and St. Louis, WSCF, Lionville, Eberline, and ESL. Double-blind-spiked standards were generally prepared in triplicate and submitted to the laboratories to check the accuracy and precision of analyses. For most constituents, the standards were matrix-matched, double-blind standards, which are prepared in a groundwater matrix from an appropriate background well. Standards for specific conductance were commercially prepared in deionized water. In all cases, the standards were submitted to the laboratories in double-blind manner (i.e., the standards were disguised as regular groundwater samples). After analysis, the laboratory's results were compared with the spiked concentrations, and a set of control limits were used to determine if the data were acceptable. The out-of-limit results were reviewed for errors. In situations where several results for the same method were unacceptable, the results were discussed with the laboratory, potential problems were investigated, and corrective actions were taken when appropriate.

Tables E-15 through E-17 summarize the number and types of double-blind standards analyzed during in the reporting period, as well as the control limits and number of unacceptable results for each constituent. WSCF and TA (Richland and St. Louis) were provided approximately the same number of test samples (303 and 313, respectively), allowing for direct comparison between their results. Lionville and Eberline received fewer blind samples, both in number and type. Overall, 87% of the double-blind spike determinations were acceptable. This was slightly lower than the percentage from FY 2008 (90%). The WSCF laboratory performance fell slightly on double-blind samples, with 87% of their blind sample results within control limits compared to 91% in FY 2008, which was still greatly improved over FY 2007 (79%). TA (Richland and St. Louis) reported acceptable results for 88% of the blind constituents. Lionville improved their performance, reporting 80% of the blinds correctly as opposed to 69% in FY 2008; however, eleven of the fourteen unacceptable results were associated with total organic carbon analyses. Lionville did not perform total organic carbon analysis in support of groundwater monitoring during the reporting period. Further corrective actions are needed prior to Lionville performing this workscope. Total organic carbon double-blind sample results for both WSCF (88%) and TA (100%) were acceptable, and these laboratories will continue to provide the primary analytical service for this analysis. Lionville's double-blind sample performance for anions was 95%, which was significantly improved over last year. Eberline performed blinds for iodine-129 and gross beta, with 86% acceptably quantified.

Significant improvement has been made in the double-blind standard analysis for total organic halides. Previous reports noted multiple failures at both WSCF and TA St. Louis. Double-blind standards for total organic halides are prepared using two different spiking solutions (2,4,5-trichlorophenol and a mixture of carbon tetrachloride, chloroform, and trichloroethene). In late FY 2008, corrective actions were implemented for the WSCF total organic halide method, which appear to have resolved the issues that were causing high variability and outlier results. Both WSCF and TA St. Louis performance for total organic halides improved during the reporting period, with WSCF correctly reporting 97% and TA St. Louis reporting 92% correctly.

WSCF and TA St. Louis are the two laboratories currently performing anion analysis routinely for the Groundwater Project. Both laboratories performed well on the analysis of anions in double-blind standards, with the exception of fluoride analysis. Combined, the laboratories correctly quantified 73% of the fluoride double-blind standards. Omitting the fluoride results, the laboratories successfully quantified 97% of the anion double-blind standards. The continued poor performance on fluoride warrants further investigation in FY 2010.

Performance for TA St. Louis and WSCF on the analysis of volatile organic compounds continued to be problematic during the reporting period. The laboratories' percentages of unacceptable results were 25% and 39%,

respectively. Both laboratories correctly quantified the double-blind standards submitted for chloroform analysis. The failures were associated with trichloroethene (60%) and carbon tetrachloride (40%). Since the water solubility of chloroform is much higher than that of carbon tetrachloride and trichloroethene, the low recoveries may be caused by volatilization of the less soluble compounds prior to analysis. Continued evaluation of the volatile organic methods is planned during FY 2010.

For radiological double-blind standards, WSCF correctly quantified 84% of the radiological parameters, while TA Richland successfully quantified 92% of the radiological blind standards. Performance on radiological double-blind standards identified improvement is needed for gross-alpha analysis. Both laboratories had multiple failures for gross alpha during the reporting period, and nearly all of the failures were biased low. A number of double-blind standards were submitted to investigate iodine-129. These results are discussed in Section E.6.4.

Overall, the evaluation of the double-blind standards indicates that the current laboratories meet the precision and accuracy requirements of the Groundwater Project. Specific analytical areas at each laboratory continue to be identified for process improvements.

E.6.3 Laboratory Internal Quality Assurance/Quality Control Programs

WSCF, TA Knoxville, TA Richland, TA St. Louis, Eberline, and Lionville maintain internal QA/QC programs that generate data on analytical performance by analyzing method blanks, laboratory control samples, matrix spikes and matrix spike duplicates, matrix duplicates, and surrogates (see Section E.9 for definitions of these terms). This information provides a means to assess laboratory performance and the suitability of a method for a particular sample matrix. Laboratory QC data are not currently used for Groundwater Project validation of individual sample results unless the laboratory is experiencing unusual performance problems with an analytical method. A brief assessment of the laboratory QC data for the October 1, 2008, through December 31, 2009, reporting period is provided in this section. Tables E-18 and E-19 provide a summary of the WSCF and TA internal QC data, respectively, by listing the percentage of QC results that were out of limits for each analyte category and QC parameter. Additional details are presented in Tables E-20 through E-26. Constituents not listed in these tables did not exceed the QC limits for WSCF or TA. An overview of the data from Lionville and Eberline is presented at the end of the section.

Approximately 98% of the laboratory QC results for the reporting period were within the acceptance limits, indicating that the analyses were in control and reliable data were generated. Method blanks, laboratory control samples, matrix spikes and matrix spike duplicates, matrix duplicates, and surrogates QC results were evaluated against the acceptance limits. Unacceptable results are summarized below.

Evaluation of results for method blanks was based on the frequency of detection above the blank QC limits. Except as noted, these limits are two times the method detection limit for chemical constituents and two times the sample-specific minimum detectable activity for radiochemistry parameters. Because minimum detectable activities were not electronically reported for radiochemistry analytes from WSCF, two times the practical quantitation limit was used as the radiochemistry QC limit for WSCF. For common laboratory contaminants such as 2-butanone, acetone, methylene chloride, phthalate esters, and toluene, the QC limit is five times the method detection limit.

Table E-10 summarizes method blank results from WSCF. Overall, 99.8% of the results were acceptable. Metals (calcium, copper, iron, nickel, silver, and sodium) accounted for 45% of the out-of-limit results. In most cases, the metal concentrations were within a factor of three of the method detection limit, and the blank results do not indicate unreasonable analytical performance. Nonetheless, the failed blanks are indicative of process improvements needed for metals analysis at the laboratory. Results associated with out-of-limit metal blank results are flagged with a “C” in the HEIS database. Four volatile organic compounds had method blank results that exceeded the QC limits. Of these, acetone and methylene chloride had the highest percentages of out-of-limit results. Both compounds are common laboratory contaminants, and low-level detections in Hanford Site groundwater samples should be considered suspect. Results associated with out-of-limit volatile blank results are flagged with a “B” by the laboratory. Table E-20 summarizes method blank results from TestAmerica. The general chemistry parameters had the greatest percentage of method blank results outside the QC limits (~4%). Blank concentrations for some of the more prevalent constituents (alkalinity, calcium, chloride, sodium, and specific conductance) were relatively insignificant compared to typical levels of these constituents in Hanford Site groundwater. As noted above, results associated with out-of-limit inorganic blank results are flagged with a “C” by the laboratory in both the hardcopy

and electronic data. Several volatile organic compounds had results that exceeded the QC limits; all of these compounds were found at trace levels (less than 1 µg/L), and their percentages of unacceptable blank results were generally low (less than 10%). Nonetheless, the apparent presence of any analytes in method blanks dictates caution when interpreting low-level results for the same constituents in Hanford Site groundwater. Results associated with out-of-limit volatile blank results are flagged with a "B" by the laboratory in both the hardcopy and electronic data. In summary, the method blank results for WSCF and TA indicate acceptable laboratory performance. Compared to FY 2008, WSCF had significantly fewer out-of-limit results for metals. For other analyte categories, both laboratories' method blank results were similar to the results for FY 2008.

Table E-22 summarizes results for the laboratory control samples from WSCF. WSCF had a relatively low number of failures; 99.4% of the results were within the control limits. Most of the unacceptable results were associated with high recoveries (111% to 220%), which suggest that some of the associated groundwater results may be biased high. Thirty-nine of the failed laboratory control sample results were for metals analyzed by the inductively coupled plasma/optical emission spectroscopy method on April 28 and May 18. Since all of the metals had recoveries of ~200%, it seems likely that a spiking problem or other procedural deviation occurred on those dates. Table E-21 summarizes results for the laboratory control samples from TA Knoxville, Richland, and St. Louis. Several volatile and semivolatile organic compounds had one or two unacceptable results, while bromomethane, iodomethane, 4,6-dinitro-2-methylphenol, and heptachlor each had five or more results outside the QC limits. The majority of these compounds are not commonly found in Hanford Site groundwater samples. However, as noted above, some bias is likely in the associated groundwater sample results for these compounds.

Table E-24 summarizes results for the matrix spikes and matrix spike duplicates from WSCF. Only those samples that were spiked at a level at least one-fourth of the original sample concentration were included in the evaluation. Approximately 99% of the results were acceptable. For the six analyte categories, the percentage of results that exceeded the QC limits ranged from 0.5 to 4.3% (volatile and semivolatile organic compounds, respectively). Individual analyte percentages varied from 0.4% for several metals to 14.8% for 2-picoline. Most of the metals had elevated recoveries, while hexavalent chromium had fifteen under-recovered results. The semivolatiles category had 45 unacceptable matrix spikes and matrix spike duplicates. Many of these failures appeared to be caused by poor analytical precision (i.e., lack of agreement between the matrix spike and matrix spike duplicate) rather than sample-matrix issues. Phenol and 2-picoline were the only semivolatile compounds listed in Table E-24 that were detected in routine groundwater samples. Table E-23 summarizes the results for the matrix spikes and matrix spike duplicates from TA Knoxville, Richland, and St. Louis. The organics categories had the greatest percentage of matrix spikes/spike duplicates exceeding the QC limits. As noted for WSCF, most of these compounds are not commonly detected in Hanford Site groundwater.

For matrix duplicates, only those samples with values five times greater than the method detection limit or the minimum detectable activity (or practical quantitation limit for WSCF) are considered. Quantifiable matrix duplicates are evaluated by comparing the relative percent difference with an acceptable relative percent difference maximum for each constituent. Tables E-26 and E-25 list the constituents from WSCF and the TestAmerica laboratories, respectively, that exceeded the relative percent difference limits. Overall, the percentage of duplicates having poor precision was low (less than 1% for all of the laboratories), demonstrating good analytical reproducibility. WSCF had minor issues with gross alpha and gross beta; six and fourteen of the respective matrix duplicates had relative percent differences between 21% and 213%. For the TestAmerica laboratories, the only constituent that had more than one matrix duplicate that failed to meet the acceptance criteria was nitrogen in nitrite (two unacceptable results with concentrations less than 1 mg/L).

Surrogate data from WSCF that were out of limits included three compounds for volatile organics and six for semivolatile organics. Approximately 99% of WSCF's surrogate results were acceptable. TA St. Louis had out-of-limit surrogate results for five methods: phenols, pesticides, volatile organics, semivolatile organics, and total petroleum hydrocarbon-diesel. Approximately 99% of TA St. Louis' surrogate results were within the acceptance limits. All of TA Knoxville's surrogate results were acceptable.

The QC data for Eberline and Lionville were limited for the reporting period because they did not analyze many samples for routine groundwater monitoring. Lionville analyzed a limited number of method blanks, laboratory

control samples, matrix spikes, and matrix duplicates for anions by ion chromatography and mercury by cold vapor atomic absorption. Only one laboratory control sample recovery was out of limits for orthophosphate on a QC sample; the recovery was slightly low at 88.7%. All other QC was stated as within the acceptance criteria. Eberline's QC data were limited to carbon-14, gross alpha, gross beta, iodine-129, protactinium-231, and tritium. All of the QC data were acceptable.

E.6.3.1 Issue Resolution

Issue resolution forms are documents used to record and resolve problems encountered with sample receipt, sample analysis, missed holding times, and data reporting (e.g., broken bottles or QC problems). The laboratories generate these forms and submit them to the Groundwater Project as soon as possible after a potential problem is identified. The forms provide a way for the Groundwater Project to direct the laboratory to resolve problems. The documentation is intended to identify occurrences, deficiencies, and/or issues that may potentially have an adverse impact on data integrity. During the reporting period, 175 issue resolution forms addressing analytical requests for groundwater monitoring samples were submitted by the WSCF, TA St. Louis, and TA Richland laboratories. Issue resolution forms were not received from the secondary or limited use laboratories.

Table E-27 indicates the specific issues identified during the reporting period and the number of analytical requests that were impacted. An analytical request is a request for a laboratory to analyze a sample by a particular method. Generally, several analytical requests are made per sample number, and multiple results will be produced for each analytical request. Issues are categorized based on whether they occurred prior to or after receipt at the laboratory. Approximately 1% of the analytical requests were documented as having a problem on an issue resolution form. Roughly one-third of the issues occurred prior to receipt at the laboratories. During the last reporting period, one-half of the issues occurred prior to receipt at the laboratory. The issues that occurred prior to receipt at the laboratory were missed holding times, broken bottles, samples received outside of temperature specifications, insufficient sample volume collected, chain-of-custody issues, and incorrect preservation of samples. These issues are tracked and, when adverse trends are identified, corrective actions are initiated. In FY 2008, the number of issues associated with incorrect preservation of samples increased, and a QA nonconformance report (NCR-08-SGRP-011) was issued to address the problem. For this reporting period, the number of issues associated with incorrect preservation of samples declined by 50%.

The number of issue resolution forms varies from year to year based on laboratory reporting. During FY 2008, WSCF did not submit issue resolution forms for laboratory QC failures or late analyses. During this reporting period, however, WSCF submitted issue resolution forms for missed or incomplete laboratory QC. Issue resolution forms submitted by WSCF for analyses impacted after receipt at the laboratory were associated with missed holding times (70%), broken bottles (1%), temperature deviations (2%), QC issues (17%), and analytical/method deviations (10%).

E.6.3.2 Laboratory/Field Audits, Assessments, and Surveillances

Laboratory and field activities were regularly evaluated by audits, assessments, and surveillances to ensure that quality problems are identified and corrected. Evaluation of laboratory and analytical activities is performed by various oversight organizations, with each using slightly differing criteria and terminology.

During FY 2009, a total of five formal reviews (audits and/or assessments) were conducted on laboratories that routinely analyzed Hanford Site groundwater samples. Four formal reviews were audits performed on commercial laboratories by the DOE Consolidated Audit Program, and one was an assessment on one of the onsite laboratories. In addition to the formal reviews, a total of eleven surveillances were performed on sampling, well construction, and analytical data verification activities. Corrective actions were initiated for all findings associated with surveillances, and process improvements were evaluated.

DOE Consolidated Audit Program audits. The goal of the DOE Consolidated Audit Program is to design and implement a program to consolidate site audits of commercial and DOE environmental laboratories providing services to DOE Environmental Management. To support this goal, audits were performed on four commercial laboratories. Audit objectives of the DOE Consolidated Audit Program were to assess the ability of the laboratories to produce data of acceptable and documented quality through analytical operations that follow approved and technically sound

methods, and the handling of DOE samples and associated waste in a manner that protects human health and the environment. The DOE Consolidated Audit Program audits were performed at the following laboratories:

- Test America (TA St. Louis), Earth City, Missouri, March 17 to 19, 2009 (090319-TAS)
- Eberline Services, Richmond, California, February 24 to 26, 2009 (090226-ESR)
- Lionville Laboratory, Inc, Lionville, Pennsylvania, March 3 to 5, 2009 (090305-LLI)
- Test America (TA Richland), Richland, Washington, June 9 to 11, 2009 (090611-TAR).

The scope of the DOE Consolidated Audit Program assessment included the following specific functional areas:

- QA management systems and general laboratory practices
- Data quality for organic analyses
- Data quality for inorganic and wet chemistry analyses
- Data quality for radiochemistry analysis
- Laboratory information management systems/electronic data management
- Hazardous and radioactive materials management
- Verification of corrective action implementation from previous audit findings.

A total of 43 findings and 25 observations were noted for the four DOE audits. All corrective actions have been accepted, and verification of the corrective actions will be performed in future audits. All of the laboratories have been recommended by the DOE Consolidated Audit Program for continuation to provide analytical services for samples generated at DOE sites.

Integrated Contractor Assessment Team (ICAT) assessments. An integrated contractor assessment team assessment was performed by Hanford Site contractor personnel on one Hanford Site analytical laboratory, Advanced Technologies and Laboratories International (ATL) (Richland, Washington). The objective of the ICAT assessment was to verify the implementation of the requirements stated in the *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD) (DOE/RL-96-68, Rev. 3, Volumes 1 and 4). The integrated contractor assessment team assessment of ATL was performed on April 6 to 13, 2009 (FH-AVS-09-03). The overall results of the assessment indicated that programs and processes reviewed were in place and implemented in accordance with the laboratory QA program plan and DOE/RL-96-68. The laboratory was qualified by the integrated contractor assessment team to continue to provide analytical services for samples generated at the Hanford Site.

A total of three findings and nineteen observations were noted during the assessment. Corrective actions have been accepted for all findings and observations, and verification of the corrective actions will be performed in a future assessment.

Groundwater Project surveillance. Eleven surveillances were performed by Groundwater Project QA personnel on various field sampling, well construction, and data management verification activities during FY 2009. Surveillances identified a total of 29 findings and 16 opportunities for improvement. A list of the surveillances performed is provided below:

- Groundwater Project surveillances on field sampling activities:
  - *Field Surveillance of Groundwater Sample Preservation*: December 11, December 29, and December 30, 2008 (QA-EQA-SGRP-SURV-09-012)
  - *Field Surveillance of Operational Monitoring Groundwater Sampling*: February 25, February 26, March 9, and March 12, 2009 (QA-SGRP-SURV-09-013)
  - *Field Surveillance of SGRP Laboratory Cleaning of Sampling Equipment*: April 14 and May 4, 2009 (QA-SGRP-SURV-09-018)
  - *Aquifer Tube Sampling*: June 17, 2009 (QA-SGRP-SURV-09-019)
  - *Field Surveillance of Sample Custody, Shipping/Handling and Storage*: April 28, June 15, and June 16, 2009 (QA-SGRP-SURV-09-022)

  - *Sampler Training Adequacy*: August 19 to 27, 2009 (QA-SGRP-SURV-09-025)
  - *Follow-Up to CR-2009-0089, Procurement of Sample Preservatives as QL 0 Related to CR-2009-1043, the Use of Expired Sample Preservative*: August 6, August 11, August 24, and August 25, 2009 (QA-SGRP-SURV-09-026)
  - *Adequacy of Sampler Procedures*: August 6 to September 30, 2009 (QA-SGRP-SURV-09-033)
- Groundwater Project surveillance on well construction activity:
  - *Well Construction Materials*: August 12 and August 31, 2009 (QA-SGRP-SURV-09-028)
- Groundwater Project surveillances on data management and verification activities:
  - *Sample Data Traceability*: November 17 to December 10, 2008 (QA-EQA-SGRP-SURV-09-011)
  - *Sample and Data Management Procedure Adequacy*: June 23 to July 6, 2009 (QA-SGRP-SURV-09-020).

E.6.4 Evaluation of Iodine-129 Low-Level Method

During the FY 2008 review of groundwater data, it was noted that a number of results for iodine-129 were reported as non-detected results above the DWS of 1 pCi/L. While all of the minimum detectable activities were reported as less than 1 pCi/L, non-detects were still reported at higher levels. Only one laboratory (TA Richland) was performing the low-level iodine method needed to reach the 1 pCi/L DWS. The laboratory used three gamma energy lines to detect iodine-129. They required both the primary and at least one of the secondary lines to be identified by the software in order to confirm the presence of iodine-129. This conservative approach minimized the potential for false-positive results (i.e., stating that iodine-129 is present when it is not). The secondary energy lines are less sensitive than the primary line; therefore, it is possible to detect iodine-129 on the primary line but have both secondary lines not detected. When this occurred, the laboratory reported the activity associated with the primary line as the non-detect value. If the value detected on the primary line is higher than the minimum detectable activity, the result is non-detected at a level above the minimum detectable activity. In FY 2009, Groundwater Project analytical support staff worked with the laboratories to improve the iodine-129 method and resolve the issues identified in FY 2008, with the goal to ensure that the detection levels reported were at or below the 1 pCi/L DWS. TA Richland was approached and tasked with developing a method improvement plan. In addition, other laboratories were asked to reassess their ability to meet the needed detection limit. Three laboratories identified capabilities to meet the required detection levels, including TA Richland. TA Richland modified their counting strategy by using longer count times and removing the conservative usage of secondary line confirmation to meet the requested limit. Eberline implemented a similar methodology. ESL indicated they could meet the limits using a modified inductively coupled plasma/mass spectrometry technique. Split well samples were submitted to these laboratories in FY 2009. Double-blind standards were also submitted in June 2009.

Double-blind standard results. In order to evaluate the improved method at TA Richland, as well as the new methods at ESL and Eberline, double-blind standards were prepared at concentrations of 1 pCi/L and 10 pCi/L and submitted to the laboratories. The results of these blind standards are in Table E-28. TA Richland successfully quantified all of the blind standards; however, the results from the other laboratories did not consistently meet the acceptance criteria. Eberline correctly quantified the 10 pCi/L blind standards, but only one of the three 1 pCi/L samples met the accuracy criteria and that result was reported as a non-detected value. All of the out of limit Eberline data were biased low. The ESL data met the accuracy criteria for the 1 pCi/L level; however, all of the data were reported as non-detected. In addition, ESL did not meet the acceptance criteria for the 10 pCi/L blind standards. Based on this data, TA Richland is recommended to remain as the primary laboratory for low-level iodine-129 analyses. Additional testing is suggested to further evaluate alternative laboratory capabilities.

Split sample results. In order to evaluate the improved method at TA Richland, as well as the new methods put in place at ESL and Eberline, five wells were sampled and analyzed by all three laboratories. In addition, seventeen wells were sampled and analyzed by two laboratories. The results of these split samples are shown in Tables E-29 and E-30. The TA Richland results are comparable to historical data; however, the laboratory can now report levels of iodine ~0.2 pCi/L. The results from Eberline appear more variable and may be biased slightly low, which is reinforced by the apparent low bias in the blind standard results. The data provided by ESL showed the highest variability and, in some cases, did not appear in line with past data trends. It should be noted that the ESL method

is significantly different from the other two laboratory methods. In addition, ESL requested that all samples be submitted to them preserved to pH >9 with sodium hydroxide. Typically, samples for iodine129 do not require preservation, and only part of the samples delivered to ESL were properly preserved as requested (these samples are noted in Tables E-29 and E-30). It is possible this negatively affected the ESL results.

In conclusion, the method improvements at TA Richland appear to be successful in lowering the effective detection limit to less than 1 pCi/L. It is noteworthy that two additional laboratories have developed low-level iodine-129 analyses; previously, no alternative laboratory was available. However, further testing is needed to ensure that data from these laboratories is comparable.

E.6.5 Evaluation of Chromium and Hexavalent Chromium

Early in the reporting period, a number of requests for data review for hexavalent chromium were submitted and evaluated. Based on that review of data, increased split samples for hexavalent and total chromium were requested in order to better understand the interlaboratory data comparability. Additionally, the necessity of filtration versus turbidity blank correction was identified by the laboratory as a potential cause for data variability; therefore, hexavalent chromium samples were sampled both filtered and unfiltered. Table E-31 provides some of the data generated from this review. Only samples with hexavalent and total chromium results greater than 10 µg/L were used for the review. Low values (less than 10 µg/L) would skew the calculations because of lower analytical precision near the detection limits. Some of the low values also represent detection limits and not measured concentrations.

Results were compared by calculating the signed percent difference (SPD), where the SPD is as follows:

$$SPD = \frac{(X1 - X2)}{(X1 + X2) / 2} \times 100$$

where X1 = WSCF result and X2 = TA Richland result.

E.6.5.1 Hexavalent Chromium

In general, there was little difference between the filtered and unfiltered hexavalent chromium results. The unfiltered samples demonstrated an average SPD of 6 with a standard deviation of 19; the filtered samples averaged SPD of 8 with a standard deviation of 15. Filtering the samples did not seem to have any appreciable effect on the data. It is interesting to note that WSCF data was higher than TA data for 75% of the hexavalent chromium results. This potential bias is being investigated further.

E.6.5.2 Total Chromium

Comparison of filtered total chromium to unfiltered total chromium split samples identified a potential bias. The SPD for filtered total chromium samples was 2, with a standard deviation of 25; however, the data were skewed by three points for one well. Omitting those points, the results were -3 with a standard deviation of 9.5. This is in contrast to the SPD for unfiltered split samples which was -13 with a standard deviation of 35. WSCF data are 13% lower than TA's data for total chromium for unfiltered samples. This potential bias is also being investigated further.

Overall, the biases observed in the split testing were not greater than the normal reporting criteria of 20%. However, since the hexavalent chromium may be slightly biased high and the total chromium may be slightly biased low, the net result of these biases may be significant, depending on the intended use of the data. Further investigation is underway.

E.7. Limit of Detection, Limit of Quantitation, and Method Detection Limit

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Detection and quantitation limits are essential to evaluate data quality and usefulness because they provide the limits of a method's measurement. The detection limit is the lower limit at which a measurement can be differentiated

from background. The quantitation limit is the lower limit where a measurement becomes quantifiably meaningful. The limit of detection, limit of quantitation, and method detection limit are all useful for evaluating groundwater data.

The limit of detection is defined as the lowest concentration level statistically different from a blank (*Detection in Analytical Chemistry: Importance, Theory, and Practice* [Currie 1988]). The concentration at which an analyte can be detected depends on the variability of the blank response. For the purpose of this discussion, the blank is discussed as a method blank.

In general, the limit of detection is calculated as the mean concentration in the blank plus three standard deviations of that concentration (EPA/540/P-87/001, 1980). The blank-corrected limit of detection is simply three times the blank standard deviation. At three standard deviations from the blank mean, the false-positive and the false-negative error rates are each ~7% (*Statistics for Analytical Chemistry, Second Edition* [Miller and Miller 1988]). A false-positive error is an instance when an analyte is declared present, but is absent; a false-negative error is an instance when an analyte is declared absent, but is present.

The limit of detection for a radionuclide is typically computed from the counting error associated with each reported result (e.g., EPA/520/1-80/012, *Upgrading Environmental Radiation Data*) and represents instrumental or background conditions at the time of analysis. In contrast, the limit of detection and limit of quantitation for the radionuclides shown in Table E-32 are based on variabilities that result from both counting errors and uncertainties introduced by sample handling. In the latter case, distilled water (submitted as a sample) is processed as if it were an actual sample. Thus, any random cross-contamination of the blank during sample processing will be included in the overall error. The values shown in Table E-32 are most useful to assess long-term variability in the overall measurement process.

The limit of quantitation is defined as the level above which quantitative results may be obtained with a specified degree of confidence (*Environmental Sampling and Analysis: A Practical Guide* [Keith 1991]). The limit of quantitation is calculated as the blank mean plus 10 standard deviations of the blank (EPA/540/P-87/001, 1987). The blank-corrected limit of quantitation is simply ten times the blank standard deviation. The limit of quantitation is most useful for defining the lower limit of the useful range of concentration measurement technology. When the analyte signal is ten times larger than the standard deviation of the blank measurements, there is a 95% probability that the true concentration of the analyte is within ±25% of the measured concentration.

The method detection limit is defined as the minimum concentration of a substance that can be measured and reported with a 99% confidence that the analyte concentration is greater than zero. The method detection limit is determined from analysis of a sample in a given matrix containing the analyte (Currie 1988). The method detection limit is 3.14 times the standard deviation of the results of seven replicates of a low-level standard. Note that the method detection limit, as defined above, is based on the variability of the response of low-level standards rather than on the variability of the blank response. This is the reporting limit most commonly provided from the analytical laboratories with groundwater data (i.e., the reporting limit in the HEIS database).

For this report, total organic carbon, total organic halides, and radionuclide field blank data are available for limit of detection and limit of quantitation determinations. The field blanks are QC samples that are introduced into a process to monitor the performance of the system. The use of field blanks to calculate the limit of detection and the limit of quantitation is preferred over the use of laboratory blanks because field blanks include error contributions from sample preparation and handling, in addition to analytical uncertainties. Methods to calculate the limit of detection and the limit of quantitation are described in detail in Appendix A of the *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site for 1990* (DOE/RL-91-03).

Because of the lack of blank data for other constituents of concern, it was necessary to calculate approximate limit of detection and limit of quantitation values by using variability information obtained from low-level standards. The data from the low-level standards are obtained from laboratory method detection limit studies. If low-level standards are used, the variability of the difference between the sample and blank response is increased by a factor of 2 (Currie 1988, p. 84). The minimum detection level (MDL), level of detection (LOD), and limit of quantitation (LOQ) calculated as follows:

$$MDL = 3.14 * s$$
$$LOD = 3(* s) = 4.24 * s$$
$$LOQ = 10(* s) = 14.4 * s$$

where s = standard deviation from the seven replicates of the low-level standard.

The results of limit of detection, limit of quantitation, and method detection limit calculations for most non-radiological constituents of concern (other than total organic carbon and total organic halides) are listed in Tables E-33 and E-34. The values in Table E-33 apply to WSCF and the values in Table E-34 apply to TA St. Louis. The radiological constituents, total organic carbon, and total organic halides are provided in Table E-32.

E.8. Conclusions

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Overall, assessments of QA/QC information from the reporting period indicate that groundwater monitoring data are reliable and defensible. Little contamination or other sampling-related problems were encountered that affected data integrity. Likewise, laboratory performance was good in most respects, based on the large percentages of acceptable field and laboratory QC results. Laboratory audits and generally acceptable results in nationally based performance evaluation studies also demonstrated acceptable laboratory performance for the Groundwater Project. However, the following areas of concern were identified and should be considered when interpreting groundwater monitoring results from the current reporting period.

Several indicator parameters, anions, metals, volatile organic compounds, and radiological parameters were detected at low levels in field and/or laboratory method blanks. This indicates possible contamination in the field and/or laboratory and data associated with this QC issue are flagged in the HEIS database. Data users must consider data flags when making decisions regarding data usability.

Maximum recommended holding times were exceeded for 0.2% of groundwater monitoring samples that were analyzed by non-radiological methods. This is improved from 3.7% in FY 2007 and 1% in FY 2008. Affected data are flagged with “H” in the HEIS database. Data users should consider “H” flags when making decisions regarding data usability.

Several analytical areas have been identified for continued evaluation and follow up in FY 2010. These include anions, metals, hexavalent and total chromium, and volatile organic compounds.

E.9. Glossary

Accuracy: Closeness of agreement between an observed value and a true value. Accuracy is assessed by means of reference samples and percent recoveries. Laboratory matrix spikes; laboratory control samples; EPA water pollution, water supply and interlaboratory comparison programs; and blind standards are all used to assess accuracy.

Blind standard: Sample that contains a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The analyzing laboratory is informed that the sample is a QC sample and not a field sample. Blind, double-blind, and matrix-matched double-blind standards are used to evaluate analytical accuracy and precision as a measure of laboratory performance.

Comparability: Degree to which one set of data can be compared to another. For example, the results from samples analyzed by more than one laboratory may or may not be comparable. Ideally, comparability should be evaluated using identical samples to ensure that valid comparisons can be made.

Completeness: Amount of acceptable data divided by the total number of data points. The Groundwater Project determines completeness by calculating the number of unflagged data resulting from the validation process, dividing by the total number of data evaluated, and multiplying by 100. The calculated percentages used in reporting completeness are conservative because all data flagged with “B,” “H,” “Q,” “R,” and “Y” (flags) are used in calculating the percentage complete; however, flagged data may still be valid.

Data management staff: Groundwater Project staff responsible for tracking samples and data from sample planning through data receipt. This title includes staff responsible for management of the databases and electronic tools used to support data management activities.

Double-blind standards: Sample that contains a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The analyzing laboratory is not informed that the sample is a QC sample. All attempts are made to make sure this sample appears like a field sample. Double-blind standards may or may not include matrix matching. Blind, double-blind, and matrix-matched double-blind standards are used to evaluate analytical accuracy and precision as a measure of laboratory performance.

Equipment blank: Sample that contains reagent water and any required preservative(s). An equipment blank is filled by pumping or washing reagent water through non-dedicated sampling equipment. The equipment blank is analyzed for all constituents scheduled for the sampling event. Equipment blanks are used to monitor contamination due to improperly cleaned equipment.

Field duplicate sample: Replicate sample to determine the precision of the sampling and analytical measurement process by comparing results from identical samples collected at the same time and location. Matching field duplicates are stored in separate containers and are analyzed independently by the same laboratory.

Field trip blank (field transfer blank): Sample that contains reagent water and any required preservative(s). At the time of sample collection, the field trip blank is filled at the sampling site by pouring reagent water from a cleaned container into sample vials. After collection, the field trip blank is treated in the same manner as the samples collected during the sampling event. Field trip blanks are collected only on days when other samples are collected for volatile organic analysis and are analyzed only for volatile organic constituents. Field trip blanks are used to check for volatile organic contamination associated with sampling activities.

Flags (as qualifiers): Codes that alert data users to limitations on reported data values. Data flags may be assigned by the laboratory or by Groundwater Project analytical support staff. A complete list of review flags is provided in Table E-1. The common flags used include, but are not limited to, the following:

- B: Data associated with contamination in the laboratory method blank (organics).
- B: Result detected was less than the contract-required detection limit but greater than the minimum detection level (inorganics).
- B: Data associated with contamination in the blank greater than two times the minimum detectable activity (radiochemistry).
- C: Data associated with contamination in the laboratory method blank (inorganics).
- F: Suspect data currently under review.
- H: Holding time exceeded.
- G: Reviewed data found to be valid.
- P: Potential problem with the sample or well that may have affected the data.
- Q: Result associated with suspect field QC data.
- R: Reviewed data found to be unusable.
- Y: Reviewed data found to be suspect.

Full trip blank: Sample that contains reagent water and any required preservative(s). A full trip blank is used to check for contamination in sample bottles and sample preparation. A full trip blank is analyzed for all constituents of interest and is collected in all types of sample bottles used during that sampling period. The full trip blank is filled during bottle preparation using the same sample preparation procedures as for regular well samples. The full trip blank is then handled the same as all other samples through delivery to the laboratory but is not opened in the field.

Groundwater Project analytical support staff: Groundwater Project staff responsible for reviewing and assessing the quality of data and analytical services. This group performs quarterly and annual reviews of QC data and ensures appropriate data flags are applied. They monitor the qualification and performance of the laboratories supporting the Groundwater Project.

Groundwater Project: The Hanford Site Groundwater Monitoring Program.

Groundwater staff: Employees of the Groundwater Project, including project scientists, analytical support staff, data management staff, field staff, etc.

Laboratory control sample: Sample of reagent water spiked with a known amount of the target analyte(s). The sample is extracted (if appropriate) and analyzed to monitor the performance of the analytical method.

Matrix duplicate: Replicate analysis of a regular (i.e., groundwater) sample. Matrix duplicates and matrix spike duplicates are used to evaluate the precision of an analysis method. Precision of ±20% is expected for matrix duplicates.

Matrix-matched double-blind standard: Sample prepared that contains a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The sample matrix is selected to closely match that of field samples. Matrix-matched double-blind standards are disguised to appear as regular well samples to help ensure that any analyses performed are representative of those for routine well samples. Most of the blind standards submitted for the Groundwater Project are matrix-matched double-blind standards.

Matrix spikes/matrix spike duplicates: Sample(s) prepared at the analytical laboratory by adding known quantities of one or more target analytes to a sample prior to extraction and analysis. Comparison of the original (i.e., unspiked) sample and matrix spike results provides information about the suitability of an analysis for the sample matrix. For example, unusually high or low recoveries of the spiked compounds may indicate that components in the sample matrix interfere with the analysis. Matrix spike duplicates are replicate matrix spike samples that are used to assess the precision of an analysis. Precision of ±20% is expected for matrix spike duplicates.

Method blank: Sample of reagent water prepared in the laboratory, extracted (if appropriate), and analyzed as if it were a regular sample. Method blanks are used to monitor the possible introduction of contaminants during sample preparation and analysis at the laboratory.

Precision: Agreement among individual measurements of the same property, usually under prescribed similar conditions. For a set of duplicate measurements, precision is calculated by the relative percent difference of the duplicate results. For the Groundwater Project, results from laboratory duplicates, matrix spike duplicates, blind standards, split samples, and field duplicates are used to evaluate precision.

Project scientist: Groundwater Project scientist responsible for the technical evaluation of data for a specific well or set of wells.

Reagent water: Distilled or deionized water free of contaminants that may interfere with analytical tests.

Relative percent difference (RPD): Calculated as follows:

$$RPD = \frac{|D1 - D2|}{(D1 + D2) / 2} \times 100$$

where $D1$ = original sample value and $D2$ = duplicate sample value.

Representativeness: Expression of the degree to which samples represent the actual composition of the material tested (e.g., groundwater in the aquifer). Representativeness is addressed qualitatively by the specification of well construction, sampling locations, sampling intervals, and sampling and analysis techniques addressed in monitoring plans.

Split samples: Samples sequentially collected from the same location in the same sampling event and analyzed by different laboratories. Split samples are used to evaluate laboratory precision and comparability.

Surrogates: Organic compounds similar to analytes of interest in chemical composition, extraction, and analytical properties, but which are not normally found in environmental samples. Surrogates are spiked into method blanks, samples, and matrix spikes and are then extracted and analyzed to monitor the effectiveness of sample preparation and analysis on individual samples.

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Table E-1. Data Review Flags.

Flag	Definition
F	Result is being reviewed as part of the RDR process. This flag is assigned when an RDR is initiated.
G	Result is valid according to further review.
H	Holding time exceeded before the sample was analyzed.
P	Potential problem. Collection/analysis circumstances make value questionable.
Q	Associated quality control sample is out of limits.
R	Result is not valid according to further review.
Y	Result is suspect. Review had insufficient evidence to show result valid or invalid.
Z	Miscellaneous circumstance exists. See project file.

Notes:
RDR = request for data review

Table E-2. Requests for Data Review, Current Reporting Period Data.

Flag "G"	Flag "Y"	Flag "R"	Flag "P"	Other Action	Pending	Number of Results with Assigned RDR
Analytical Results						
602	675	80	4	40	258	1,659
Water-Level Measurements						
2	54	4	0	0	13	73

Notes:
G = result was reviewed and determined to be correct or data was corrected
P = potential problem with the well, collection, or analysis that makes the result questionable
R = result was reviewed and found to be unusable
RDR = requests for data review
Y = result is suspect

Table E-3. Summary of Data Completeness.

	Suspect Data	Rejected Data	Field QC	Holding Time	Method Blank	Total
Number of results flagged	668	83	3,734	406	1,042	5,841
Percent flagged data	0.3%	0.0%	1.8%	0.2%	0.5%	2.8%
Percent acceptable data			98.2%	99.8%	99.5%	97.2%

Notes:
The total number of reported results was 206,204.

QC = quality control

Table E-4. Full Trip Blanks Exceeding Quality Control Limits.

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
Ammonia and Anions					
Chloride	2	143	1.4	40 – 188 µg/L	310 – 11,800 µg/L
Nitrogen in nitrate	3	143	2.1	76.2 – 548 µg/L	770 – 7,660 µg/L
Metals					
Aluminum	1	22	4.6	10 – 20 µg/L	142 µg/L
Arsenic	1	72	1.4	0.8 – 130 µg/L	1.8 µg/L
Barium	4	232	1.7	0.4 – 8 µg/L	9.6 – 17.2 µg/L
Calcium	81	222	36.5	37.2 – 146 µg/L	44.1 – 25,200 µg/L
Copper	2	232	0.9	0.2 – 12 µg/L	0.201 – 17.1 µg/L
Iron	8	222	3.6	32 – 50 µg/L	36.1 – 123 µg/L
Magnesium	36	222	16.2	32 – 220 µg/L	32.4 – 7,540 µg/L
Potassium	6	222	2.7	110 – 3,300 µg/L	318 – 4,490 µg/L
Silver	7	232	3.0	0.2 – 12 µg/L	10.2 – 19.6 µg/L
Sodium	62	222	27.9	34 – 268 µg/L	43.6 – 10,300 µg/L
Strontium	1	222	0.5	1.08 – 8 µg/L	142 µg/L
Uranium	3	65	4.6	0.1 – 0.2 µg/L	0.122 – 2.18 µg/L
Vanadium	1	222	0.5	8.2 – 24 µg/L	31.8 µg/L
Zinc	4	222	1.8	8 – 18 µg/L	27 – 406 µg/L
Volatile Organic Compounds					
Carbon tetrachloride	9	62	14.5	0.146 – 2 µg/L	2.4 – 4.7 µg/L
Methylene chloride	10	62	16.1	0.5 – 50 µg/L	5.1 – 140 µg/L
Radiological Parameters					
Gross beta	4	71	5.6	2.6 – 19 pCi/L	3.3 – 19 pCi/L
Potassium-40	1	30	3.3	37.6 – 420 pCi/L	46.3 pCi/L
Technetium-99	1	65	1.5	11.4 – 20.6 pCi/L	14 pCi/L
Total beta radiostrontium	2	31	6.5	1.84 – 8.8 pCi/L	16 – 25 pCi/L
Tritium	3	90	3.3	45.6 – 500 pCi/L	980 – 32,000 pCi/L

Notes:
* Because method detection limits are specific to the laboratory and may change throughout the year, the limits are presented as a range. However, each result was evaluated according to the method detection limit in effect at the time the sample was analyzed.

QC = quality control

Table E-5. Field Transfer Blanks Exceeding Quality Control Limits.

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
Volatile Organic Compounds					
2-Butanone	1	237	0.42	4.15 – 5 µg/L	10 **µg/L**
Acetone	2	237	0.84	2.1 – 5 **µg/L**	4.3 – 22 **µg/L**
Carbon disulfide	1	236	0.42	0.058 – 2 **µg/L**	0.085 **µg/L**
Carbon tetrachloride	24	237	10.13	0.084 – 2 **µg/L**	0.097 – 46 **µg/L**
Chloroform	5	237	2.11	0.134 – 2 **µg/L**	0.39 – 1.5 **µg/L**
Methylene chloride	98	237	41.35	0.455 – 5 **µg/L**	0.53 – 47 **µg/L**
Tetrachloroethene	2	237	0.84	0.13 – 2 **µg/L**	0.38 – 0.45 **µg/L**
Trichloroethene	8	237	3.38	0.182 – 2 **µg/L**	0.19 – 0.56 **µg/L**

Notes:
* Because method detection limits are specific to the laboratory and may change throughout the year, the limits are presented as a range. However, each result was evaluated according to the method detection limit in effect at the time the sample was analyzed.

QC = quality control

Table E-6. Equipment Blanks Exceeding Quality Control Limits.

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
General Chemistry Parameters					
Oil and grease	1	4	25.00	1,000 – 4,200 µg/L	1,600 µg/L
Ammonia and Anions					
Chloride	1	63	1.60	86 – 188 µg/L	471 µg/L
Nitrogen in nitrate	2	64	3.10	106.2 – 548 µg/L	567 – 863 µg/L
Sulfate	1	64	1.60	132 – 600 µg/L	961 µg/L
Metals					
Calcium	37	97	38.1	37.2 – 146 µg/L	49 – 12,000 µg/L
Cobalt	2	101	2.0	0.1 – 10 µg/L	0.104 – 0.139 µg/L
Copper	4	101	4.0	0.2 – 12 µg/L	0.246 – 12.3 µg/L
Iron	10	98	10.2	32 – 50 µg/L	36.4 – 317 µg/L
Magnesium	19	98	19.4	32 – 220 µg/L	32.6 – 254 µg/L
Manganese	4	98	4.1	0.2 – 8 µg/L	0.866 – 9.1 µg/L
Potassium	4	97	4.1	110 – 3,300 µg/L	127 – 378 µg/L
Selenium	1	6	16.7	0.6 – 90 µg/L	2.89 µg/L
Silver	1	101	1.0	0.2 – 12 µg/L	0.473 µg/L
Sodium	38	97	39.2	34 – 268 µg/L	46.2 – 1,160 µg/L
Strontium	1	97	1.0	1.08 – 8 µg/L	16 µg/L
Uranium	1	32	3.1	0.1 – 0.2 µg/L	0.776 µg/L
Zinc	2	97	2.1	8 – 18 µg/L	13.8 – 24.3 µg/L
Volatile Organic Compounds					
Carbon tetrachloride	6	29	20.7	2 µg/L	2.5 – 7.4 µg/L
Methylene chloride	2	29	6.9	5 µg/L	7 – 7.6 µg/L
Radiological Parameters					
Technetium-99	2	35	5.7	11.8 – 23 pCi/L	13 – 18 pCi/L
Total beta radiostrontium	1	22	4.5	1.64 – 8.6 pCi/L	5.6 pCi/L
Tritium	1	40	2.5	380 – 500 pCi/L	5,500 pCi/L

Notes:
* Because method detection limits are laboratory specific and may change throughout the year, the limits are presented as a range. However, each result was evaluated according to the method detection limit in effect at the time the sample was analyzed.

QC = quality control

Table E-7. Field Duplicates Exceeding Quality Control Limits.

Constituent	Total Number of Duplicates	Number of Duplicates Evaluated[a]	Number Out of Limits	Percent Out of Limits	Range of Out-of-Limit RPD[b]
General Chemistry Parameters					
Total petroleum hydrocarbon - diesel range	9	2	1	50.0	94.5
Total petroleum hydrocarbon - gasoline range	7	1	1	100.0	172.2
Ammonia and Anions					
Cyanide	18	4	1	25.0	50.7
Fluoride	188	37	2	5.4	31.7 – 79.8
Nitrogen in ammonium	17	2	2	100.0	78.1 – 128.1
Nitrogen in nitrate	191	180	1	0.6	33.4
Sulfate	189	188	2	1.1	29.6 – 36.8
Metals					
Aluminum	32	4	1	25.0	166.7
Barium	306	291	3	1.0	30.4 – 33.7
Calcium	290	290	1	0.3	113.0
Chromium	308	64	2	3.1	59.4 – 167.5
Copper	306	3	3	100.0	41.8 – 140.0
Hexavalent Chromium	252	162	6	3.7	21.6 – 53.7
Iron	291	53	19	35.8	20.3 – 138.9
Lead	37	1	1	100.0	26.8
Magnesium	291	289	3	1.0	20.8 – 38.9
Manganese	291	42	5	11.9	20.8 – 102.5
Mercury	46	4	1	25.0	20.4
Nickel	291	11	2	18.2	31.7 – 96.9
Strontium	290	287	1	0.3	24.3
Uranium	82	81	2	2.5	26.6 – 103.6
Zinc	290	15	3	20.0	29.6 – 186.8
Volatile Organic Compounds					
Acetone	86	5	4	80.0	30.8 – 184.6
Carbon disulfide	82	1	1	100.0	42.6
Carbon tetrachloride	87	23	1	4.3	187.1
Chloroform	87	21	1	4.8	195.7
Chloromethane	11	1	1	100.0	75.9
Iodomethane	2	1	1	100.0	182.6
Methylene chloride	86	7	6	85.7	138.7 – 191.7
Semivolatile Organic Compounds					
Bis(2-ethylhexyl) phthalate	15	2	2	100.0	29.1 – 61.3
Radiological Parameters					
Americium-241	7	1	1	100.0	51.3
Carbon-14	32	18	7	38.9	21.2 – 111.6
Gross alpha	74	8	2	25.0	34.1 – 35.3
Gross beta	82	50	10	20.0	21.9 – 187.3
Iodine-129	51	22	6	27.3	25.9 – 205.7
Technetium-99	83	45	1	2.2	182.9
Total beta radiostrontium	64	12	3	25.0	33.3 – 200.1
Tritium	133	88	3	3.4	34.1 – 51.9
Uranium-234	2	2	1	50.0	38.4
Uranium-238	2	2	1	50.0	21.9

Notes:
a. Duplicates with both results less than five times the method detection limit or minimum detectable activity were excluded from the evaluation.
b. In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used for the non-detected concentration.

RPD = relative percent diffference

Table E-8. Field Splits Exceeding Quality Control Limits.

Constituent	Total Number of Splits	Number of Splits Evaluated[a]	Number Out of Limits	Percent Out of Limits	Range of Out-of-Limit RPD[b]
General Chemistry Parameters					
Alkalinity	7	7	1	14.3	32.8
Total organic carbon	16	4	2	50.0	22.0 – 197.2
Ammonia and Anions					
Chloride	68	68	2	2.9	21.6 – 126.8
Cyanide	4	1	1	100.0	66.2
Fluoride	68	56	47	83.9	21.2 – 120.0
Nitrogen in nitrate	61	60	2	3.3	32.4 – 189.3
Nitrogen in nitrite	61	9	5	55.6	22.6 – 104.3
Sulfate	68	68	1	1.5	94.5
Metals					
Arsenic	26	8	4	50.0	23.0 – 124.1
Barium	82	82	3	3.7	21.4 – 62.3
Cadmium	82	1	1	100.0	50.0
Calcium	76	76	1	1.3	71.9
Chromium	82	48	13	27.1	20.7 – 136.6
Cobalt	82	3	3	100.0	36.3 – 146.0
Copper	82	4	4	100.0	92.1 – 198.2
Hexavalent chromium	186	138	26	18.8	20.4 – 187.2
Iron	76	22	15	68.2	25.4 – 166.9
Magnesium	76	76	1	1.3	68.6
Manganese	76	15	6	40.0	22.5 – 97.2
Nickel	76	3	1	33.3	30.0
Potassium	76	76	34	44.7	22.3 – 110.3
Strontium	76	76	20	26.3	21.1 – 66.1
Uranium	28	7	2	28.6	25.5 – 169.6
Vanadium	76	6	2	33.3	21.2 – 21.9
Zinc	76	15	10	66.7	20.3 – 193.4
Semivolatile Organic Compounds					
Naphthalene	17	1	1	100.0	27.7
Radiological Parameters					
Carbon-14	12	8	8	100.0	26.0 – 207.3
Gross beta	24	7	2	28.6	33.3 – 103.6
Iodine-129	34	30	8	26.7	32.8 – 71.8
Technetium-99	34	15	5	33.3	22.0 – 178.9
Tritium	35	22	2	9.1	21.0 – 24.1
Uranium	28	21	2	9.5	25.5 – 169.6

Notes:
a. Splits with both results less than five times the method detection limit or minimum detectable activity were excluded from the evaluation.
b. In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used for the non-detected concentration.

RPD = relative percent difference

Table E-9. Summary of Analytical Method Categories.

Category	HEIS Method Name	Description
General chemistry parameters	120.1_CONDUCT	Specific conductivity, conductance bridge
	120.1_CONDUCT_FLD	Specific conductivity, field measurement
	150.1_PH	pH by electrode
	160.2_TSS	Total suspended solids
	2320_ALKALINITY	Alkalinity
	310.1_ALKALINITY	Alkalinity, titrametric
	360.1_OXYGEN	Dissolved oxygen
	360.1_OXYGEN_FLD	Dissolved oxygen
	410.4_COD	Chemical oxygen demand, automated; manual
	413.1_OILGREASE	Oil and grease, total recoverable, gravimetric, separatory funnel extraction
	420.2_PHENOLIC	Phenolics, automated colorimetric
	9020_TOX	Total organic halides
	9060_TOC	Total organic carbon
	9070_OILGREASE	Total recoverable oil and grease, gravimetric
	9223_COLIFORM	Coliform by enzyme substrate test
	CONDUCT_FLD	Field conductivity by instrument manufacturer instructions
	PH_ELECT_FLD	pH analysis by electrode, field measurement
	REDOX_PROBE_FLD	Oxidation-reduction potential by platinum electrode
	TEMP_FLD	Temperature, field measurement
	TURBIDITY_FLD	Nephelometric turbidity, field measurement
	WTPH_DIESEL	Total petroleum hydrocarbons, SE/GC-FID, Ecology
	WTPH_GASOLINE	Total petroleum hydrocarbons, P&T/GC-FID, Ecology
Ammonia and anions	300.0_ANIONS_IC	Anions by ion chromatography
	300.7_CATIONS_IC	Cations by ion chromatography
	335.2_CYANIDE	Total cyanide, titrametric, spectrophotometric
	350.1_AMMONIA	Ammonia, automated phenate
	9012_CYANIDE	Cyanide, automated colorimetric
	9030_SULFIDE	Sulfide by titration
Metals	200.8_METALS_ICPMS	Metals by ICP/MS
	6010_METALS_ICP	Metals by ICP
	6020_METALS_ICPMS	Metals by ICP/MS
	7196_CR6	Chromium (hexavalent) - Cr+6, colorimetric
	7470_HG_CVAA	Mercury (Hg) by CVAA
	COLOR_TK_CR6_FLD	Color by test kit for hexavalent chromium, field measurement
Volatile organic compounds	8015_VOA_GC	Non-halogenated volatiles by GC
	8260_VOA_GCMS	Volatile organics by GC/MS capillary column
Semivolatile organic compounds	1668A_PCB_CONGENER	PCB congeners by high-resolution gas chromatography/high-resolution mass spectrometry
	8040_PHENOLIC_GC	Phenols by GC
	8081_PEST_GC	Organoclhorine pesticides by GC
	8082_PCB_GC	PCBs bY GC
	8151_HERBICIDE_GC	Chlorinated herbicides by GC using methylation or pentafluorobenzylation derivatization: capillary column technique
	8270_SVOA_GCMS	Semivolatile organic analytes by GC/MS
	8290_DIOXINS_GCMS	Dioxins by HRGC/HRMS
	8310_SVOA_HPLC	Semivolatile organic analysis by HPLC (PAHs)

Table E-9. (Cont.)

Category	HEIS Method Name	Description
Radiological parameters	900.0_ALPHABETA_GPC	Gross alpha/beta by GPC
	906.0_H3_LSC	Tritium in drinking water, LSC
	906.0ML_H3_LSC	Tritium in drinking water, mid-level, liquid scintillation
	9310_ALPHABETA_GPC	Gross alpha and gross beta by GPC
	ALPHA_GPC	Gross alpha, GPC
	AMCMISO_IE_PREC_AEA	Americium/curium isotopic, separated by ion exchange, precipitated, alpha spec
	BETA_GPC	Gross beta, GPC
	C14_CHEM_LSC	Carbon-14, chemical oxidation/LSC
	C14_LSC	Carbon-14 analysis by unknown method
	GAMMA_GS	Gamma spectroscopy, germanium high-energy detectors
	GAMMALL_GS	Gamma spectroscopy, low-level germanium high-energy detector
	I129_SEP_LEPS_GS	Iodine-129, separation, precipitation, LEPS
	I129LL_SEP_LEPS_GS	Iodine-129, low-level, separation, precipitation, LEPS detection
	NI63_LSC	Nickel-63 by LSC
	NP237_LLE_PLATE_AEA	Neptunium isotopic, liquid-liquid extraction, electroplated, alpha spec
	PA231_IE_PLATE_AEA	Protactinium 231, separated by ion exchange, plated, alpha spec
	PUISO_IE_PRECIP_AEA	Isotopic plutonium, ion-exchange separation, precipitated on disk, alpha spec
	PUISO_PLATE_AEA	Isotopic plutonium, unknown separation, electroplated, alpha spec
	RADISOTOPES_ICPMS	Radioisotopes by ICP/MS
	SE79_SEP_IE_LSC	Selenium-79, separated, ion-exchange resin, LSC
	SRISO_SEP_PRECIP_GPC	Strontium beta isotopic, chemical separation, precipitated, GPC
	SRTOT_SEP_PRECIP_GPC	Total beta strontium, chemical separation, precipitation, GPC
	TC99_3MDSK_LSC	Technetium-99, 3M disk separation, LSC
	TC99_ETVDSK_LSC	Technetium-99, Eichrome Teva disk separation, LSC
	TC99_SEP_LSC	Technetium-99, ppt. and ion-exchange resin separation, LSC
	TC99_TR_SEP_GPC	Technetium-99, separated, tracer yield, GPC
	THISO_IE_PRECIP_AEA	Isotopic thorium, ion exchanges separation with and from lead-210, precipitated, alpha spec
	TRITIUM_EIE_LSC	Tritium in water, purification by Eichrome ion exchange, LSC
	UISO_PLATE_AEA	Uranium isotopic, separation unknown, electroplated, alpha spectrometry
	UTOT_KPA	Total uranium, unknown separation, laser phosphorimetry

Notes:
CVAA = cold vapor atomic absorption
Ecology = Washington State Department of Ecology
GC = gas chromatography
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
LSC = liquid scintillation counter
MS = mass spectrometry
PCB = polychlorinated biphenyl

Table E-10. Method Blank Results, WSCF.

Constituent	Percent Out of Limit[a]	Number of Analyses	Concentration Range of Out-of-Limit Results
General Chemistry Parameters			
Total general chemistry parameters	0.0	252	—
Ammonia and Anions			
Total ammonia and anions	0.0	3,434	—
Metals			
Total metals	0.1	6,698	—
Copper	21.4	14	0.22 – 0.33 µg/L
Calcium	0.3	308	169 µg/L
Copper	0.3	308	9.4 µg/L
Iron	0.6	308	89.5 – 106 µg/L
Nickel	0.3	307	8.6 µg/L
Silver	2.6	307	10.1 – 14.2 µg/L
Sodium	0.3	308	281 µg/L
Volatile Organic Compounds			
Total volatile organic compounds	0.1	4,918	—
2-Pentanone, 4-methyl	1.1	180	5.9 µg/L
Acetone[b]	2.7	183	6.6 – 100 µg/L
Carbon tetrachloride	1.1	186	2.2 – 3.9 µg/L
Methylene chloride[b]	2.2	185	5.3 – 150 µg/L
Semivolatile Organic Compounds			
Total semivolatile organic compounds	0.0	818	—
Radiological Parameters			
Total radiochemistry parameters	0.3	1,571	—
Gross alpha	0.5	193	11 pCi/L
Gross beta	0.4	224	10 pCi/L
Total beta radiostrontium	2.2	182	4.1 – 28 pCi/L
Tritium	0.9	225	4,400 pCi/L

Notes:
a. Quality control limits are twice the method detection limit.
b. Quality control limits are five times the method detection limit.

WSCF = Waste Sampling and Characterization Facility

Table E-11. Hanford Groundwater Remediation Project Maximum Recommended Holding Times.

Method	Constituent	Holding Time
120.1 (EPA-600/4-81-004)	Conductivity	28 days
160.1 (EPA-600/4-81-004)	Total dissolved solids	7 days
300.0 (EPA-600/4-81-004)	Bromide	28 days
300.0 (EPA-600/4-81-004)	Chloride	28 days
300.0 (EPA-600/4-81-004)	Fluoride	28 days
300.0 (EPA-600/4-81-004)	Nitrate	48 hours
300.0 (EPA-600/4-81-004)	Nitrite	48 hours
300.0 (EPA-600/4-81-004)	Phosphate	48 hours
300.0 (EPA-600/4-81-004)	Sulfate	28 days
310.1 (EPA-600/4-81-004)	Alkalinity	14 days
350.1 (EPA-600/4-81-004)	Ammonia	28 days
410.4 (EPA-600/4-81-004)	Chemical oxygen demand	28 days
6010 (SW-846)	Inductively coupled plasma metals	6 months
6020 (SW-846)	Inductively coupled plasma-mass spectrometry metals	6 months
7196 (SW-846)	Hexavalent chromium	24 hours
7470 (SW-846)	Mercury	28 days
8015M (SW-846)	Total petroleum hydrocarbons	14 days
8040 (SW-846)	Phenols	7 days before extraction; 40 days after extraction
8081 (SW-846)	Pesticides	7 days before extraction; 40 days after extraction
8082 (SW-846)	Polychlorinated biphenyls	1 year before extraction; 1 year after extraction
8260 (SW-846)	Volatile organics	14 days
8270 (SW-846)	Semivolatile organics	7 days before extraction; 40 days after extraction
9012 (SW-846)	Cyanide	14 days
9020 (SW-846)	Total organic halides	28 days
9030 (SW-846)	Sulfides	7 days
9060 (SW-846)	Total organic carbon	28 days
9223 (APHA et al. 1998)	Coliform	24 hours

Notes:
Standard Methods for the Examination of Water and Wastewater (APHA et al. 1998).
EPA/600/4-81/004, *Environmental Radioactivity Laboratory Intercomparison Studies Program: Fiscal Year 1980-81.*
SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods.*

Table E-12. Summary of TestAmerica Water Pollution and Water Supply Performance Evaluation Studies.

Study and Date	TA St. Louis	TA Richland
Accreditation Laboratory, Environmental Resource Associates		
WP-168, March 2009	561 of 572[a]	--
WP-173, August 2009	546 of 555[b]	--
WP-174, September 2009	75 of 76[c]	--
DOE Mixed Analyte Performance Evaluation Program, Radiological and Environmental Sciences Laboratory		
MAPEP-09-OrW19, April 2009	73 of 74[d]	--
MAPEP-09-GrW19, April 2009	2 of 2	2 of 2
MAPEP-09-MaW19, April 2009	33 of 34[e]	15 of 15
MAPEP-09-OrW20, July 2009	71 of 74[f]	--
MAPEP-09-GrW20, July 2009	2 of 2	2 of 2
MAPEP-09-MaW20, July 2009	34 of 34	15 of 15

Notes:
a. Unacceptable results were for volatile solids, nitrite as N, COD, trans-1,2-dichloroethylene, 2,4-DB, hexachlorocyclopentadiene, benzene, ethylbenzene, toluene, and xylenes (total).
b. Unacceptable results were for ortho-phosphate as P (2), boron (2), ethylbenzene (3), 2,4-D, and dichloprop.
c. Unacceptable result was for naphthalene.
d. Unacceptable result was for gamma-BHC.
e. Unacceptable result was for nickel-63.
f. Unacceptable results were for banzo(a)anthracene, chrysene, and hexachlorobenzene.

DOE = U.S. Department of Energy
MAPEP = Mixed Analyte Performance Evaluation Program
TA = TestAmerica
WP = water pollution

Table E-13. Summary of WSCF Water Pollution and Waste Supply Performance Evaluation Studies.

Study and Date	WSCF
Accreditation Laboratory, Environmental Resource Associates	
WP-168, March 2009	83 of 83
WP-174, September 2009	85 of 85
DOE Mixed Analyte Performance Evaluation Program, Radiological and Environmental Sciences Laboratory	
MAPEP-08-OrW19, December 2008	56 of 57[a]
MAPEP-08-GrW19, December 2008	2 of 2
MAPEP-08-MaW19, December 2008	30 of 31[b]
MAPEP-09-MaWR1, January 2009	1 of 1
MAPEP-09-OrW20, July 2009	57 of 57
MAPEP-09-GrW20, July 2009	2 of 2
MAPEP-09-MaW20, July 2009	31 of 31
MAPEP-09-OrW21, November 2009	57 of 57
MAPEP-09-GrW21, November 2009	2 of 2
MAPEP-09-MaW21, November 2009	30 of 30
InterLaB RadCheM Proficiency Testing Program, Environmental Resource Associates	
RAD-75, November 2008	8 of 9[c]
RAD-76, March 2009	4 of 4

Notes:
a. Unacceptable results were for 2,4,6-trichlorophenol.
b. Unacceptable results were for technetium.
c. Unacceptable result was for radium-228.

DOE = U.S. Department of Energy
MAPEP = Mixed Analyte Performance Evaluation Program
WP = water pollution
WSCF = Waste Sampling and Characterization Facility

Table E-14. Summary of Eberline Services and Lionville Laboratory Water Supply Performance Evaluation Studies.

Study and Date	Eberline	Lionville
DOE Mixed Analyte Performance Evaluation Program, Radiological and Environmental Sciences Laboratory		
MAPEP-08-OrW19, December 2008	--	55 of 57[a]
MAPEP-08-GrW19, December 2008	2 of 2	--
MAPEP-08-MaW19, December 2008	--	15 of 15
MAPEP-09-OrW20, July 2009	--	56 of 57[b]
MAPEP-09-GrW20, July 2009	2 of 2	--
MAPEP-09-MaW20, July 2009	--	15 of 15
InterLaB RadCheM Proficiency Testing Program, Environmental Resource Associates		
RAD-75, December 2008	3 of 3	--
RAD-76, March 2009	13 of 13	--
RAD-77, June 2009	4 of 4	--
RAD-78, September 2009	13 if 14[c]	--
RAD-79, December 2009	1 of 1	--
Wibby Environmental Water Supply and Water Pollution		
Rapid Return Proficiency (RR-04955), March 2009	--	22 of 23[d]
Water Pollution Proficiency (WP0209), April 2009	--	566 of 605[e]

Notes:
a. Unacceptable results were for 4-bromophenyl-phenylether and phenathrene.
b. Unacceptable results were for hexachrlorocyclopentadiene.
c. Unacceptable results were for radium-126.
d. Unacceptable results were for thallium.
e. Unacceptable results were for tin, total organic carbon (2), orthophosphate as O (2), total phosphorous (2), bromodichloromethane, bromoform, carbon tetrachloride, chlorobenzene, chloroform, dibromochloromethane, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane (2), trans-1,3-dichloropropene, ethylbenzene, styrene, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, cis-1,3-dichloropropylene, 2-hexanone, 1,1,1,2-tetrachloroethane, acenaphthylene, bis(2-chloroethoxy)methane, N-nitrosodiphenylamine, benzyl alcohol, toxaphene, Aroclor 1232, Aroclor 1242, and parathion-ethyl.

DOE = U.S. Department of Energy
MAPEP = Mixed Analyte Performance Evaluation Program
WP = water pollution

Table E-15. Summary of TestAmerica Laboratories Double-Blind Spike Determinations.

Constituent	Laboratory	Sample Frequency	Number of Results Reported[a]	Number of Results Outside QC Limits	Acceptable Results	Control Limits[b] (%)
General Chemical Parameters						
Specific conductance	St. Louis	Quarterly	15	0	100%	±25
Total organic carbon (potassium hydrogen phthalate spike)	St. Louis	Quarterly	16	0	100%	±25
Total organic halides (2,4,5-trichlorophenol spike)	St. Louis	Quarterly	17	3	82%	±25
Total organic halides (carbon tetrachloride, chloroform, and trichloroethene spike)	St. Louis	Quarterly	18	0	100%	±25
Ammonia and Anions						
Chloride	St. Louis	Quarterly	15	0	100%	±25
Cyanide	St. Louis	Semiannually	12	4	67%	±25
Fluoride	St. Louis	Quarterly	19	9	53%	±25
Nitrate as nitrogen	St. Louis	Quarterly	18	0	100%	±25
Nitrite as nitrogen	St. Louis	Quarterly	15	0	100%	±25
Metals						
Chromium (total)	St. Louis	Quarterly[c]	12	0	100%	±20
Hexavalent chromium	Richland	Quarterly[c]	12	3	75%	±20
Volatile Organic Compounds						
Carbon tetrachloride	St. Louis	Semiannually	12	6	50%	±25
Chloroform	St. Louis	Semiannually	12	0	100%	±25
Trichloroethene	St. Louis	Semiannually	12	3	75%	±25
Radiological Parameters						
Gross alpha (plutonium-239 spike)	Richland	Quarterly	15	9	40%	±30
Gross beta (strontium-90 spike)	Richland	Quarterly	15	0	100%	±30
Cesium-137	Richland	Annually	3	0	100%	±30
Cobalt-60	Richland	Annually	3	0	100%	±30
Iodine-129	Richland	Semiannually	12	0	100%	±30
Plutonium-239	Richland	Quarterly	15	0	100%	±30
Strontium-90	Richland	Annually	3	0	100%	±30
Technetium-99	Richland	Quarterly	15	0	100%	±30
Tritium	Richland	Semiannually	12	0	100%	±30
Uranium-238	Richland	Quarterly	15	0	100%	±30

Notes:
a. Blind standards were generally submitted in triplicate or quadruplicate.
b. Each result must be within the specified percentage of the known value to be acceptable.
c. Results for February 2009 were not evaluated. An alternative preparation technique was determined to be unsuccessful.

QC = quality control

Table E-16. Summary of WSCF Double-Blind Spike Determinations.

Constituent	Sample Frequency	Number of Results Reported[a]	Number of Results Outside QC Limits	Acceptable Results	Control Limits[b] (%)
General Chemical Parameters					
Specific conductance	Quarterly	15	0	100%	±25
Total organic carbon (potassium hydrogen phthalate spike)	Quarterly	16	2	88%	±25
Total organic halides (2,4,5-trichlorophenol spike)	Quarterly	17	0	100%	±25
Total organic halides (carbon tetrachloride, chloroform, and trichloroethene spike)	Quarterly	18	1	94%	±25
Ammonia and Anions					
Chloride	Quarterly	15	3	80%	±25
Cyanide	Semiannually	12	0	100%	±25
Fluoride	Quarterly	18	5	72%	±25
Nitrate as nitrogen	Quarterly	18	0	100%	±25
Nitrite as nitrogen	Quarterly	15	0	100%	±25
Metals					
Chromium (total)	Quarterly	12	1	92%	±20
Hexavalent chromium	Quarterly	12	0	100%	±20
Volatile Organic Compounds					
Carbon tetrachloride	Quarterly	15	4	73%	±25
Chloroform	Quarterly	15	0	100%	±25
Trichloroethene	Quarterly	15	10	33%	±25
Radiological Parameters					
Gross alpha (plutonium-239 spike)	Quarterly	15	6	60%	±30
Gross beta (strontium-90 spike)	Quarterly	15	4	73%	±30
Cesium-137	Annually	3	0	100%	±30
Cobalt-60	Annually	3	1	67%	±30
Plutonium-239	Quarterly	15	3	80%	±30
Strontium-90	Annually	3	0	100%	±30
Technetium-99	Quarterly	15	0	100%	±30
Tritium	Semiannually	6	0	100%	±30
Uranium-238	Quarterly	15	0	100%	±30

Notes:
a. Blind standards were generally submitted in triplicate or quadruplicate.
b. Each result must be within the specified percentage of the known value to be acceptable.

QC = quality control

Table E-17. Summary of Lionville Laboratory and Eberline Services Double-Blind Spike Determinations.

Constituent	Laboratory	Sample Frequency	Number of Results Reported[a]	Number of Results Outside QC Limits	Acceptable Results	Control Limits[b] (%)
General Chemical Parameters						
Total organic carbon (potassium hydrogen phthalate spike)	Lionville	Quarterly	16	11	31%	±25
Ammonia and Anions						
Chloride	Lionville	Quarterly	12	3	75%	±25
Fluoride	Lionville	Quarterly	15	0	100%	±25
Nitrate as nitrogen	Lionville	Quarterly	15	0	100%	±25
Nitrite as nitrogen	Lionville	Quarterly	15	0	100%	±25
Radiological Parameters						
Gross beta (strontium-90 spike)	Eberline	Quarterly	15	1	93%	±30
Iodine-129	Eberline	Annually	6	2	67%	±30

Notes:
a. Blind standards were generally submitted in triplicate or quadruplicate.
b. Each result must be within the specified percentage of the known value to be acceptable.

QC = quality control

Table E-18. Percentage of Out-of-Limit Quality Control Results by Category, WSCF.

QC Parameter	General Chemistry Parameters	Ammonia and Anions	Metals	VOCs	SVOCs	Radiological Parameters	Totals
Method blanks	0.0	0.0	0.1	0.1	0.0	0.3	0.2
Laboratory control samples	0.2	0.2	0.7	0.0	0.0	2.1	0.6
Matrix spikes	0.6	0.6	0.7	0.5	4.3	0.7	0.8
Matrix duplicates	0.5	0.1	0.3	0.0	0.0	0.9	0.4
Surrogates	—	—	—	0.3	3.7	—	1.1

Notes:
The “Totals” column indicates the total number of QC out-of-limits ÷ by the total number of QC x 100.

QC = quality control
SVOC = semivolatile organic compound
VOC = volatile organic compound
WSCF = Waste Sampling and Characterization Facility

Table E-19 Percentage of Out-of-Limit Quality Control Results by Category, TestAmerica Laboratories.

QC Parameter	General Chemistry Parameters	Ammonia and Anions	Metals	VOCs	SVOCs	Radiological Parameters	Totals
Method blanks	4.1	0.7	0.7	0.2	0.1	0.1	0.6
Laboratory control samples	2.0	2.5	0.1	1.7	4.3	1.8	2.5
Matrix spikes	2.8	3.1	1.9	6.2	12.0	3.8	7.8
Matrix duplicates	2.2	0.9	0.9	0.0	0.0	0.3	0.5
Surrogates	—	—	—	0.9	1.2	—	1.1

Notes:
The “Totals” column indicates the total number of QC out-of-limits ÷ by the total number of QC x 100.

QC = quality control
SVOC = semivolatile organic compound
VOC = volatile organic compound

Table E-20. Method Blank Results, TestAmerica.

Constituent	Percent Out of Limit*	Number of Analyses	Concentration Range of Out-of-Limit Results
General Chemistry Parameters			
Total general chemistry parameters	4.1	97	—
Specific conductance	60.0	5	0.31 – 0.63 µS/cm
Alkalinity	22.2	9	1.0 – 1.6 mg/L
Oil and grease	50.0	2	2.1 mg/L
Total organic carbon	4.8	21	0.47 mg/L
Ammonia and Anions			
Total ammonia and anions	0.7	303	—
Chloride	9.1	55	0.05 – 0.14 mg/L
Nitrogen in nitrite	12.7	55	0.007 – 0.018 mg/L
Metals			
Total metals	0.7	690	—
Barium	3.2	31	1.8 µg/L
Beryllium	3.2	31	1.8 µg/L
Cadmium	3.2	31	1.6 µg/L
Calcium	9.7	31	37.4 – 40.4 µg/L
Iron	3.2	31	93.3 µg/L
Volatile Organic Compounds			
Total volatile organic compounds	0.2	2,409	—
Chloroform	4.0	50	0.61 – 0.69 µg/L
Chloromethane	17.6	34	0.073 – 0.84 µg/L
Iodomethane	5.9	34	0.29 – 0.3 µg/L
Styrene	5.9	34	0.10 – 0.14 µg/L
Tetrachloroethene	4.0	50	0.57 µg/L
Trichloroethene	8.0	50	0.27 – 0.46 µg/L
Semivolatile Organic Compounds			
Total semivolatile organic compounds	0.1	3,197	—
Bis(2-ethylhexyl) phthalate	2.9	35	10 µg/L
Hexachlorophene	11.1	9	71 µg/L
Radiological Parameters			
Total radiochemistry parameters	0.1	1,458	—
Thorium-230	6.3	16	0.761 pCi/L

Notes:
* Quality control limits are twice the method detection limit.

Table E-21. Laboratory Control Samples, TestAmerica Laboratories.

Constituent	Percent Out of Limit	Number of Analyses
General Chemistry Parameters		
Total general chemical parameters	2.0	98
Oil and grease	50.0	4
Ammonia and Anions		
Total ammonia and anions	2.5	320
Chloride	1.8	56
Fluoride	1.8	57
Nitrogen in nitrate	1.8	56
Nitrogen in nitrite	3.5	57
Sulfate	1.8	57
Cyanide	10.0	20
Metals		
Total metals	0.1	687
Hexavalent chromium	0.9	107
Volatile Organic Compounds		
Total volatile organic compounds	1.7	2,289
1,2-Dibromo-3-chloropropane	2.9	34
1,2-Dichloroethane	2.0	50
1,4-Dichlorobenzene	2.0	50
1,4-Dioxane	2.0	49
1-Butanol	2.1	48
Acetone	2.0	50
Acrolein	2.9	34
Benzene	4.1	49
Bromodichloromethane	2.9	34
Bromoform	2.9	34
Bromomethane	17.6	34
Carbon disulfide	2.0	51
Chlorobenzene	2.9	34
Chloroethane	2.9	34
Chloroprene	5.9	34
Dichlorodifluoromethane	2.9	34
Iodomethane	14.7	34
Methylene chloride	1.9	52
Tetrachloroethene	3.9	51
trans-1,3-Dichloropropene	2.9	34
trans-1,4-Dichloro-2-butene	5.9	34
Trichloromonofluoromethane	2.9	34
Vinyl acetate	8.8	34
Semivolatile Organic Compounds		
Total semivolatile organic compounds	4.3	2,233
2,3,4,6-Tetrachlorophenol	13.9	36
2,4,5-Trichlorophenol	5.6	36
2,4,6-Trichlorophenol	5.6	36
2,4-Dichlorophenol	5.6	36
2,4-Dimethylphenol	2.8	36
2,4-Dinitrophenol	8.3	36
2,6-Dichlorophenol	5.6	36
2-Chlorophenol	5.6	36

Table E-21. (Cont.)

Constituent	Percent Out of Limit	Number of Analyses
2-Methylphenol (cresol, o-)	2.8	36
2-Nitrophenol	2.8	36
3+4 Methylphenol (cresol, m+p)	2.8	36
4,6-Dinitro-2-methylphenol	13.9	36
4-Chloro-3-methylphenol	5.6	36
4-Nitrophenol	8.3	36
Dinoseb(2-secButyl-4,6-dinitrophenol)	5.6	36
Pentachlorophenol	8.3	36
Phenol	5.6	36
4,4'-DDD (Dichlorodiphenyldichloroethane)	8.8	34
4,4'-DDE (Dichlorodiphenyldichloroethylene)	5.9	34
4,4'-DDT (Dichlorodiphenyltrichloroethane)	6.1	33
Aldrin	5.9	34
Alpha-BHC	2.9	34
beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-BHC)	3.0	33
Delta-BHC	9.1	33
Dieldrin	5.9	34
Endosulfan I	3.0	33
Endosulfan II	8.8	34
Endosulfan sulfate	8.8	34
Endrin	6.1	33
Endrin aldehyde	12.1	33
Gamma-BHC (Lindane)	6.1	33
Heptachlor	27.3	33
Heptachlor epoxide	5.9	34
Methoxychlor	6.1	33
Aroclor-1016	7.7	13
Aroclor-1260	16.7	12
2,4-Dinitrophenol	2.9	34
4-Nitrophenol	10.0	10
Benzo(k)fluoranthene	10.0	10
n-Nitrosodiphenylamine	20.0	10
Phenol	2.8	36
Benzo(b)fluoranthene	25.0	4
Benzo(k)fluoranthene	25.0	4
Dibenz[a,h]anthracene	50.0	4
Radiological Parameters		
Total radiochemistry parameters	1.8	856
Gross alpha	5.3	38
Carbon-14	3.4	58
Plutonium-239/240	10.0	10
Thorium-232	100.0	1
Uranium-235	47.4	19

Table E-22. Laboraty Control Samples, WSCF.

Constituent	Percent Out of Limit	Number of Analyses
General Chemistry Parameters		
Total general chemistry parameters	0.2	551
TPH - gasoline range	6.7	15
Ammonia and Anions		
Total ammonia and anions	0.2	2,982
Chloride	0.2	541
Fluoride	0.4	560
Nitrogen in nitrate	0.2	551
Sulfate	0.2	559
Cyanide	2.0	51
Metals		
Total metals	0.7	6,906
Mercury	5.6	71
Uranium	0.6	155
Antimony	0.6	317
Barium	0.6	320
Beryllium	0.6	315
Cadmium	0.6	318
Calcium	1.0	315
Chromium	0.6	310
Cobalt	0.6	313
Copper	0.6	314
Iron	0.6	319
Magnesium	0.6	321
Manganese	0.6	315
Nickel	0.6	315
Potassium	0.6	316
Silver	0.6	324
Sodium	1.0	311
Strontium	0.6	313
Vanadium	0.6	315
Zinc	0.6	322
Hexavalent chromium	0.5	437
Volatile Organic Compounds		
Total volatile organic compounds	0.0	1,025
Semivolatile Organic Compounds		
Total semivolatile organic compounds	0.0	552

Table E-22. (Cont.)

Constituent	Percent Out of Limit	Number of Analyses
Radiological Parameters		
Total radiochemistry parameters	2.1	1,147
Gross alpha	5.2	194
Gross beta	2.7	221
Cesium-137	1.9	54
Cobalt-60	1.9	53
Plutonium-239/240	4.5	44
Total beta radiostrontium	0.6	177
Technetium-99	1.5	134
Tritium	0.9	223

Notes:
TPH = total petroleum hydrocarbons
WSCF = Waste Sampling and Characterization Facility

Table E-23. Matrix Spikes and Matrix Spike Duplicates, TestAmerica Laboratories.

Constituent	Percent Out of Limit	Number of Analyses
General Chemistry Parameters		
Total general chemistry parameters	2.8	109
Alkalinity	11.1	9
Oil and grease	50.0	4
Ammonia and Anions		
Total ammonia and anions	3.1	318
Chloride	5.1	59
Nitrogen in nitrate	1.8	57
Nitrogen in nitrite	1.8	57
Sulfate	1.7	60
Nitrogen in ammonia	60	5
Cyanide	8.3	12
Metals		
Total metals	1.9	1,410
Antimony	3.1	64
Calcium	1.6	64
Magnesium	1.6	64
Potassium	4.7	64
Sodium	3.1	64
Strontium	3.1	64
Thallium	100.0	2
Hexavalent chromium	6.5	214
Volatile Organic Compounds		
Total volatile organic compounds	6.2	5,024
1,1,1,2-Tetrachloroethane	3.3	60
1,1,1-Trichloroethane	4.4	135
1,1,2-Trichloroethane	1.5	131
1,1-Dichloroethane	1.5	130
1,1-Dichloroethene	2.3	129
1,2-Dibromo-3-chloropropane	8.3	60
1,2-Dichloroethane	4.6	130
1,4-Dichlorobenzene	1.5	131
1,4-Dioxane	30.5	128
1-Butanol	22.6	124
2-Butanone	7.9	127
2-Hexanone	6.7	60
2-Pentanone, 4-Methyl	6.0	133
Acetone	22.0	127
Acetonitrile	6.7	60
Acrolein	20.0	60
Benzene	3.1	127
Bromodichloromethane	1.7	60
Bromoform	3.3	60
Bromomethane	19.0	58
Carbon disulfide	4.5	132
Carbon tetrachloride	6.2	113
Chlorobenzene	3.4	58
Chloroethane	11.7	60
Chloroform	3.9	127
Chloromethane	7.1	56

Table E-23. (Cont.)

Constituent	Percent Out of Limit	Number of Analyses
Chloroprene	3.3	60
cis-1,2-Dichloroethylene	3.1	131
Dichlorodifluoromethane	8.3	60
Ethyl cyanide	1.5	130
Ethyl methacrylate	10.0	60
Ethylbenzene	1.5	131
Iodomethane	20.7	58
Isobutyl alcohol	24.1	58
Methacrylonitrile	10.0	60
Methyl methacrylate	3.3	60
Methylene chloride	1.6	129
Tetrachloroethene	3.8	130
Tetrahydrofuran	4.5	132
Toluene	3.0	132
trans-1,2-Dichloroethylene	3.1	129
trans-1,3-Dichloropropene	3.3	60
trans-1,4-Dichloro-2-butene	10.3	58
Trichloroethene	1.6	126
Trichloromonofluoromethane	3.4	58
Vinyl acetate	10.3	58
Vinyl chloride	5.4	130
Semivolatile Organic Compounds		
Total semivolatile organic compounds	12.0	4,430
2,3,4,6-Tetrachlorophenol	19.4	72
2,4,5-Trichlorophenol	16.7	72
2,4,6-Trichlorophenol	16.7	72
2,4-Dichlorophenol	13.9	72
2,4-Dimethylphenol	13.9	72
2,4-Dinitrophenol	29.2	72
2,6-Dichlorophenol	16.7	72
2-Chlorophenol	18.1	72
2-Methylphenol (cresol, o-)	13.9	72
2-Nitrophenol	16.7	72
3+4 Methylphenol (cresol, m+p)	13.9	72
4,6-Dinitro-2-methylphenol	22.2	72
4-Chloro-3-methylphenol	13.9	72
4-Nitrophenol	34.7	72
Dinoseb(2-secButyl-4,6-dinitrophenol)	22.2	72
Pentachlorophenol	18.1	72
Phenol	13.9	72
4,4'-DDD (Dichlorodiphenyldichloroethane)	10.6	66
4,4'-DDE (Dichlorodiphenyldichloroethylene)	7.4	68
4,4'-DDT (Dichlorodiphenyltrichloroethane)	13.4	67
Alpha-BHC	9.0	67
beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-BHC)	8.8	68
Delta-BHC	12.1	66
Dieldrin	6.1	66
Endosulfan I	4.5	67
Endosulfan II	3.0	67
Endosulfan sulfate	11.8	68

Table E-23. (Cont.)

Constituent	Percent Out of Limit	Number of Analyses
Endrin	21.2	66
Endrin aldehyde	18.2	66
Gamma-BHC (Lindane)	7.4	68
Heptachlor	61.2	67
Heptachlor epoxide	12.1	66
Methoxychlor	10.4	67
Aroclor-1016	14.8	27
Aroclor-1260	14.8	27
1,3-Dichlorobenzene	10.0	20
1,4-Dichlorobenzene	14.3	70
2,4,5-Trichlorophenol	10.0	20
2,4,6-Trichlorophenol	10.0	20
2,4-Dichlorophenol	5.7	70
2,4-Dinitrophenol	6.1	66
2-Chlorophenol	10.0	20
2-Methylphenol (cresol, o-)	5.7	70
2-Nitrophenol	5.7	70
3,3'-Dichlorobenzidine	35.0	20
3+4 Methylphenol (cresol, m+p)	3.7	54
3-Nitroaniline	30.0	20
4,6-Dinitro-2-methylphenol	10.0	20
4-Bromophenylphenyl ether	10.0	20
4-Chloroaniline	40.0	20
4-Nitroaniline	10.0	20
4-Nitrophenol	10.0	20
Bis(2-ethylhexyl) phthalate	2.9	70
Hexachlorobenzene	10.0	20
Hexachloroethane	10.0	20
Naphthalene	2.9	70
n-Nitrosodiphenylamine	5.0	20
Pentachlorophenol	5.7	70
Phenol	8.6	70
Acenaphthene	38.5	13
Acenaphthylene	50.0	14
Anthracene	38.5	13
Benzo(a)anthracene	25.0	12
Benzo(a)pyrene	23.1	13
Benzo(b)fluoranthene	57.1	14
Benzo(ghi)perylene	9.1	11
Benzo(k)fluoranthene	53.8	13
Chrysene	46.2	13
Dibenz[a,h]anthracene	33.3	12
Fluoranthene	13.3	15
Fluorene	33.3	12
Indeno(1,2,3-cd)pyrene	28.6	14
Naphthalene	45.5	11
Phenanthrene	25.0	12
Radiological Parameters		
Total radiochemistry parameters	3.8	80
Technetium-99	10.7	28

Table E-24. Matrix Spikes and Matrix Spike Duplicates, WSCF.

Constituent	Percent Out of Limit	Number of Analyses
General Chemistry Parameters		
Total general chemistry parameters	0.6	642
TPH - gasoline range	13.8	29
Ammonia and Anions		
Total ammonia and anions	0.6	5,601
Chloride	0.9	1066
Fluoride	0.9	1057
Nitrogen in nitrite	0.9	1068
Cyanide	3.4	87
Metals		
Total metals	0.7	10,626
Chromium	10.0	20
Uranium	2.5	161
Antimony	0.4	513
Barium	0.4	523
Beryllium	0.4	513
Cadmium	0.4	517
Calcium	0.8	509
Chromium	0.4	522
Cobalt	0.4	522
Copper	0.4	517
Iron	1.5	533
Magnesium	0.4	517
Manganese	0.4	527
Nickel	0.4	522
Potassium	0.8	522
Silver	0.8	524
Sodium	0.6	510
Strontium	1.0	503
Vanadium	0.4	525
Zinc	0.4	515
Hexavalent chromium	3.7	464
Volatile Organic Compounds		
Total volatile organic compounds	0.5	1,540
1,1-Dichloroethene	1.6	305
Trichloroethene	0.7	302
Semivolatile Organic Compounds		
Total semivolatile organic compounds	4.3	1,040
1,2,4-Trichlorobenzene	1.5	65
1,4-Dichlorobenzene	4.3	70
2,4-Dichlorophenol	3.6	28
2,4-Dinitrotoluene	3.0	66
2-Chlorophenol	4.8	63
2-Methylphenol (cresol, o-)	3.4	29
2-Nitrophenol	10.7	28
2-Picoline	14.8	27

Table E-24. (Cont.)

Constituent	Percent Out of Limit	Number of Analyses
4-Chloro-3-methylphenol	9.5	63
4-Nitrophenol	9.7	62
Pentachlorophenol	13.7	73
Phenol	7.6	66
Radiological Parameters		
Total radiochemistry parameters	0.7	302
Technetium-99	0.8	122
Tritium	0.6	180

Notes:
TPH = total petroleum hydrocarbons
WSCF = Waste Sampling and Characterization Facility

Table E-25. Matrix Duplicates, TestAmerica Laboratories.

Constituent	Percent Out of Limit	Number of Analyses
General Chemistry Parameters		
Total general chemistry parameters	2.2	91
Specific Conductance	20.0	5
Total organic halides	2.9	34
Ammonia and Anions		
Total ammonia and anions	0.9	316
Nitrogen in nitrate	1.6	61
Nitrogen in nitrite	3.6	56
Metals		
Total metals	0.9	108
Hexavalent chromium	0.9	108
Volatile Organic Compounds		
Total volatile organic compounds	0.0	0
Semivolatile Organic Compounds		
Total semivolatile organic compounds	0.0	0
Radiological Parameters		
Total radiochemistry parameters	0.3	1,412
Gross alpha	5.4	37
Carbon-14	1.8	56
Uranium-238	2.8	36

Table E-26. Matrix Duplicates, WSCF.

Constituent	Percent Out of Limit	Number of Analyses
General Chemistry Parameters		
Total general chemistry parameters	0.5	209
Total petroleum hydrocarbon - gasoline range	7.1	14
Ammonia and Anions		
Total ammonia and anions	0.1	3,248
Nitrogen in nitrate	0.2	615
Nitrogen in nitrite	0.2	636
Metals		
Total metals	0.3	576
Hexavalent chromium	0.3	576
Volatile Organic Compounds		
Total volatile organic compounds	0.0	13
Semivolatile Organic Compounds		
Total semivolatile organic compounds	0.0	0
Radiological Parameters		
Total radiochemistry parameters	0.9	2,993
Gross alpha	3.1	193
Gross beta	6.5	216
Potassium-40	4.2	48
Total beta radiostrontium	2.3	175

Notes:
WSCF = Waste Sampling and Characterization Facility

Table E-27. Summary of Issue Resolution Forms, Current Reporting Period.

Issue Category	Number of Analyses Impacted		
	Prior to Receipt at Laboratory	After Receipt at TA Laboratory*	After Receipt at WSCF Laboratory
Holding time missed	16	5	107
Broken bottles	16	--	2
Late analysis	--	8	--
Temperature deviation	11	--	3
Bottle size/type (insufficient volume or headspace)	33	--	--
Chain-of-custody form issues	7	--	--
Laboratory QC out of limits/incomplete	--	40	26
Incorrect preservation of the sample	28	1	--
Analytical preparation deviations/method failures/ discontinued analyses	--	23	16
Totals	**111**	**77**	**154**

Notes:
* Includes data from TA St. Louis and TA Richland.

QC = quality control
TA = TestAmerica
WSCF = Waste Sampling and Characterization Facility

Table E-28. Iodine-129 Blind Standards.

Constituent	Spike Amount	Lab	Result 1		Recovery 1	Result 2		Recovery 2	Result 3		Recovery 3	Mean	RSD%
Iodine-129	1.02 pCi/L	EBRLE	0.598	U	58.6%	0.817	U	80.1%	0.359	U	35.2%	0.591	38.7%
Iodine-129	1.02 pCi/L	TARL	0.716		70.2%	0.856		83.9%	1.23		120.6%	0.934	28.5%
Iodine-129	1.02 pCi/L	ESL	0.808	U	79.2%	0.808	U	79.2%	0.808	U	79.2%	0.808	0.0%
Iodine-129	10.03 pCi/L	EBRLE	10.6		105.7%	8.7		86.7%	9.09		90.6%	9.463	10.6%
Iodine-129	10.03 pCi/L	TARL	8.61		85.8%	8.45		84.2%	9.75		97.2%	8.937	7.9%
Iodine-129	10.03 pCi/L	ESL	5.28		52.6%	6.9		68.8%	5.86		58.4%	6.013	13.6%

Notes:
Shaded cells indicate out-of-limit results.

EBRLE = Eberline Services
ESL = Environmental Services Laboratory
TARL = TestAmerica, Richland
RSD = relative standard deviation

Table E-29. Iodine-129 Split Samples (Two Laboratories).

Well	Date Sampled	Lab_1	Result_1		Method_1	Sample_2	Result_2		Method_2	Average	%RPD
199-B5-5	10/14/2009	TARL	0.0165	U	I129LL_SEP_LEPS_GS	B224W1	-0.429	U	I129_SEP_LEPS_GS	-0.20625	-216.0
299-E16-2	4/21/2009	TARL	1.46		I129LL_SEP_LEPS_GS	B203M8	2.3		RADISOTOPES_ICPMS	1.88	44.7
299-E24-18	4/10/2009	TARL	0.932		I129LL_SEP_LEPS_GS	B203P9	0.893	U	RADISOTOPES_ICPMS	0.9125	4.3
299-E25-17	4/20/2009	TARL	4.01		I129LL_SEP_LEPS_GS	B203R4	2.02		RADISOTOPES_ICPMS	3.015	66.0
299-E25-20	4/20/2009	TARL	2.505		I129LL_SEP_LEPS_GS	B203V1	1.62		RADISOTOPES_ICPMS	2.0625	42.9
299-E25-22	4/20/2009	TARL	2.34		I129LL_SEP_LEPS_GS	B203V5	2.05		RADISOTOPES_ICPMS	2.195	13.2
299-E32-7	6/23/2009	TARL	0.777		I129LL_SEP_LEPS_GS	B20LT4	2.48		RADISOTOPES_ICPMS	1.6285	104.6
299-E33-341	6/26/2009	TARL	2.69		I129LL_SEP_LEPS_GS	B20P35	3.17		RADISOTOPES_ICPMS	2.93	16.4
299-W19-48	11/19/2008	TARL	1.35		I129LL_SEP_LEPS_GS	B1XKT1	0.637	U	I129_SEP_LEPS_GS	0.9935	71.8
299-W22-83	6/17/2009	TARL	0.439		I129LL_SEP_LEPS_GS	B20MX3	0.893	U	RADISOTOPES_ICPMS	0.666	68.2
699-38-65	8/14/2009	TARL	0.568		I129LL_SEP_LEPS_GS	B20MY5	0.893	U	RADISOTOPES_ICPMS	0.7305	44.5
699-42-40A	7/8/2009	TARL	0.46		I129LL_SEP_LEPS_GS	B20PP7	2.39		RADISOTOPES_ICPMS	1.425	135.4
699-55-60A	4/29/2009	TARL	0.564		I129LL_SEP_LEPS_GS	B202Y0	0.893	U	RADISOTOPES_ICPMS	0.7285	45.2
699-57-59	4/29/2009	TARL	1.97		I129LL_SEP_LEPS_GS	B203D8	2.23		RADISOTOPES_ICPMS	2.1	12.4
699-59-58	4/29/2009	TARL	1.01		I129LL_SEP_LEPS_GS	B203F3	0.893	U	RADISOTOPES_ICPMS	0.9515	12.3
699-60-60	4/29/2009	TARL	0.498		I129LL_SEP_LEPS_GS	B203F8	2.4		RADISOTOPES_ICPMS	1.449	131.3
699-61-62	4/30/2009	TARL	0.803		I129LL_SEP_LEPS_GS	B203H3	0.893	U	RADISOTOPES_ICPMS	0.848	10.6

Notes:
All results are reported in pCi/L.
TestAmerica and Eberline use low-energy photon detectors.
Environmental Sciences Laboratory uses inductively coupled plasma/mass spectrometry.
Shaded results represent duplicate samples that have been averaged.
RPDs greater than 20% are highlighted.

RPD = relative percent difference
TARL = TestAmerica Richland
U = non-detect

Table E-30. Iodine-129 Split Samples (Three Laboratories).

Well	Date Sampled	Result_1 (TARL)		MDA_1	Result_2 (EBRLNE)		MDA_2	Result_3 (ESL)		MDA_3	Average	%RSD
299-E28-23	6/24/2009	1.77		0.228	1.45		0.826	3.025		0.893	2.082	40.0
299-E28-25	6/25/2009	2		0.229	0.954		0.849	2.388		0.893	1.781	41.7
299-E28-27	6/23/2009	0.693		0.181	0.36	U	0.749	0.893		0.893	0.649	41.5
299-E32-3	6/23/2009	0.429		0.168	0.091	U	0.862	1.332		0.893	0.617	103.9
299-E32-6	6/23/2009	0.521		0.197	-0.122	U	0.812	0.893	U	0.893	0.431	119.2

Notes:
All results are in pCi/L.
TestAmerica and Eberline use low-energy photon detectors.
ESL uses inductively coupled plasma/mass spectrometry.
RPDs greater than 20% are highlighted

EBRLNE = Eberline Services
ESL = Environmental Sciences Laboratory
MDA = minimum detectable activity
RPD = relative percent difference
RSD = relative standard deviation
TARL = TestAmerica Richland
U = non-detect

Table E-31. Chromium Split Sample Data.

Well_Name	Samp_Date_Time	Filtered	Method_1	Con_Long_Name	WSCF Result (µg/L)		TA Result (µg/L)		SPD
199-D4-93	9/14/09 11:05 AM	N	6010_METALS_ICP	Chromium	13	U	69		-136.5853659
299-W22-49	3/11/09 10:24 AM	N	6010_METALS_ICP	Chromium	13	U	34.3		-90.06342495
199-D5-123	12/31/08 9:57 AM	N	7196_CR6	Hexavalent chromium	88.6		162		-58.57940942
199-D4-14	11/19/08 8:50 AM	N	6010_METALS_ICP	Chromium	64.1	B	90.4		-34.04530744
199-D5-37	11/24/08 10:07 AM	N	6010_METALS_ICP	Chromium	66		90.1		-30.87764254
199-B5-5	10/14/09 9:50 AM	N	7196_CR6	Hexavalent chromium	17.8		24		-29.66507177
199-H4-9	11/10/08 10:46 AM	N	6010_METALS_ICP	Chromium	33		43.8		-28.125
699-97-51A	11/24/08 11:49 AM	N	6010_METALS_ICP	Chromium	19.1	B	25.1		-27.14932127
199-N-76	3/18/09 10:09 AM	N	6010_METALS_ICP	Chromium	13	U	16		-20.68965517
199-K-111A	10/21/09 10:41 AM	N	7196_CR6	Hexavalent chromium	26.9		33		-20.3672788
199-D4-1	11/3/09 8:41 AM	Y	6010_METALS_ICP	Chromium	51.1	B	60.6		-17.00984781
699-97-51A	11/24/08 11:49 AM	Y	6010_METALS_ICP	Chromium	21	B	24.9		-16.99346405
199-K-157	12/8/08 12:42 PM	N	7196_CR6	Hexavalent chromium	62		71		-13.53383459
699-99-44	11/13/08 9:06 AM	N	6010_METALS_ICP	Chromium	41.7	B	47.3		-12.58426966
199-D4-25	6/15/09 9:07 AM	N	7196_CR6	Hexavalent chromium	54.1		61		-11.98957428
199-H4-12C	11/10/08 10:22 AM	N	6010_METALS_ICP	Chromium	82.2		92.1		-11.35972461
199-D4-14	11/19/08 8:50 AM	Y	6010_METALS_ICP	Chromium	53.4	B	59.4		-10.63829787
199-D4-25	6/15/09 9:07 AM	Y	6010_METALS_ICP	Chromium	51.7	B	57		-9.751609936
299-W22-26	1/5/09 10:23 AM	N	6010_METALS_ICP	Chromium	61.3		67.3		-9.33125972
199-D5-43	11/17/08 11:30 AM	Y	6010_METALS_ICP	Chromium	430		467		-8.249721293
199-D4-38	11/19/08 11:05 AM	N	6010_METALS_ICP	Chromium	158		171		-7.902735562
199-H4-5	9/2/09 10:09 AM	N	6010_METALS_ICP	Chromium	13.8	B	14.9		-7.665505226
199-D4-23	10/7/09 8:57 AM	N	7196_CR6	Hexavalent chromium	24.1		26		-7.584830339
199-D4-38	11/19/08 11:05 AM	Y	6010_METALS_ICP	Chromium	158		170		-7.317073171
C5676	3/5/09 10:51 AM	N	7196_CR6	Hexavalent chromium	50.3		54		-7.094918504
299-W22-26	1/5/09 10:23 AM	Y	6010_METALS_ICP	Chromium	56		60		-6.896551724
199-K-141	1/26/09 10:24 AM	Y	6010_METALS_ICP	Chromium	368		394		-6.824146982
199-K-141	1/26/09 10:24 AM	N	6010_METALS_ICP	Chromium	374		400		-6.718346253
199-D4-22	11/19/08 9:51 AM	Y	6010_METALS_ICP	Chromium	786		839		-6.523076923
199-D4-23	10/7/09 8:57 AM	Y	7196_CR6	Hexavalent chromium	25.4		27		-6.106870229
199-H4-12C	11/10/08 10:22 AM	Y	6010_METALS_ICP	Chromium	86.3		91.3		-5.630630631
199-K-108A	10/6/08 9:29 AM	N	6010_METALS_ICP	Chromium	83.7		87.6		-4.553415061
199-D4-23	10/7/09 8:57 AM	N	6010_METALS_ICP	Chromium	32.9	B	34.4		-4.457652303
199-D2-8	10/6/08 10:24 AM	N	7196_CR6	Hexavalent chromium	254		265		-4.238921002
199-K-108A	10/6/08 9:29 AM	Y	6010_METALS_ICP	Chromium	79.9		83.3		-4.166666667
199-D5-37	11/24/08 10:07 AM	Y	6010_METALS_ICP	Chromium	63.6	B	66.2		-4.006163328

Table E-31. (Cont.)

Well_Name	Samp_Date_Time	Filtered	Method_1	Con_Long_Name	WSCF Result (µg/L)		TA Result (µg/L)		SPD
199-D5-43	8/11/09 8:09 AM	N	7196_CR6	Hexavalent chromium	369		383		-3.723404255
199-H3-4	10/11/09 9:32 AM	N	7196_CR6	Hexavalent chromium	50.4		52		-3.125
199-D5-121	5/7/09 10:21 AM	N	7196_CR6	Hexavalent chromium	34.9		36		-3.102961918
199-K-111A	10/21/09 10:41 AM	N	6010_METALS_ICP	Chromium	29.7	B	30.6		-2.985074627
199-D4-84	10/8/09 9:51 AM	N	7196_CR6	Hexavalent chromium	60.4		62		-2.614379085
199-D8-71	5/14/09 9:35 AM	Y	7196_CR6	Hexavalent chromium	114		117		-2.597402597
199-D5-43	6/15/09 12:18 PM	N	7196_CR6	Hexavalent chromium	358		367		-2.482758621
199-D4-22	11/19/08 9:51 AM	N	7196_CR6	Hexavalent chromium	828	D	844		-1.913875598
199-D4-36	8/13/09 8:31 AM	N	7196_CR6	Hexavalent chromium	94.4		96		-1.680672269
699-99-44	11/13/08 9:06 AM	N	7196_CR6	Hexavalent chromium	43.5		44		-1.142857143
199-D2-8	7/22/09 8:31 AM	N	7196_CR6	Hexavalent chromium	81.4		82		-0.734394125
199-D5-38	4/14/09 7:38 AM	N	7196_CR6	Hexavalent chromium	703	D	708		-0.708717222
199-D5-43	11/17/08 11:30 AM	N	7196_CR6	Hexavalent chromium	455		458		-0.657174151
199-D5-43	12/3/08 8:49 AM	N	7196_CR6	Hexavalent chromium	461		464		-0.648648649
699-99-44	11/13/08 9:06 AM	Y	6010_METALS_ICP	Chromium	47.5	B	47.8		-0.629590766
199-H3-4	10/11/09 9:32 AM	Y	7196_CR6	Hexavalent chromium	51.7		52		-0.578592093
199-K-137	6/19/09 12:41 PM	N	7196_CR6	Hexavalent chromium	575	D	578		-0.520381613
199-D4-14	11/19/08 8:50 AM	N	7196_CR6	Hexavalent chromium	58.7		59		-0.509770603
199-D5-13	2/24/09 8:42 AM	N	7196_CR6	Hexavalent chromium	722	D	725		-0.414651002
199-K-161	10/21/09 10:35 AM	Y	6010_METALS_ICP	Chromium	88		88.3		-0.340328985
199-H3-3	5/28/09 10:55 AM	Y	7196_CR6	Hexavalent chromium	38.9		39		-0.256739409
199-H3-3	5/28/09 10:55 AM	N	7196_CR6	Hexavalent chromium	38.9		39		-0.256739409
199-K-137	6/19/09 12:41 PM	Y	7196_CR6	Hexavalent chromium	583	D	581		0.343642612
199-D5-43	8/11/09 8:09 AM	Y	7196_CR6	Hexavalent chromium	376		374		0.533333333
199-K-36	10/22/09 10:52 AM	N	6010_METALS_ICP	Chromium	69.9		69.4		0.71787509
199-D5-120	6/15/09 10:10 AM	N	7196_CR6	Hexavalent chromium	117		116		0.858369099
199-D8-71	5/14/09 9:35 AM	N	7196_CR6	Hexavalent chromium	115		114		0.873362445
199-D5-43	2/12/09 8:33 AM	N	7196_CR6	Hexavalent chromium	417		413		0.963855422
199-D4-39	11/3/09 8:58 AM	N	6010_METALS_ICP	Chromium	766		758		1.049868766
199-D5-43	3/18/09 9:49 AM	N	7196_CR6	Hexavalent chromium	489		483		1.234567901
199-D5-102	1/20/09 9:30 AM	N	7196_CR6	Hexavalent chromium	452		446		1.336302895
199-D5-43	2/12/09 8:33 AM	N	6010_METALS_ICP	Chromium	436		430	N	1.385681293
199-D4-78	5/11/09 10:10 AM	Y	7196_CR6	Hexavalent chromium	29.5		29		1.709401709
199-K-161	10/21/09 10:35 AM	N	6010_METALS_ICP	Chromium	88.2		86.7		1.715265866
199-D8-88	2/24/09 10:22 AM	N	7196_CR6	Hexavalent chromium	107		105		1.886792453
199-D4-84	10/8/09 9:51 AM	Y	7196_CR6	Hexavalent chromium	63.3		62		2.075019952

Table E-31. (Cont.)

Well_Name	Samp_Date_Time	Filtered	Method_1	Con_Long_Name	WSCF Result (µg/L)		TA Result (µg/L)		SPD
199-D5-43	6/15/09 12:18 PM	Y	7196_CR6	Hexavalent chromium	359		351		2.253521127
199-N-71	10/21/09 8:18 AM	N	6010_METALS_ICP	Chromium	13.1	B	12.8		2.316602317
199-D4-15	7/21/09 10:01 AM	Y	7196_CR6	Hexavalent chromium	1,010	D	986		2.404809619
199-H3-5	2/26/09 11:16 AM	N	7196_CR6	Hexavalent chromium	72.8		71		2.503477051
199-D5-38	8/12/09 1:03 PM	Y	7196_CR6	Hexavalent chromium	680		663		2.53164557
199-D4-39	11/3/09 8:58 AM	Y	6010_METALS_ICP	Chromium	756		737		2.545210985
199-D4-22	8/10/09 8:52 AM	N	7196_CR6	Hexavalent chromium	826	D	804		2.699386503
199-D4-15	5/4/09 12:11 PM	Y	7196_CR6	Hexavalent chromium	1,060	DN	1,030		2.870813397
199-B5-5	10/14/09 9:50 AM	N	200.8_METALS_ICPMS	Chromium	24.5	D	23.8		2.898550725
199-D4-38	11/19/08 11:05 AM	N	7196_CR6	Hexavalent chromium	201		195		3.03030303
199-H4-12C	11/10/08 10:22 AM	N	7196_CR6	Hexavalent chromium	86.6		84		3.048065651
199-K-36	10/22/09 10:52 AM	N	7196_CR6	Hexavalent chromium	20.7		20		3.43980344
199-K-18	11/24/08 10:06 AM	N	7196_CR6	Hexavalent chromium	173		167		3.529411765
199-D4-15	7/21/09 10:01 AM	N	7196_CR6	Hexavalent chromium	1,020	D	984		3.592814371
199-K-108A	10/6/08 9:29 AM	N	7196_CR6	Hexavalent chromium	83		80		3.680981595
199-D5-38	8/12/09 1:03 PM	N	7196_CR6	Hexavalent chromium	682		657		3.734129948
199-D5-16	10/7/09 9:33 AM	Y	7196_CR6	Hexavalent chromium	288		277		3.89380531
199-D5-97	9/15/09 10:58 AM	N	7196_CR6	Hexavalent chromium	492		473		3.937823834
199-D4-36	8/13/09 8:31 AM	Y	7196_CR6	Hexavalent chromium	99.9		96		3.981623277
199-K-18	7/22/09 10:37 AM	Y	7196_CR6	Hexavalent chromium	203		195		4.020100503
199-K-18	7/22/09 10:37 AM	N	7196_CR6	Hexavalent chromium	201		193		4.060913706
199-D5-43	2/12/09 8:33 AM	Y	6010_METALS_ICP	Chromium	424		407	N	4.091456077
199-D4-15	9/14/09 11:48 AM	Y	7196_CR6	Hexavalent chromium	983		942		4.25974026
199-D4-22	11/19/08 9:51 AM	N	6010_METALS_ICP	Chromium	821		786		4.35594275
199-D5-120	6/15/09 10:10 AM	Y	7196_CR6	Hexavalent chromium	116		111		4.405286344
199-K-165	9/23/09 9:14 AM	N	7196_CR6	Hexavalent chromium	231		221		4.424778761
199-D4-15	10/8/09 10:52 AM	Y	7196_CR6	Hexavalent chromium	899		860		4.434337692
199-D4-22	8/10/09 8:52 AM	Y	7196_CR6	Hexavalent chromium	818	D	782		4.5
199-K-108A	3/18/09 8:07 AM	N	7196_CR6	Hexavalent chromium	129		123		4.761904762
199-D5-43	11/17/08 11:30 AM	N	6010_METALS_ICP	Chromium	462		438		5.333333333
199-D5-16	10/7/09 9:33 AM	N	7196_CR6	Hexavalent chromium	287		272		5.366726297
199-D4-15	9/14/09 11:48 AM	N	7196_CR6	Hexavalent chromium	1,010	D	957		5.388917133
199-D8-55	5/14/09 10:11 AM	N	7196_CR6	Hexavalent chromium	22.2		21		5.555555556
199-D5-37	5/7/09 9:27 AM	N	7196_CR6	Hexavalent chromium	57.1		54		5.580558056
199-D4-23	10/7/09 8:57 AM	Y	6010_METALS_ICP	Chromium	25.7	B	24.3		5.6

Table E-31. (Cont.)

Well_Name	Samp_Date_Time	Filtered	Method_1	Con_Long_Name	WSCF Result (µg/L)		TA Result (µg/L)		SPD
199-K-165	9/23/09 9:14 AM	Y	7196_CR6	Hexavalent chromium	231		218		5.79064588
199-D5-97	9/15/09 10:58 AM	Y	7196_CR6	Hexavalent chromium	494		466		5.833333333
199-D4-15	5/4/09 12:11 PM	N	7196_CR6	Hexavalent chromium	1,060	DN	995		6.326034063
199-D4-20	11/2/09 11:28 AM	Y	7196_CR6	Hexavalent chromium	54.6		51		6.818181818
199-K-131	10/20/09 10:10 AM	Y	7196_CR6	Hexavalent chromium	62.1		58		6.82764363
199-K-131	10/20/09 10:10 AM	N	7196_CR6	Hexavalent chromium	60		56		6.896551724
699-97-51A	11/24/08 11:49 AM	N	7196_CR6	Hexavalent chromium	23.6		22		7.01754386
199-K-108A	11/18/08 10:35 AM	N	7196_CR6	Hexavalent chromium	84.8		79		7.081807082
199-D5-37	11/24/08 10:07 AM	N	7196_CR6	Hexavalent chromium	70.1		65		7.54996299
199-D5-37	5/7/09 9:27 AM	Y	7196_CR6	Hexavalent chromium	57.2		53		7.622504537
199-D4-15	10/8/09 10:52 AM	N	7196_CR6	Hexavalent chromium	918		849		7.809847199
199-D4-78	5/11/09 10:10 AM	N	7196_CR6	Hexavalent chromium	30.3		28		7.890222985
199-D4-78	5/11/09 10:10 AM	N	7196_CR6	Hexavalent chromium	30.3		28		7.890222985
199-D2-8	7/22/09 8:31 AM	Y	7196_CR6	Hexavalent chromium	84.6		78		8.118081181
199-D4-25	6/15/09 9:07 AM	Y	7196_CR6	Hexavalent chromium	54.3		50		8.245445829
199-D4-20	11/2/09 11:28 AM	N	7196_CR6	Hexavalent chromium	55.4		51		8.270676692
199-D4-15	10/6/08 9:39 AM	N	7196_CR6	Hexavalent chromium	1,330	D	1,220		8.62745098
199-K-141	1/26/09 10:24 AM	N	7196_CR6	Hexavalent chromium	459		420		8.873720137
199-K-126	10/21/09 9:08 AM	N	7196_CR6	Hexavalent chromium	38.3		35		9.004092769
199-K-161	10/21/09 10:35 AM	N	7196_CR6	Hexavalent chromium	89.8		82		9.08032596
199-D5-121	5/7/09 10:21 AM	Y	7196_CR6	Hexavalent chromium	35.1		32		9.239940387
199-D5-126	2/12/09 8:33 AM	N	7196_CR6	Hexavalent chromium	1,670	D	1,520		9.404388715
199-D8-55	5/14/09 10:11 AM	Y	7196_CR6	Hexavalent chromium	20.9		19		9.523809524
199-D4-15	4/13/09 9:31 AM	N	7196_CR6	Hexavalent chromium	1090	D	987		9.91815118
199-K-161	10/21/09 10:35 AM	Y	7196_CR6	Hexavalent chromium	89.5		81		9.970674487
199-D5-126	12/30/08 1:03 PM	N	7196_CR6	Hexavalent chromium	1,790	D	1,610		10.58823529
199-D4-1	11/3/09 8:41 AM	N	6010_METALS_ICP	Chromium	63	B	56.3		11.23218776
199-D5-38	1/20/09 8:55 AM	N	7196_CR6	Hexavalent chromium	793	D	705		11.74899866
199-K-126	10/21/09 9:08 AM	Y	7196_CR6	Hexavalent chromium	40.7		36		12.25554107
199-K-111A	10/21/09 10:41 AM	Y	6010_METALS_ICP	Chromium	30.5	B	26.8		12.91448517
199-D5-121	8/11/09 8:27 AM	Y	7196_CR6	Hexavalent chromium	53.8		47		13.49206349
199-D8-69	8/12/09 11:35 AM	Y	7196_CR6	Hexavalent chromium	22.1		19		15.08515815
199-D5-34	3/18/09 8:44 AM	N	7196_CR6	Hexavalent chromium	36.2		31		15.47619048
199-D4-15	1/20/09 8:26 AM	N	7196_CR6	Hexavalent chromium	1,290	DN	1,100		15.89958159
199-D5-121	3/23/09 10:13 AM	N	7196_CR6	Hexavalent chromium	30.5		26		15.92920354

Table E-31. (Cont.)

Well_Name	Samp_Date_Time	Filtered	Method_1	Con_Long_Name	WSCF Result (µg/L)		TA Result (µg/L)		SPD
199-D5-104	10/8/09 8:57 AM	N	7196_CR6	Hexavalent chromium	4,100	D	3,480		16.35883905
199-D5-104	10/8/09 8:57 AM	Y	7196_CR6	Hexavalent chromium	4,160	D	3,530		16.38491547
199-K-34	2/2/09 8:52 AM	N	7196_CR6	Hexavalent chromium	17.7		15		16.51376147
199-K-36	10/22/09 10:52 AM	Y	7196_CR6	Hexavalent chromium	18.9		16		16.61891117
199-D5-104	4/13/09 10:23 AM	N	7196_CR6	Hexavalent chromium	4,030	D	3,410		16.66666667
199-D5-121	8/11/09 8:27 AM	N	7196_CR6	Hexavalent chromium	56		47		17.47572816
199-D5-104	10/6/08 9:40 AM	N	7196_CR6	Hexavalent chromium	5,440	D	4,560		17.6
199-H4-5	9/2/09 10:09 AM	Y	6010_METALS_ICP	Chromium	15.6	B	12.5		22.06405694
199-D8-69	8/12/09 11:35 AM	N	7196_CR6	Hexavalent chromium	22.5		18		22.22222222
199-K-111A	10/21/09 10:41 AM	Y	7196_CR6	Hexavalent chromium	28.5		22		25.74257426
199-K-151	2/17/09 12:35 PM	N	7196_CR6	Hexavalent chromium	22.3		17		26.97201018
199-K-140	10/28/08 12:10 PM	N	7196_CR6	Hexavalent chromium	16.2		11		38.23529412
199-D4-25	6/15/09 9:07 AM	N	6010_METALS_ICP	Chromium	103	B	57.3		57.01809108
199-D5-122	10/8/09 9:55 AM	Y	7196_CR6	Hexavalent chromium	58,600	D	22,300		89.74042027
199-D5-122	10/8/09 9:55 AM	N	7196_CR6	Hexavalent chromium	58,400	D	20,800		94.94949495
199-D5-122	4/14/09 7:57 AM	N	7196_CR6	Hexavalent chromium	49,700	D	16,900		98.4984985
199-K-36	10/22/09 10:52 AM	Y	6010_METALS_ICP	Chromium	75.9		24.6		102.0895522

Notes:
SPD = signed percent difference
TA = TestAmerica
WSCF = Waste Sampling and Characterization Facility

Table E-32. Summary of Analytical Laboratory Detection/Quantitation Limits Determined from Field Blanks Data, TestAmerica Laboratories (Richland and St. Louis) and WSCF.

Period[a]	Number of Samples	Mean	Standard Deviation	Limit of Detection[c]	Limit of Quantitation[c]
Total Organic Carbon (µg/L)					
3/13/2008 to 10/29/2008	78	-54.72	73.28	220	733
4/1/2008 to 2/3/2009	74	-58.97	72.76	218	728
7/1/2008 to 5/28/2009	61	-62.44	79.78	239	798
10/24/2008 to 9/15/2009	56	-55.99	46.66	140	467
1/7/2009 to 12/9/2009	54	-25.42	129.6	389	1,300
Summary[d]	**70**	**-52.53**	**119.6**	**359**	**1,200**
Total Organic Halides (µg/L)					
2/7/2008 to 10/29/2008	69	0.87	1.01	3.0	10.1
4/7/2008 to 2/3/2009	68	0.72	0.89	2.7	8.9
7/1/2008 to 5/28/2009	54	0.9	0.9	2.7	9.0
10/8/2008 to 9/9/2009	53	1.09	1.01	3.0	10.1
1/7/2009 to 10/19/2009	49	1.00	1.05	3.2	10.5
Summary[d]	**65**	**1.12**	**1.07**	**3.2**	**10.7**
Cesium-137 (pCi/L)					
10/06/2008 to 11/25/2008	7	-1.05	1.62	4.87	16.25
1/14/2009 to 3/04/2009	7	-1.59	2.21	6.62	22.06
4/21/2009 to 6/18/2009	4	0.61	2.09	6.28	20.92
7/31/2009 to 9/30/2009	5	0.95	1.04	3.11	10.37
10/7/2009 to 11/12/2009	7	0.23	0.51	1.53	5.11
Summary	**30**	**-0.32**	**1.60**	**4.80**	**16.00**
Constituent: Cobalt-60 (pCi/L)					
10/6/2008 to 11/25/2008	7	-0.46	2.02	6.06	20.18
1/14/2009 to 3/4/2009	7	0.00	1.08	3.25	10.83
4/21/2009 to 6/18/2009	4	-2.02	4.11	12.33	41.10
7/31/2009 to 9/20/2009	5	-0.34	0.72	2.16	7.18
10/7/2009 to 11/12/2009	7	0.46	0.88	2.63	8.76
Summary	**30**	**-0.33**	**1.88**	**5.65**	**18.85**
Europium-152 (pCi/L)					
10/6/2008 to 11/25/2008	7	3.49	5.36	16.07	53.57
1/14/2009 to 3/4/2009	7	0.27	5.13	15.38	51.26
4/21/2009 to 6/18/2009	4	-2.74	6.44	19.32	64.41
7/31/2009 to 9/20/2009	5	4.54	7.80	23.40	77.99
10/7/2009 to 11/12/2009	7	0.78	1.52	4.56	15.20
Summary	**30**	**1.45**	**5.33**	**16.00**	**53.35**
Europium-154 (pCi/L)					
10/6/2008 to 11/25/2008	7	-1.95	2.86	8.57	28.57
1/14/2009 to 3/4/2009	7	-1.39	4.49	13.48	44.95
4/21/2009 to 6/18/2009	4	-2.84	5.58	16.73	55.75
7/31/2009 to 9/20/2009	5	2.68	4.00	11.99	39.97
10/7/2009 to 11/12/2009	7	-0.61	1.84	5.51	18.38
Summary	**30**	**-0.86**	**3.73**	**11.19**	**37.29**
Europium-155 (pCi/L)					
10/6/2008 to 11/25/2008	7	-2.79	3.88	11.63	38.76
1/14/2009 to 3/4/2009	7	-1.38	4.14	12.41	41.35
4/21/2009 to 6/18/2009	4	-0.69	1.42	4.25	14.17
7/31/2009 to 9/20/2009	5	-0.66	1.82	5.46	18.19
10/7/2009 to 11/12/2009	7	-0.50	0.90	2.70	9.01

Table E-32 (Cont.)

Period[a]	Number of Samples	Mean	Standard Deviation	Limit of Detection[c]	Limit of Quantitation[c]
Summary	**30**	**-1.29**	**2.95**	**8.84**	**29.45**
Gross Alpha (pCi/L)					
10/6/2008 to 11/21/2008	12	0.05	0.35	1.04	3.48
1/7/2009 to 3/25/2009	15	0.06	0.57	1.70	5.66
4/1/2009 to 6/30/2009	10	0.04	0.51	1.54	5.13
7/7/2009 to 9/20/2009	14	0.07	0.46	1.38	4.60
10/4/2009 to 12/9/2009	17	0.57	1.64	4.91	16.36
Summary	**68**	**0.18**	**0.92**	**2.77**	**9.24**
Gross Beta (pCi/L)					
10/26/2008 to 11/21/2008	13	1.35	1.98	5.93	19.75
1/7/2009 to 3/25/2009	16	0.82	1.37	4.12	13.74
4/1/2009 to 6/30/2009	10	1.00	0.48	1.44	4.80
7/7/2009 to 9/20/2009	13[b]	1.27	1.74	5.22	17.40
10/4/2009 to 12/29/2009	18	1.21	1.88	5.63	18.78
Summary	**70[b]**	**1.13**	**1.63**	**4.90**	**16.34**
Iodine-129 (pCi/L)					
10/14/2008 to 11/23/2008	4	0.03	0.05	0.16	0.53
1/27/2009 to 2/26/2009	10	0.05	0.18	0.54	1.80
4/6/2009 to 6/22/2009	6	0.07	0.20	0.60	2.00
7/8/2009 to 9/20/2009	13	0.15	0.40	1.21	4.02
10/4/2009 to 12/9/2009	10	0.07	0.20	0.59	1.95
Summary	**43**	**0.08**	**0.27**	**0.81**	**2.71**
Total Beta Radiostrontium (pCi/L)					
10/6/2008 to 11/13/2008	2	-0.95	0.04	0.13	0.42
1/12/2009 to 3/4/2009	5	-1.50	1.57	4.71	15.7
4/2/2009 to 6/18/2009	6	-1.63	9.25	27.8	92.5
8/27/2009 to 9/20/2009	4	-2.05	4.06	12.18	40.62
10/6/2009 to 12/9/2009	13[b]	-4.66	3.96	11.87	39.57
Summary	**30[b]**	**-2.93**	**5.20**	**15.59**	**51.97**
Technetium-99 (pCi/L)					
10/6/2008 to 12/17/2008	11	-2.28	1.79	5.38	17.94
1/6/2009 to 3/26/2009	15	-8.23	4.28	12.83	42.77
4/6/2009 to 6/26/2009	8	-7.42	8.47	25.42	84.73
7/14/2009 to 9/20/2009	15	-2.59	3.31	9.92	33.08
10/4/2009 to 12/9/2009	16	-5.03	11.54	34.62	115.41
Summary	**65**	**-5.04**	**7.00**	**21.01**	**70.02**
Tritium (pCi/L)					
10/6/2008 to 12/17/2008	16	48.2	76.9	231	769
1/12/2009 to 3/26/2009	17	38.6	42.6	128	426
4/1/2009 to 6/26/2009	14	-58.4	76.2	228	762
7/8/2009 to 9/20/2009	17[b]	26.8	56.9	170	569
10/4/2009 to 12/2/2009	23[b]	77.5	81.1	243	811
Summary	**87[b]**	**396**	**68.9**	**207**	**689**

Notes:
a. Time period covered for total organic carbon and total organic halides is a moving average of four quarters.
b. Excluded outliers.
c. Limit of detection (blank corrected) equals three times the blank standard deviation; limit of quantitation (blank-corrected) equals ten times the blank standard deviation. Numbers are rounded.
d. Summaries span a period of five quarters.

WSCF = Waste Sampling and Characterization Facility

Table E-33. Summary of Detection and Quantitation Limits, WSCF.

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
General Chemical Parameters								
EPA/600/R-93/100, 120.1	Conductivity[b]	0.5	0.68	2.25				
APHA/AWWA/WEF, 2320	Alkalinity	1,000	1,350	4,503				
Ammonia and Anions								
EPA/600/R-93/100, 300.0[c]	Chloride	50	68	225	5/1/2009	43	58	194
EPA/600/R-93/100, 300.0[c]	Fluoride	20	27	90	5/1/2009	30	41	135
EPA/600/R-93/100, 300.0[c]	Nitrate	44.3	59.8	199	5/1/2009	137	185	617
EPA/600/R-93/100, 300.0[c]	Nitrite	32.8	44.3	148	5/1/2009	59.1	79.8	266
EPA/600/R-93/100, 300.0[c]	Sulfate	100	135	450	5/1/2009	66	89	297
EPA/600/R-93/100, 300.7	Ammonium	12	16	54	5/26/2009	4.38	5.91	19.7
EPA/600/R-93/100, 335.2	Cyanide	4	5	18				
Metals								
SW-846, 6010	Aluminum	52	70	234				
SW-846, 6010	Antimony	56	76	252	3/30/2009	38	51	171
SW-846, 6010	Barium	4	5	18				
SW-846, 6010	Beryllium	4	5	18				
SW-846, 6010	Cadmium	4	5	18				
SW-846, 6010	Calcium	73	99	329	3/30/2009	39	53	176
SW-846, 6010	Chromium[d]	13	18	59				
SW-846, 6010	Cobalt	4	5	18				
SW-846, 6010	Copper	6	8	27	3/30/2009	4	5	18
SW-846, 6010	Iron	25	34	113	3/30/2009	18	24	81
SW-846, 6010	Magnesium	50	68	225	3/30/2009	16	22	72
SW-846, 6010	Manganese	4	5	18				
SW-846, 6010	Nickel	4	5	18				
SW-846, 6010	Potassium	170	230	766	3/30/2009	55	74	248
SW-846, 6010	Silver	5	7	23				
SW-846, 6010	Sodium[d]	51	69	230	3/30/2009	23	31	104
SW-846, 6010	Strontium (elemental)	4	5	18				
SW-846, 6010	Vanadium	12	16	54				
SW-846, 6010	Zinc[d]	9	12	41	5/6/2009	6	8	27
EPA/600/R-94/111, 200.8	Aluminum	5	7	23				
EPA/600/R-94/111, 200.8	Antimony	0.3	0.4	1				
EPA/600/R-94/111, 200.8	Arsenic	0.4	0.5	2				
EPA/600/R-94/111, 200.8	Barium	0.2	0.3	0.9				
EPA/600/R-94/111, 200.8	Cadmium	0.1	0.1	0.5				

Table E-33. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
EPA/600/R-94/111, 200.8	Chromium	0.5	0.7	2				
EPA/600/R-94/111, 200.8	Cobalt	0.05	0.1	0.2				
EPA/600/R-94/111, 200.8	Copper	0.1	0.1	0.5				
EPA/600/R-94/111, 200.8	Lead	0.1	0.1	0.5				
EPA/600/R-94/111, 200.8	Mercury	0.05	0.1	0.2				
EPA/600/R-94/111, 200.8	Strontium (elemental)	0.1	0.1	0.5				
EPA/600/R-94/111, 200.8	Thallium[d]	0.05	0.1	0.2				
EPA/600/R-94/111, 200.8	Uranium	0.05	0.1	0.2				
Volatile Organic Compounds								
SW-846, 8260	1,1,2,2-Tetrachloroethane	1	1	5				
SW-846, 8260	1,1,1-Trichloroethane	1	1	5				
SW-846, 8260	1,1,2-Trichloroethane	1	1	5				
SW-846, 8260	1,1-Dichloroethane	1	1	5				
SW-846, 8260	1,1-Dichloroethene	1	1	5				
SW-846, 8260	1,2-Dichloroethane	1	1	5				
SW-846, 8260	1,2-Dichloroethene (Total)	1	1	5				
SW-846, 8260	1,4-Dichlorobenzene	1	1	5				
SW-846, 8260	1-Butanol	100	135	450				
SW-846, 8260	2-Butanone	1	1	5				
SW-846, 8260	2-Hexanone	1	1	5				
SW-846, 8260	2-Petanone, 4-Methyl	1	1	5				
SW-846, 8260	Acetone	1	1	5				
SW-846, 8260	Benzene	1	1	5				
SW-846, 8260	Bromodichloromethane	1	1	5				
SW-846, 8260	Bromoform	1	1	5				
SW-846, 8260	Bromomethane	1	1	5				
SW-846, 8260	Carbon disulfide	1	1	5				
SW-846, 8260	Carbon tetrachloride	1	1	5				
SW-846, 8260	Chlorobenzene	1	1	5				
SW-846, 8260	Chloroethane	1	1	5				
SW-846, 8260	Chloroform	1	1	5				
SW-846, 8260	Chloromethane	1	1	5				
SW-846, 8260	Dibromomethane	1	1	5				
SW-846, 8260	cis-1,2-Dichloroethylene	1	1	5				
SW-846, 8260	cis-1,3-Dichloropropene	1	1	5				
SW-846, 8260	Ethyl cyanide	2	3	9				

Table E-33. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8260	Ethylbenzene	1	1	5				
SW-846, 8260	Methylene chloride	1	1	5				
SW-846, 8260	Styrene	1	1	5				
SW-846, 8260	Tetrachloroethene	1	1	5				
SW-846, 8260	Tetrahydrofuran	2	3	9				
SW-846, 8260	Toluene	1	1	5				
SW-846, 8260	trans-1,2-Dichloroethylene	1	1	5				
SW-846, 8260	trans-1,3-Dichloropropene	1	1	5				
SW-846, 8260	Trichloroethene	1	1	5				
SW-846, 8260	Vinyl chloride	1	1	5				
SW-846, 8260	Xylenes (total)	1	1	5				
SW-846, 8015	TPH, gasoline fraction[c]	50	68	225				
Semivolatile Organic Compounds								
SW-846, 8015	TPH, diesel fraction[c]	71	96	320	1/8/2009	70	95	315
SW-846, 8015	TPH, kerosene fraction[c]	71	96	320	1/8/2009	70	95	315
SW-846, 8270	1,2,4-Trichlorobenzene	2.1	2.8	9.5	3/11/2009	0.7	0.9	3.2
SW-846, 8270	1,2,4-Trimethylbenzene	1	1	5	3/11/2009	0.7	0.9	3.2
SW-846, 8270	1,4-Dichlorobenzene[c]	1.3	1.8	5.9	3/11/2009	0.9	1.2	4.1
SW-846, 8270	2,3,4,6-Tetrachlorophenol	0.48	0.65	2.2			0.0	0.0
SW-846, 8270	2,4,5-Trichlorophenol	0.62	0.84	2.8	10/15/2009	0.5	0.7	2
SW-846, 8270	2,4,6-Trichlorophenol	0.48	0.65	2.2	10/15/2009	0.5	0.7	2
SW-846, 8270	2,4-Dichlorophenol[c]	0.48	0.65	2.2	1/14/2009	0.5	0.7	2
SW-846, 8270	2,4-Dimethylphenol[c]	0.9	1	4	10/15/2009	0.5	0.7	2
SW-846, 8270	2,4-Dinitrophenol	1.9	2.6	8.6	10/15/2009	0.6	0.8	3
SW-846, 8270	2,4-Dinitrotoluene	0.48	0.65	2.2	3/11/2009	0.5	0.7	2
SW-846, 8270	2,6-Dichlorophenol	0.57	0.77	2.6				
SW-846, 8270	2-Chlorophenol	0.48	0.65	2.2	3/11/2009	0.5	0.7	2
SW-846, 8270	2-Methylphenol (cresol, o-)[c]	0.48	0.65	2.2	1/14/2009	0.8	1.1	4
SW-846, 8270	2-Nitroaniline	0.5	0.7	2.3				
SW-846, 8270	2-Nitrophenol	0.48	0.65	2.2	1/14/2009	0.5	0.7	2
SW-846, 8270	2-Picoline	4.8	6.48	22	1/14/2009	1	1	5
SW-846, 8270	3+4-Methylphenol (cresol, m+p)[c]	0.48	0.65	2.2	1/14/2009	0.6	0.8	3
SW-846, 8270	4,6-Dinitro-2-methylphenol	0.95	1.3	4.3	10/15/2009	0.7	0.9	3
SW-846, 8270	4-Chloro-3-methylphenol	0.48	0.6	2.2	3/11/2009	0.5	0.7	2
SW-846, 8270	4-Chloroaniline	0.7	0.9	3	10/15/2009	0.6	0.8	3
SW-846, 8270	4-Chlorophenyl phenyl ether	0.6	0.8	3	10/16/2009	0.5	0.7	2

Table E-33. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	4-Nitrophenol[c]	0.95	1.3	4.3	3/11/2009	0.6	0.8	3
SW-846, 8270	Acenaphthene	2.5	3.4	11	3/11/2009	0.5	0.7	2
SW-846, 8270	Benzo(a)anthracene	0.5	0.7	2				
SW-846, 8270	Benzo(a)pyrene	0.6	0.8	3				
SW-846, 8270	Benzo(b)fluoranthene	0.5	0.7	2				
SW-846, 8270	Benzo(ghi)perylene	0.7	0.9	3				
SW-846, 8270	Benzo(k)fluoranthene	0.7	0.9	3				
SW-846, 8270	Benzoic acid	5	7	23				
SW-846, 8270	Benzothiazole	0.57	0.77	2.6	1/14/2009	0.5	0.7	2
SW-846, 8270	Bis(2-chloroethoxy) methane	0.5	0.7	2				
SW-846, 8270	Bis(2-chloro-1-methylethyl) ether	0.6	0.8	3	10/16/2009	0.5	0.7	2
SW-846, 8270	Bis(2-chloroethyl) ether	0.6	0.8	3				
SW-846, 8270	Bis(2-ethylhexyl) phthalate	0.76	1.0	3.4	1/20/2009	0.8	1.1	4
SW-846, 8270	Naphthalene	2	3	9	1/14/2009	0.5	0.7	2
SW-846, 8270	Dinoseb(2-secButyl-4,6-dinitrophenol)	0.95	1.3	4.3				
SW-846, 8270	Pentachlorophenol[c]	1.4	1.9	6.3	1/14/2009	0.5	0.7	2
SW-846, 8270	Phenanthrene	0.6	0.8	2.7	10/16/2009	0.5	0.7	2
SW-846, 8270	Phenol	0.48	0.65	2.16	3/11/2009	0.9	1	4
SW-846, 8270	Pyrene	0.48	0.65	2.16	3/11/2009	0.9	1	4
SW-846, 8270	Pyridine	1	1	5	10/16/2009	0.9	1	4
SW-846, 8270	Total cresols	0.95	1.3	4.3	1/14/2009	0.5	0.7	2
SW-846, 8270	Tributyl phosphate	0.48	0.65	2.16	1/14/2009	0.5	0.7	2
SW-846, 8270	Tris-2-chloroethyl phosphate	0.62	0.84	2.8	1/14/2009	0.5	0.7	2
SW-846, 8270	n-Nitrosodi-n-dipropylamine	0.57	0.77	2.6	3/11/2009	0.5	0.7	2
SW-846, 8270	n-Nitrosodimethylamine[c]	0.72	1.0	3.2	1/14/2009	0.5	0.7	2

Notes:
Standard Methods for the Examination of Water and Wastewater (APHA et al. 1998).
EPA/600/481/004, *Environmental Radioactivity Laboratory Intercomparison Studies Program: Fiscal Year 198081.*
SW846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods.*
a. The MDLs for many constituents changed during the fiscal year. For these constituents, the initial MDL, LOD, and LOQ were in effect until the date the values were updated (ending values, effective date). In cases where the MDL did not change, no ending values are listed.
b. µMhos/cm.
c. Additional MDLs were used during the year for these compounds.

LOD = limit of detection
LOQ = limit of quantitation
MDL = method detection limit
TPH = total petroleum hydrocarbon
WSCF = Waste Sampling and Characterization Facility

Table E-34. Summary of Detection and Quantitation Units, TestAmerica Laboratory.

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
General Chemical Parameters								
EPA/600/4-81-004, 120.1	Conductivity[b]	0.97	1.3	4.4				
EPA/600/4-81-004, 310.1	Alkalinity	100	135	450	3/31/2009	310	419	1,396
EPA/600/4-81-004, 413.1	Oil and grease	500	675	2,252				
Ammonia and Anions								
EPA/600/R-93/100, 300.0[c]	Chloride	20	27	90				
EPA/600/R-93/100, 300.0[c]	Fluoride	10	14	45				
EPA/600/R-93/100, 300.0[c]	Nitrate	38	51	171				
EPA/600/R-93/100, 300.0[c]	Nitrite	7	9	32	1/21/2009	10	14	45
EPA/600/R-93/100, 300.0[c]	Sulfate	50	68	225				
SW-846, 9012	Cyanide	3.6	4.9	16				
SW-846, 9030[c]	Sulfide	180	243	811	3/17/2009	83	112	374
Metals								
SW-846, 6010	Aluminum	79.9	108	360				
SW-846, 6010	Antimony	4	5	18				
SW-846, 6010	Barium	0.85	1.1	3.8	7/28/2009	4	5	18
SW-846, 6010	Beryllium	0.5	0.68	2.3	7/28/2009	0.61	0.82	2.7
SW-846, 6010	Cadmium	0.45	0.61	2.0	7/28/2009	0.91	1.2	4.1
SW-846, 6010	Calcium	18.6	25.1	83.8	10/6/2009	106	143	477
SW-846, 6010	Chromium	3.1	4.2	14				
SW-846, 6010	Cobalt	4	5	18				
SW-846, 6010	Copper	4.6	6.2	21				
SW-846, 6010	Iron	16	22	72	7/28/2009	28.2	38.1	127
SW-846, 6010	Lithium	9.6	13	43				
SW-846, 6010	Magnesium	110	149	495	7/28/2009	132	178	594
SW-846, 6010	Manganese	0.96	1.3	4.3	7/28/2009	3.3	4.5	15
SW-846, 6010	Nickel	13.3	18.0	59.9				
SW-846, 6010	Potassium	1,650	2,228	7,430				
SW-846, 6010	Silver	6	8	27				
SW-846, 6010	Sodium	134	181	603	7/28/2009	324	438	1,459
SW-846, 6010	Strontium (elemental)	0.54	0.73	2.4				
SW-846, 6010	Vanadium	4.1	5.5	18				
SW-846, 6010	Zinc	5.2	7.0	23				
SW-846, 6020	Aluminum	8.7	12	39				
SW-846, 6020	Arsenic	1.9	3	9	7/17/2009	0.52	0.7	2.3

Table E-34. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 6020	Selenium	0.24	0.32	1.08				
SW-846, 6020	Thallium	0.2	0.3	0.9	6/9/2008	0.14	0.19	0.63
SW-846, 7470	Mercury	0.044	0.059	0.20	7/17/2009	0.045	0.06	0.20
Volatile Organic Compounds								
SW-846, 8260	1,1,1,2-Tetrachloroethane	0.1	0.1	0.5	2/25/2009	0.16	0.22	0.72
SW-846, 8260	1,1,1-Trichloroethane	0.1	0.1	0.5	2/24/2009	0.09	0.1	0.4
SW-846, 8260	1,1,2,2-Tetrachloroethane	0.27	0.36	1.2	2/25/2009	0.11	0.15	0.50
SW-846, 8260	1,1,2-Trichloroethane	0.19	0.26	0.86	2/24/2009	0.071	0.10	0.32
SW-846, 8260	1,1-Dichloroethane	0.07	0.09	0.3	2/24/2009	0.083	0.11	0.37
SW-846, 8260	1,1-Dichloroethene	0.085	0.11	0.38	2/24/2009	0.11	0.15	0.50
SW-846, 8260	1,2,3-Trichloropropane	0.22	0.30	0.99	2/25/2009	0.23	0.31	1.04
SW-846, 8260	1,2-Dibromo-3-chloropropane	0.48	0.65	2.16	2/25/2009	0.2	0.3	0.9
SW-846, 8260	1,2-Dibromoethane	0.15	0.20	0.68	2/25/2009	0.098	0.13	0.44
SW-846, 8260	1,2-Dichloroethane	0.18	0.24	0.81	2/24/2009	0.05	0.07	0.23
SW-846, 8260	1,2-Dichloroethene (total)	0.14	0.19	0.63	2/25/2009	0.21	0.28	0.95
SW-846, 8260	1,2-Dichloropropane	0.077	0.10	0.35	2/25/2009	0.054	0.073	0.24
SW-846, 8260	1,4-Dichlorobenzene	0.1	0.1	0.5	2/24/2009	0.11	0.15	0.50
SW-846, 8260	1,4-Dioxane	7	9	32	2/24/2009	45	61	203
SW-846, 8260	1-Butanol	14	19	63	3/10/2009	8.1	11	36
SW-846, 8260	2-Butanone	0.96	1.3	4.3	2/24/2009	0.83	1.1	3.7
SW-846, 8260	2-Hexanone	0.08	0.1	0.4	2/25/2009	1.3	1.8	5.9
SW-846, 8260	Acetone	0.56	0.76	2.5	2/24/2009	0.42	0.57	1.89
SW-846, 8260	Acetonitrile	4.2	5.7	19				
SW-846, 8260	Acrolein	0.52	0.70	2.3	2/25/2009	2.6	3.5	11.7
SW-846, 8260	Allyl chloride	0.2	0.3	0.9	2/25/2009	0.12	0.16	0.54
SW-846, 8260	Benzene	0.032	0.043	0.14	2/24/2009	0.06	0.1	0.3
SW-846, 8260	Bromodichloromethane	0.088	0.12	0.40	2/25/2009	0.098	0.13	0.44
SW-846, 8260	Bromoform	0.27	0.36	1.2	2/25/2009	0.15	0.20	0.68
SW-846, 8260	Bromomethane	0.5	0.7	2	2/25/2009	0.096	0.13	0.43
SW-846, 8260	Carbon disulfide	0.029	0.039	0.13	2/24/2009	0.52	0.70	2.3
SW-846, 8260	Carbon tetrachloride	0.042	0.057	0.19	2/25/2009	0.073	0.10	0.33
SW-846, 8260	Chlorobenzene	0.48	0.65	2.2	2/25/2009	0.06	0.1	0.3
SW-846, 8260	Chloroethane	0.085	0.11	0.38				0.0
SW-846, 8260	Chloroform	0.08	0.1	0.4	2/25/2009	0.067	0.090	0.30
SW-846, 8260	Chloromethane	0.036	0.049	0.16	2/24/2009	0.086	0.12	0.39

Table E-34. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8260	Chloroprene	0.085	0.11	0.38	2/25/2009	0.083	0.11	0.37
SW-846, 8260	Dibromochloromethane	0.17	0.23	0.77	2/25/2009	0.21	0.28	0.95
SW-846, 8260	Dibromomethane	0.14	0.19	0.63	2/25/2009	0.095	0.13	0.43
SW-846, 8260	Dichlorodifluoromethane	0.074	0.10	0.33	2/25/2009	0.058	0.078	0.26
SW-846, 8260	Ethyl cyanide	4.7	6.3	21	2/24/2009	2.1	2.8	9.5
SW-846, 8260	Ethyl methacrylate	0.39	0.53	1.8	2/25/2009	0.74	1.0	3.3
SW-846, 8260	Ethylbenzene	0.061	0.082	0.27	2/24/2009	0.11	0.15	0.50
SW-846, 8260	Hexane	0.16	0.22	0.72				
SW-846, 8260	Iodomethane	0.33	0.45	1.5	2/25/2009	0.091	0.12	0.41
SW-846, 8260	Isobutyl alcohol	6.1	8.2	27	2/25/2009	54	73	243
SW-846, 8260	Methacrylonitrile	1.8	2.4	8.1	2/25/2009	1.4	1.9	6.3
SW-846, 8260	Methyl methacrylate	0.62	0.84	2.8	2/25/2009	0.97	1.3	4.4
SW-846, 8260	Methylene chloride	0.091	0.12	0.41	2/24/2009	0.1	0.1	0.5
SW-846, 8260	Styrene	0.079	0.11	0.36	2/24/2009	0.042	0.06	0.19
SW-846, 8260	Tetrachloroethene	0.14	0.19	0.63	2/24/2009	0.065	0.088	0.29
SW-846, 8260	Tetrahydrofuran	3.2	4.3	14	2/24/2009	7.5	10	34
SW-846, 8260	Toluene	0.029	0.039	0.13	2/24/2009	0.07	0.1	0.3
SW-846, 8260	trans-1,2-Dichloroethylene	0.089	0.12	0.40	2/24/2009	0.081	0.1	0.4
SW-846, 8260	trans-1,3-Dichloropropene	0.08	0.1	0.4	2/25/2009	0.23	0.31	1.04
SW-846, 8260	trans-1,4-Dichloro-2-butene	0.75	1.0	3.4	2/25/2009	0.2	0.3	0.9
SW-846, 8260	Trichloroethene	0.11	0.15	0.50	2/25/2009	0.09	0.1	0.4
SW-846, 8260	Trichloromonofluoromethane	0.1	0.1	0.5	2/25/2009	0.11	0.15	0.50
SW-846, 8260	Vinyl acetate	0.22	0.30	0.99	2/25/2009	0.23	0.31	1.0
SW-846, 8260	Vinyl chloride	0.13	0.18	0.59	2/24/2009	0.091	0.12	0.41
SW-846, 8260	Xylenes (total)	1.6	2.2	7.2	2/24/2009	0.22	0.3	1.0
SW-846, 8015	TPH, gasoline fraction	10	14	45				
Semivolatile Organic Compounds								
SW-846, 8015	TPH, diesel fraction	17	23	77				
SW-846, 8040	2,3,4,6-Tetrachlorophenol	2	3	9				
SW-846, 8040	2,4,5-Trichlorophenol	2.2	3.0	9.9				
SW-846, 8040	2,4,6-Trichlorophenol	2.2	3.0	9.9				
SW-846, 8040	2,4-Dichlorophenol	2.1	2.8	9.5				
SW-846, 8040	2,4-Dimethylphenol	2.1	2.8	9.5				
SW-846, 8040	2,4-Dinitrophenol	2.4	3.2	11				
SW-846, 8040	2,6-Dichlorophenol	2.1	2.8	9.5				

Table E-34. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8040	2-Chlorophenol	2.2	3.0	9.9				
SW-846, 8040	2-Methylphenol (cresol, o-)	2.2	3.0	9.9				
SW-846, 8040	2-Nitrophenol	2.3	3.1	10				
SW-846, 8040	Dinoseb (2-secButyl-4,6-dinitrophenol)	2.4	3.2	11				
SW-846, 8040	3- + 4-Methylphenol	2.2	3.0	9.9				
SW-846, 8040	4,6-Dinitro-2-methyl phenol	2.2	3.0	9.9				
SW-846, 8040	4-Chloro-3-methylphenol	2.4	3.2	11				
SW-846, 8040	4-Nitrophenol	2.2	3.0	9.9				
SW-846, 8040	Pentachlorophenol	2.4	3.2	11				
SW-846, 8040	Phenol	2.3	3.1	10				
SW-846, 8081	4,4'-DDD[d]	0.0031	0.0042	0.014	7/16/2009	0.01	0.01	0.05
SW-846, 8081	4,4'-DDE[d]	0.0059	0.008	0.027	7/16/2009	0.02	0.03	0.09
SW-846, 8081	4,4'-DDT[d]	0.0098	0.013	0.044	7/16/2009	0.01	0.01	0.05
SW-846, 8081	Aldrin[d]	0.0047	0.0063	0.021	7/16/2009	0.01	0.01	0.05
SW-846, 8081	alpha-BHC[d]	0.0044	0.0059	0.020	7/16/2009	0.01	0.01	0.05
SW-846, 8081	beta-BHC[d]	0.0065	0.0088	0.029	7/16/2009	0.01	0.01	0.05
SW-846, 8081	Chlordane[d]	0.032	0.043	0.144	7/16/2009	0.04	0.05	0.2
SW-846, 8081	delta-BHC[d]	0.0032	0.0043	0.014	7/16/2009	0.01	0.01	0.05
SW-846, 8081	Dieldrin[d]	0.0036	0.0049	0.016	7/16/2009	0.01	0.01	0.05
SW-846, 8081	Endosulfan I[d]	0.0031	0.0042	0.014	7/16/2009	0.02	0.03	0.09
SW-846, 8081	Endosulfan II[d]	0.0032	0.0043	0.014	7/16/2009	0.01	0.01	0.05
SW-846, 8081	Endosulfan sulfate[d]	0.0082	0.011	0.037	7/16/2009	0.01	0.01	0.05
SW-846, 8081	Endrin[d]	0.0067	0.009	0.030	7/16/2009	0.01	0.01	0.05
SW-846, 8081	Endrin aldehyde[d]	0.0027	0.0036	0.012	7/16/2009	0.01	0.01	0.05
SW-846, 8081	gamma-BHC (lindane)[d]	0.0029	0.0039	0.013	10/31/2009	0.003	0.004	0.01
SW-846, 8081	Heptachlor[d]	0.0052	0.0070	0.023	7/16/2009	0.003	0.004	0.01
SW-846, 8081	Heptachlor epoxide[d]	0.0041	0.0055	0.018	7/16/2009	0.01	0.014	0.05
SW-846, 8081	Methoxychlor[d]	0.0081	0.011	0.036	7/16/2009	0.001	0.001	0.005
SW-846, 8081	Toxaphene[d]	0.19	0.26	0.86	7/16/2009	0.66	0.89	3.0
SW-846, 8082	Aroclor-1016	0.21	0.28	0.95	10/17/2009	0.14	0.19	0.63
SW-846, 8082	Aroclor-1221	0.21	0.28	0.95	10/17/2009	0.14	0.19	0.63
SW-846, 8082	Aroclor-1232	0.21	0.28	0.95	10/17/2009	0.14	0.19	0.63
SW-846, 8082	Aroclor-1242	0.21	0.28	0.95	10/17/2009	0.14	0.19	0.63
SW-846, 8082	Aroclor-1248	0.21	0.28	0.95	10/17/2009	0.14	0.19	0.63
SW-846, 8082	Aroclor-1254	0.14	0.19	0.63	10/17/2009	0.093	0.13	0.42

Table E-34. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8082	Aroclor-1260	0.14	0.19	0.63	10/17/2009	0.093	0.13	0.42
SW-846, 8082	Aroclor-1262	0.093	0.13	0.42				
SW-846, 8082	Aroclor-1268	0.093	0.13	0.42				
SW-846, 8270	1,2,4,5-Tetrachlorobenzene	1	1	5	8/17/2009	1	1	5
SW-846, 8270	1,2,4-Trichlorobenzene	1	1	5				
SW-846, 8270	1,2-Dichlorobenzene	1	1	5				
SW-846, 8270	1,3-Dichlorobenzene	1	1	5				
SW-846, 8270	1,4-Dichlorobenzene	1	1	5				
SW-846, 8270	1,4-Dioxane	2	3	9	11/5/2008	5	7	23
SW-846, 8270	1,4-Naphthoquinone	1	1	5				
SW-846, 8270	1-Naphthylamine	1	1	5				
SW-846, 8270	2,3,4,6-Tetrachlorophenol	1	1	5				
SW-846, 8270	2,4,5-Trichlorophenol	2	3	9				
SW-846, 8270	2,4,6-Trichlorophenol	2	3	9				
SW-846, 8270	2,4-Dichlorophenol	1	1	5				
SW-846, 8270	2,4-Dimethylphenol	1	1	5				
SW-846, 8270	2,4-Dinitrophenol	2	3	9				
SW-846, 8270	2,4-Dinitrotoluene	1	1	5				
SW-846, 8270	2.6-Dichlorophenol	1	1	5				
SW-846, 8270	2,6-Dinitrotoluene	1	1	5				
SW-846, 8270	2-Acetylaminofluorene	1	1	5				
SW-846, 8270	2-Chloronaphthalene	1	1	5				
SW-846, 8270	2-Chlorophenol	1	1	5				
SW-846, 8270	2-Methylnaphthalene	1	1	5				
SW-846, 8270	2-Methylphenol (cresol, o-)	2	3	9				
SW-846, 8270	2-Naphthylamine	1	1	5				
SW-846, 8270	2-Nitroaniline	2	3	9				
SW-846, 8270	2-Nitrophenol	1	1	5				
SW-846, 8270	2-Picoline	1	1	5				
SW-846, 8270	Dinoseb (2-secButyl-4,6-dinitrophenol)	2	3	9				
SW-846, 8270	3,3'-Dichlorobenzidine	1	1	5	3/24/2009	1.3	1.8	5.9
SW-846, 8270	3,3'-Dimehtylbenzidine	2.6	3.5	12				
SW-846, 8270	3+4-Methylphenol (cresol, m+p)	1	1	5	4/29/2009	2	3	9
SW-846, 8270	3-Methylcholanthrene	1	1	5				
SW-846, 8270	3-Nitroaniline	1	1	5				

Table E-34. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	4,6-Dinitro-2-methyl phenol	2	3	9				
SW-846, 8270	4-Aminobiphenyl	1	1	5				
SW-846, 8270	4-Bromophenylphenyl ether	1	1	5				
SW-846, 8270	4-Chloro-3-methylphenol	1	1	5				
SW-846, 8270	4-Chloroaniline	1	1	5	3/24/2009	1.3	1.8	5.9
SW-846, 8270	4-Chlorophenylphenyl ether	1	1	5				
SW-846, 8270	4-Methylphenol (cresol, p-)[d]	10	14	45	3/17/2009	20	27	90
SW-846, 8270	4-Nitroaniline	1	1	5				
SW-846, 8270	4-Nitrophenol	2	3	9				
SW-846, 8270	4-Nitroquinoline-1-oxide	5	7	23				
SW-846, 8270	5-Nitro-o-toluidine	1	1	5				
SW-846, 8270	7,12-Dimethylbenz[a]anthracene	1	1	5				
SW-846, 8270	Acenaphthene	1	1	5				
SW-846, 8270	Acenaphthylene	1	1	5				
SW-846, 8270	Acetophenone	1	1	5	3/24/2009	1.2	1.6	5.4
SW-846, 8270	alpha,alpha-Dimethylphenethylamine	22	30	99				
SW-846, 8270	Aniline	2	3	9				
SW-846, 8270	Anthracene	1	1	5				
SW-846, 8270	Aramite[d]	20	27	90				
SW-846, 8270	Azobenzene	1	1	5				
SW-846, 8270	Benzo(a)anthracene	1	1	5				
SW-846, 8270	Benzo(a)pyrene	1	1	5				
SW-846, 8270	Benzobfluoranthene	1	1	5				
SW-846, 8270	Benzo(ghi)perylene	1	1	5				
SW-846, 8270	Benzo(k)fluoranthene	1	1	5				
SW-846, 8270	Benzothiazole	1	1	5	4/29/2009	1.1	1.5	5.0
SW-846, 8270	Benzyl alcohol	1	1	5				
SW-846, 8270	Bis(2-Chloroethoxy)methane	1	1	5				
SW-846, 8270	Bis(2-chloro-1-methylethyl ether)	1	1	5	3/24/2009	1.1	1.5	5.0
SW-846, 8270	Bis(2-chloroethyl) ether	1	1	5				
SW-846, 8270	Bis(2-ethylhexyl) phthalate	1	1	5				
SW-846, 8270	Butylbenzylphthalate	1	1	5				
SW-846, 8270	Chlorobenzilate	1	1	5				
SW-846, 8270	Chrysene	1	1	5				
SW-846, 8270	Diallate	2	3	9				

Table E-34. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	Di-n-butylphthalate	1	1	5				
SW-846, 8270	Di-n-octylphthalate	1	1	5				
SW-846, 8270	Dibenz[a,h]anthracene	1	1	5				
SW-846, 8270	Dibenzofuran	1	1	5				
SW-846, 8270	Diethylphthalate	1	1	5				
SW-846, 8270	Dimethoate	1.1	1.5	5.0	3/24/2009	1	1	5
SW-846, 8270	Dimethyl phthalate	1.1	1	5	3/24/2009	1	1	5
SW-846, 8270	Disulfoton	1	1	5				
SW-846, 8270	Ethyl methanesulfonate	1	1	5	3/24/2009	1.2	1.6	5.4
SW-846, 8270	Famphur	1.7	2.3	7.7				
SW-846, 8270	Fluoranthene	1	1	5				
SW-846, 8270	Fluorene	1	1	5				
SW-846, 8270	Hexachlorobenzene	1	1	5				
SW-846, 8270	Hexachlorobutadiene	1	1	5				
SW-846, 8270	Hexachlorocyclopentadiene	1	1.4	4.5				
SW-846, 8270	Hexachloroethane	1	1	5				
SW-846, 8270	Hexachlorophene	10	14	45				
SW-846, 8270	Hexachloropropene	2.4	3.2	11	3/24/2009	1	1.35	4.50
SW-846, 8270	Indeno(1,2,3-cd)pyrene	1	1	5				
SW-846, 8270	Isodrin	1	1	5				
SW-846, 8270	Isophorone	1	1	5				
SW-846, 8270	Isosafrole	2	2.7	9.0	3/24/2009	2.3	3.1	10.4
SW-846, 8270	Kepone	20	27	90				
SW-846, 8270	m-Dinitrobenzene	1	1	5				
SW-846, 8270	Methapyrilene	13	18	59	3/24/2009	1.6	2.16	7.21
SW-846, 8270	Methyl methanesulfonate	2	3	9				
SW-846, 8270	Methyl parathion	1	1	5				
SW-846, 8270	Naphthalene	1	1	5				
SW-846, 8270	Nitrobenzene	1	1	5				
SW-846, 8270	Nitrosopyrrolidine	1	1	5				
SW-846, 8270	n-Nitrosodiethylamine	1	1	5	3/24/2009	1.2	1.6	5.4
SW-846, 8270	n-Nitrosodimethylamine	2	3	9				
SW-846, 8270	n-Nitroso-di-n-butylamine	1	1	5	3/24/2009	1.2	1.6	5.4
SW-846, 8270	n-Nitroso-di-n-propylamine	1	1	5				
SW-846, 8270	n-Nitrosodiphenylamine	1	1	5				

Table E-34. (Cont.)

Method	Constituent	Initial MDL[a] (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL[a] (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	n-Nitrosomethylethylamine	1	1	5	3/24/2009	1.1	1.5	5.0
SW-846, 8270	n-Nitrosomorpholine	0.96	1.3	4.3	3/24/2009	1.2	1.6	5.4
SW-846, 8270	n-Nitrosopiperidine	1	1	5				
SW-846, 8270	O,O,O-Triethyl phosphorothioate	1	1	5	8/17/2009	1.2	1.6	5.4
SW-846, 8270	O,O-Diethyl0-2-pyrazinyl phosphorothioa	1	1	5				
SW-846, 8270	o-Toluidine	1	1	5				
SW-846, 8270	Parathion	1	1	5				
SW-846, 8270	p-Dimethylaminoazobenzene	1	1	5				
SW-846, 8270	Pentachlorobenzene	1	1	5				
SW-846, 8270	Pentachloroethane	2.4	3.2	11	3/24/2009	1.2	1.6	5.4
SW-846, 8270	Pentachloronitrobenzene (PCNB)	1.1	1.5	5.0	3/24/2009	1	1.35	4.50
SW-846, 8270	Pentachlorophenol	2	3	9				
SW-846, 8270	Phanacetin	0.94	1.3	4.2	3/24/2009	1	1	5
SW-846, 8270	Phenanthrene	1	1	5				
SW-846, 8270	Phenol	4	5	18				
SW-846, 8270	Phorate	1	1	5				
SW-846, 8270	p-Dimethylaminoazobenzene	1	1	5				
SW-846, 8270	p-Phenylenediamine	1	1	5				
SW-846, 8270	Pronamide	1	1	5				
SW-846, 8270	Pyrene	1	1	5				
SW-846, 8270	Pyridine	5.7	7.7	26	3/24/2009	2	3	9
SW-846, 8270	Safrol	1	1	5	3/24/2009	1.1	1.5	5.0
SW-846, 8270	sym-Trinitrobenzene	1.4	1.9	6.3				
SW-846, 8270	Tetraethyl dithiopyrophosphate (Sulfotepp)	1	1	5				
SW-846, 8270	Tributyl phosphate	1.5	2.0	6.8	3/24/2009	1	1	5

Notes:
EPA/600/4-81/004, *Environmental Radioactivity Laboratory Intercomparison Studies Program: Fiscal Year 1980-81*.
SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.
a. The MDLs for many constituents changed during the fiscal year. For these constituents, the initial MDL, LOD, and LOQ were in effect until the date the values were updated (ending values, effective date). In cases where the MDL did not change, no ending values are listed.
b. µMhos/cm.
c. Units for this method are mg/L.
d. Additional MDLs were used during the year for these compounds.

LOD = limit of detection
LOQ = limit of quantitation
MDL = method detection limit