Monitoring Report for
CSMRI Site
First Quarter 2012

Prepared for:

Colorado School of Mines
Golden, Colorado

Prepared by:

The S.M. Stoller Corporation
Broomfield, Colorado

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ACRONYMS

bgs	below ground surface
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CSMRI	Colorado School of Mines Research Institute
DOC	dissolved organic carbon
ICP	Inductively Coupled Plasma
MCL	maximum contaminant level
MS	matrix spike
MSD	matrix spike duplicate
µg/L	micrograms per liter
µ	micron
mg/L	milligrams per liter
NTU	nephlometer turbidity unit
ORP	oxidation-reduction potential
pCi/ µg	picoCuries per microgram
pCi/L	picoCuries per liter
QA/QC	quality assurance/ quality control
TDS	total dissolved solids
USGS	U.S. Geological Survey

1. Introduction

This report presents the first quarter (January, February, March) 2012 results for groundwater and surface water monitoring conducted at the Colorado School of Mines Research Institute (CSMRI) site in Golden, Colorado. The monitoring was conducted by the S.M. Stoller Corporation (Stoller). This is the fifth sampling event to include new and replacement monitor wells after the flood plain characterization effort in late 2010.

2. Sampling and Analysis

Stoller obtained quarterly samples of groundwater and surface water on March 13, 14, and 15, 2012 from 14 groundwater monitor wells and three Clear Creek surface water sample locations. Water levels in all monitor wells were obtained on March 12, 2011. Groundwater quality samples were obtained on March 13 (CSMRI-4, CSMRI-5, CSMRI-6C, CSMRI-8B, CSMRI-11B, CSMRI-12, and CSMRI-13); March 14 (CSMRI-1, CSMRI-7C, CSMRI-9, CSMRI-10, and CSMRI-14); and March 15 (CSMRI-1B, CSMRI-2). Monitor wells CSMRI-1B, CSMRI-7C, and CSMRI-14 required purging on March 13, 2012 and monitor well CSMRI-2 required purging on March 14, 2012. Sample collection took place on subsequent visits over the following days to obtain sufficient sample volume.

Clear Creek surface water samples were collected on March 14, 2012, from sample locations SW-1, SW-2, and SW-3. All aqueous samples were placed on ice in coolers and couriered to ALS Laboratory Group in Fort Collins, Colorado or to TestAmerica, Inc. in Arvada, Colorado for analyses.

Figure 1 presents the monitor well and Clear Creek surface water sample locations at the CSMRI site. The figure also shows the groundwater potentiometric surface elevations posted adjacent to each monitor well location. Potentiometric surface elevations are based on depth to groundwater relative to the surveyed top-of-casing and represent groundwater elevations as measured before purging. Groundwater levels are measured at each well to the nearest 1/100th of a foot (0.01) prior to purging and sample collection. The figure shows a northeasterly component of flow on the bench terrace area and then a northerly component of flow as groundwater flows over the bench terrace slope and into the Clear Creek flood plain area. The figure suggests uniform flow of groundwater occurring along the interface of surficial deposits and bedrock down the terrace slope; however, preferential pathways resulting from an uneven bedrock/alluvial contact are thought to exist.

Figure 2 presents hydrographs of groundwater potentiometric elevations for monitor wells CSMRI-1, CSMRI-1B, CSMRI-4, CSMRI-5, CSMRI-6C, CSMRI-8 (abandoned October 2010), CSMRI-9, CSMRI-10, and CSMRI-11B. Monitor wells CSMRI-7C, CSMRI-8B, CSMRI-12, CSMRI-13, and CSMRI-14, which were installed or deepened in January 2011, are also presented on Figure 2. Gaps in the graph denote the intermittent presence of groundwater in the monitor wells because groundwater is occasionally below the bottom depth of a monitor well, even though the bottom of the screened interval is within the underlying bedrock. Monitor wells included on Figure 2 are located within the CSMRI site proper and illustrate historical trends in the water table fluctuations throughout the site.

Figure 3 is a hydrograph of monitor well CSMRI-2. Monitor well CSMRI-2 is located near the southeast corner of the freshman parking lot on West Campus Drive and the former Welch Ditch. CSMRI-2 is upgradient of the CSMRI site and historically has been used to provide background groundwater quality conditions. Early potentiometric elevation data reflect the use of and leakage from the nearby irrigation ditch. For example, this hydrograph shows a marked seasonal rise of up to 15 feet in the potentiometric surface during the summer months in 2005 and 2006. In 2007, the Welch Ditch was diverted upstream of CSMRI and piped to Washington Avenue in Golden and then to down-ditch users. From late 2006 through late 2007, the water level remained elevated. From mid-2009 through 2012, the potentiometric surface elevation has been fluctuating no more than 5 feet on a quarterly basis.

At the request of the Colorado Department of Public Health and Environment (CDPHE), Hazardous Materials and Waste Management Division, Radiation Program, two offset monitor wells were installed in the flood plain area in January 2011 to assess groundwater quality and potentiometric elevations in both the alluvial aquifer and the underlying Foxhills Sandstone Formation. Monitor well CSMRI-13 was installed to a depth of 8.25 feet below ground surface (bgs) and is screened through the saturated portion of the alluvial aquifer. Monitor well CSMRI-14 was installed in the Foxhills Sandstone Formation to a depth of 55.8 feet bgs and screened from the interval of 45.3 feet to 55.3 feet bgs. After the monitor wells were installed, the adjacent ground surface and top-of-casing elevations were surveyed to an accuracy of 0.01 feet. The two monitor wells are separated horizontally by 3.88 feet. Both monitor wells were fully developed after installation.

On March 12, 2012, the depth to water in both monitor wells was measured and recorded. The potentiometric surface of monitor well CSMRI-13 (alluvial) is measured at 5,673.14 feet and at monitor well CSMRI-14 (bedrock) at 5,673.92 feet. The 0.78-feet-elevation difference between the potentiometric surfaces of the two monitor wells indicates an upwelling of groundwater in the underlying Foxhills Sandstone Formation into the overlying alluvial formation.

In January 2011, existing monitor wells CSMRI-6C and CSMRI-11B were overdrilled and extended to the top of bedrock. The screened interval now incorporates the full saturated section at each well.

Replacement monitor wells CSMRI-7C and CSMRI-8B were installed at approximately the same location as their predecessors, CSMRI-7B and CSMRI-8, respectively. These two wells were abandoned in early October 2010 before source material characterization field activities began. Monitor well CSMRI-7C is located within 1.5 feet of its former location, and CSMRI-8B is within 5.9 feet of its former location.

Monitor well CSMRI-12 is a new flood plain alluvial well and was installed at the request of CDPHE. The well is located approximately midway between wells CSMRI-8B to the west and CSMRI-13/CSMRI-14 to the east. This monitor well was installed to a depth of 8.7 feet and is screened through the saturated portion of the alluvial aquifer (Figure 1).

2.1 Groundwater Sampling

Water quality samples were collected following the procedure outlined in Appendix A, Groundwater Sampling Procedures. Sample collection forms provide a record of water quality parameters as measured in the field as groundwater was purged from monitor wells. These forms also indicate the volume of water removed from each well. Sample collection forms are provided in Appendix B. After three casing volumes of groundwater were purged, water samples were filtered through a 0.45 micron (µ) filter, collected in laboratory-provided containers, and preserved in the field as appropriate for the analyte and analytical method. Monitor wells CSMRI-1B, CSMRI-2, CSMRI-7C, and CSMRI-14 were purged dry and then sampled on subsequent days. Monitor well CSMRI-1B required multiple visits to collect sufficient sample volume because it recharges so slowly.

The conductivity probe on the rental Horriba U-22 water quality meter worked sporadically on the first day of sampling. The conductivity values for monitor wells CSMRI-1B, CSMRI-6C, and CSMRI-7C were affected by the inoperative probe. The problem with the inoperative probe was discovered during the purging of CSMRI-7C and subsequently corrected for all other monitor wells. All other field-monitored water quality parameters, including temperature, pH, oxygen reduction potential, and turbidity were calibrated correctly each morning and were monitored during the purging process.

2.2 Surface Water Sampling

Surface water samples from Clear Creek were collected on March 14, 2012, from three locations: one upstream of the site (SW-1), one downstream of the site (SW-2), and one between the upstream and downstream sample locations and due north of monitor well CSMRI-8B (SW-3) (Figure 1). All surface water samples were collected following the procedure outlined in Appendix C, Surface Water Sampling Procedures. Surface water samples are filtered through a 0.45µ filter, collected in laboratory-provided containers, and preserved in the field as appropriate for the analyte and analytical method.

Discharge data of stream flow for Clear Creek, as measured by the U.S. Geological Survey (USGS), gauging station #06719505 (USGS Surface Water Online Database) for the quarter from January 1, 2012 through March 31, 2012, are presented as Figure 4. Tabulated stream flow data for the time period of March 13 through March 15, 2012, when the groundwater and surface water samples were collected, indicate the mean stream flow measurements at the gauging station range from 40 rising to 54 cubic feet per second.

2.3 Analyses

All samples collected were analyzed using a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)-certified analytical laboratory. The results received from the laboratory were evaluated based on the following parameters:

- Data completeness
- Holding times and preservation
- Instrument initial calibrations
- Instrument performance checks
- Preparation blanks

- Duplicate sample results
- Laboratory control sample results
- Compound quantization and reporting limits (full validation only)

As a quality assurance/quality control (QA/QC) check, an equipment blank sample was collected in the field by pouring distilled water through a sample bailer. The equipment blank sample was submitted for the identical analytical parameters as the groundwater and surface water samples.

The results of the equipment blank analyses did not identify interferences or anomalies in the laboratory data. Results of the QA/QC review for the groundwater and surface water samples did not identify any significant issues regarding analytical laboratory results. No analytical data were excluded or qualified from the data set. Data validation results are presented in Appendix D.

2.3.1 Groundwater Quality Analyses

Summaries of groundwater results for radioisotopes, metals, and inorganic anions and cations are presented in Table 2-1, Table 2-2, and Table 2-3, respectively. Groundwater parameters are reported as picoCuries per liter (pCi/L) for radioisotopes, micrograms per liter (µg/L) for uranium, and milligrams per liter (mg/L) for all other metals and ions.

ALS Laboratory Group in Fort Collins, Colorado and TestAmerica Laboratories, Inc. in Arvada, Colorado conducted laboratory analyses of the aqueous samples. Analytical samples submitted to ALS were analyzed for radium isotopes (Ra-226 and Ra-228), uranium (U), calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), chloride (Cl), sulfate (SO_4), carbonate as calcium carbonate (CO_3), bicarbonate as calcium carbonate (HCO_3), alkalinity, and dissolved organic carbon (DOC).

Analytical samples submitted to TestAmerica were tested for the presence of nitrate (NO_3), nitrite (NO_2), ferrous iron (Fe^2), ferric iron (Fe^3), sulfide (S^2), and total dissolved solids (TDS). TestAmerica conducts the short holding time analyses because of their close proximity to the CSMRI site.

Groundwater samples were measured onsite for temperature, pH, specific conductance, oxidation-reduction potential (ORP), and turbidity as nephlometer turbidity units (NTU) during the purging process using a Horiba U-22 multi-probe. Monitor well parameter measurements of groundwater and purge volumes are presented on the sample collection forms in Appendix B. The forms also document the monitor wells that were affected by the inoperative multi-probe.

Analytical data from ALS and TestAmerica were transmitted as an electronic data deliverable and are included in Appendix E on a compact disk. Data are formatted as a series of Excel spreadsheets. Appendix F presents copies of the chain-of-custody for the CSMRI samples.

2.3.2 Surface Water Analyses

Clear Creek surface water results for radioisotopes, metals, and inorganic anions and cations are presented in Table 2-4, Table 2-5, and Table 2-6, respectively. Surface water parameters are reported as pCi/L for radioisotopes, µg/L for uranium, and mg/L for all other metals and ions. Surface water samples were measured onsite for temperature, pH, specific conductance, ORP, dissolved oxygen and NTU as the sampling was conducted. Field parameter values for the surface water samples were not affected by the inoperative multi-parameter probe; sample collection forms are presented in Appendix B.

2.4 Health and Safety Program

Stoller implements a program to protect the health and safety of field personnel during the environmental monitoring at the CSMRI site. This program has been developed in accordance with requirements of 29 Code of Federal Regulations 1910.120. Stoller recently implemented an Environmental Management System (EMS). The purpose of this system is to ensure that company policies and procedures adequately address environmental hazards and comply with regulatory requirements.

3. Results

Groundwater analytical results for samples collected from the CSMRI site during the first quarter 2012 for radioisotopes, metals, and anions and cations are summarized on Table 2-1, Table 2-2, and Table 2-3, respectively. Surface water analytical results for samples collected from the CSMRI site during the first quarter 2012 for radioisotopes, metals, and anions and cations are summarized on Table 2-4, Table 2-5, and Table 2-6, respectively. Table 2-7 presents historical data collected by previous consultants for select contaminants of potential concern in groundwater at the site. The historical uranium data presented in Table 2-7 are presented in pCi/L as “activity,” more recent (2005 through 2012) analytical data are presented in µg/L as “mass concentration.” The December 7, 2000, *Federal Register* discusses the final uranium maximum contaminant level (MCL) and presents a conversion factor of a geometric average mass: activity ratio of 0.9 pCi/µg for values near the National Primary Drinking Water Standards MCL, based on data from the National Inorganics and Radionuclides Survey.

Tables G-1 and G-2 in Appendix G present the quarterly historical groundwater radioisotopic and metals sample results, respectively, collected by Stoller since February 2005. Tables G-3 and G-4 in Appendix G present the quarterly historical Clear Creek surface water radioisotopic and metals sample results, respectively, collected by Stoller since February 2005.

3.1 Groundwater Conditions

Groundwater monitor wells are strategically located in areas likely to detect impacts, if any, to groundwater emanating from the site and at locations that represent background water quality. Monitor wells CSMRI-4 and CSMRI-5 are downgradient of the site in the Clear Creek flood plain. Well CSMRI-1 is located along Clear Creek upstream of the site, and well CSMRI-2 is located offsite in the southeast corner of the freshman parking lot on West Campus Drive. Both monitor wells CSMRI-1 and CSMRI-2 are upgradient of the site.

In February 2007, seven new groundwater monitor wells were installed to assess the effectiveness of the source removal excavation that was conducted in 2006. Monitor well CSMRI-8 is located along Clear Creek within the flood plain area, and monitor wells CSMRI-1B, CSMRI-6B, CSMRI-7B, CSMRI-9, CSMRI-10, and CSMRI-11 are located on the bench terrace and encircle the CSMRI site.

In July 2008, two monitor wells (CSMRI-6B and CSMRI-11) were abandoned because of construction activities at the CSMRI site. These two wells were replaced in December 2008 as CSMRI-6C and CSMRI-11B, respectively.

In January 2011, monitor wells CSMRI-6C and CSMRI-11B were overdrilled and lengthened so that the screened interval extended through the full length of the saturated section above bedrock. Monitor wells CSMRI-7C and CSMRI-8B were drilled near their former locations after source characterization field work was completed in late 2010. Monitor wells CSMRI-12, CSMRI-13, and CSMRI-14 were installed in the flood plain.

3.2 Groundwater Quality

Groundwater samples were collected from 14 monitor wells and tested for the presence of metals and radioisotopes as identified in Section 2.3.1. Uranium was detected in groundwater samples from monitor wells CSMRI-4 (77 µg/L), CSMRI-8B (380 µg/L), CSMRI-9 (50 µg/L), CSMRI-12 (380 µg/L), and CSMRI-13 (58 µg/L), all at concentrations exceeding the State of Colorado groundwater standard of 30 µg/L. Uranium was also detected in samples from the remaining nine groundwater monitor wells but at concentrations below the groundwater standard.

Groundwater from monitor well CSMRI-4 historically has had elevated concentrations of uranium. Values had been declining since 1991 until the last several quarterly sampling events as depicted on Figure 5. The spike in the uranium concentration in 2003 was attributed to precipitation effects and removal of asphalt and concrete as discussed in Section 4.2.2 of the New Horizons Remedial Investigation/Feasibility Study (New Horizons 2004). The 2009 increase in the uranium concentration in this monitor well appears to be attributed to stormwater discharge from the new Colorado School of Mines artificial turf athletic fields. Since 2009, the concentration of uranium in this monitor well has declined to the current value of 77 µg/L.

Figure 6 presents the potentiometric surface elevation of groundwater in CSMRI-4 (left Y axis) and the uranium concentration (right Y axis) from 2005 through the first quarter 2012. The figure indicates the uranium concentration in groundwater was fluctuating seasonally from slightly above to slightly below the groundwater standard of 30 µg/L through seven quarterly sampling events in 2005 and 2006. An ice chest from the fourth quarter 2006 (December) sampling event was lost by the courier service resulting in a gap in the analytical data for CSMRI-4. The concentration of uranium in groundwater at this well increased since the 2006 surface soil remediation activities but has since decreased significantly to near the 2007 and 2008 concentration values.

The uranium concentration in groundwater at monitor well CSMRI-9 (50 µg/L) increased slightly from the previous quarterly sample concentration (46 µg/L). This monitor well is located at the top of the bench terrace that rises above the flood plain and is downgradient of the CSMRI site. Figure 7 presents the historical water table elevations (left Y axis) and uranium concentrations (right Y axis) since January 2007.

The uranium concentration in groundwater from flood plain monitor well CSMRI-8B (380 µg/L) increased from its previous fourth quarter value of 340 µg/L. This monitor well is a replacement well for its predecessor, CSMRI-8, and is located within the area where source material was characterized and removed in October and November 2010. The current groundwater concentration for uranium is significantly lower after peaking in December 2008. Figure 8 presents the historical water table elevations (left Y axis) and uranium concentrations (right Y axis) since the initial March 2007 sampling event. The figure denotes when sampling commenced for monitor well CSMRI-8B as a replacement for well CSMRI-8.

Monitor wells CSMRI-12 and CSMRI-13 are new alluvial flood plain monitor wells, and the groundwater sample results from these wells indicate the presence of uranium at concentrations of 380 µg/L and 58 µg/L, respectively. The value at well CSMRI-12 increased from the previous fourth quarter value. The concentration of uranium in well CSMRI-13 rose slightly from the previous quarterly sampling event.

Monitor well CSMRI-14 was installed in the flood plain area and is screened in the underlying Foxhills Sandstone Formation. The groundwater sample from this well indicates the presence of uranium at a concentration of 1.4 µg/L. This value is well below the groundwater quality standard for uranium.

Quarterly sampling and analytical testing of water quality parameters will continue, and trends in the concentration of uranium will continue to be monitored. Future analytical data from the recently retrofitted and newly installed monitor wells in the flood plain area will provide a better overall picture of groundwater conditions across the CSMRI site.

3.2.1 Ionic Balance Evaluation

The ionic testing and balancing is conducted to determine the different groundwater hydrochemical facies within the CSMRI site and to assess the analytical QC procedures since the sum of the major anions should equal the sum of the major cations when the ionic concentrations are converted to millequivalents per liter.

All groundwater and surface water samples were collected and tested for major anions, cations, and DOC, and from the five flood plain monitor wells (CSMRI-4, CSMRI-5, CSMRI-8B, CSMRI-12, and CSMRI-13) for ferric/ferrous iron and sulfide. Analytical results for these parameters are presented in Table 2-3 for groundwater and Table 2-6 for surface water.

AqQA® geochemical software is used to calculate ionic balances of water samples and to present the graphical representation of anions and cations. Ionic balance calculations for the anions and cations for the water samples generally range from a low of 0.4 percent to a high of 14.9 percent (monitor well CSMRI-1B). Significant inequalities of the ionic balance between the anions and cations suggest internal analytical laboratory quality issues; inequalities could also indicate that an ion is present in the water sample and is not being analyzed. Overall, there is fair agreement between the anion and cation data sets, indicating that the laboratory procedures are generally performed properly.

Summary sheets from the AqQA® geochemical software for each of the water samples are presented in Appendix H. Dominant water types identified at the CSMRI site include Ca-Cl (CSMRI-1, CSMRI-1B, CSMRI-4, CSMRI-10 and CSMRI-11B); Ca-HCO_3 (CSMRI-2, CSMRI-5, CSMRI-6C, CSMRI-7C, CSMRI-8B, CSMRI-9 and CSMRI-13); Na-HCO_3 (CSMRI-14); and Ca-SO_4 (CSMRI-12, SW-1, SW-2, and SW-3).

A Piper quadrilateral diagram is included in Appendix H and illustrates the overall ionic properties for each water sample. The cation triangle in the lower left of the figure indicates the cation composition of the water samples is generally similar as exhibited by the tight grouping of the plotted results. The anion triangle in the lower right of the figure indicates the anion composition of the water samples is more diverse as exhibited by the dispersed nature of the plotted results.

3.2.2 Comparison of Upgradient and Downgradient Groundwater Quality

Monitor wells CSMRI-4 and CSMRI-5 are downgradient from the upper terrace portion of the site and are located on the Clear Creek flood plain. Monitor well CSMRI-9 is located downgradient of the CSMRI site at the top of the bench terrace above the flood plain. Monitor wells CSMRI-10 and CSMRI-11B are located at the eastern edge of the site, and monitor wells CSMRI-1B and CSMRI-6C are located upgradient of the site.

Uranium was detected in groundwater from downgradient monitor wells CSMRI-4 (77 µg/L) and CSMRI-9 (50 µg/L), exceeding the groundwater standard of 30 µg/L. Uranium was also detected in groundwater from monitor well CSMRI-5 (20 µg/L) but a concentrations below the groundwater standard.

Uranium was detected in upgradient monitor wells CSMRI-6C (12 µg/L) and CSMRI-11B (18 µg/L). In 2010, both of these wells were overdrilled and lengthened so that the well screen now spans the entire saturated section of the groundwater column.

3.2.3 Comparison with Previous Groundwater Quality Analyses

Table 2-7 presents historical groundwater analytical results from past sampling events by other consultants dating back to 1991 for radioisotopes of concern. The data indicate fluctuating activities of tested analytes, especially uranium, for monitor well CSMRI-4. The table also presents historical analytical activity results for existing monitor wells CSMRI-1, CSMRI-2, and CSMRI-5. Monitor well CSMRI-3 has since been closed by other consultants.

As additional data are collected for each sampling quarter and as trends become more defined, graphs of concentration versus time are produced and presented. These analytical data are incorporated to show long-term trends and correlation between the detected concentration of uranium in groundwater, the fluctuating water table, and seasonal variability if present.

3.2.4 Comparison with Colorado Groundwater Standards

As discussed previously, the groundwater standard of 30 µg/L for uranium in groundwater was exceeded in monitor wells CSMRI-4 (77 µg/L), CSMRI-8B (380 µg/L), CSMRI-9 (50 µg/L), CSMRI-12 (380 µg/L), and CSMRI-13 (58 µg/L). In January 2008, the CDPHE Water Quality Control Commission adopted the surface water quality standard of 30 µg/L as the groundwater quality standard in an effort to keep both uranium standards consistent.

Monitor wells CSMRI-8B, CSMRI-12, and CSMRI-13 are new monitor wells, and the first quarter 2012 sampling event is the fifth groundwater sample from each well. Sampling will continue at these wells to assess changes in water quality.

Groundwater from monitor well CSMRI-9, as shown on Figure 7, has exceeded the groundwater quality standard for uranium since a large spike was detected in the June 2009 sampling event. The concentration of uranium has since gone down significantly since the 2009 spike but has gradually been increasing during the 2011 and 2012 sampling events.

Ra-226 and -228 was detected in groundwater from two monitor wells, CSMRI-12 and CSMRI-14, exceeding the groundwater standard of 5 pCi/L. Groundwater sample results from monitor well CSMRI-12 indicates the presence of Ra-226 at concentrations of 10.7 pCi/L and Ra-228 at 2.04 pCi/L. Sample results from monitor well CSMRI-14 indicate the presence of Ra-226 at concentrations of 7.5 pCi/L and Ra-228 at 0.54 pCi/L.

3.3 Surface Water Quality

Surface water samples are collected from three locations at the site. Location SW-1 is located over 400 feet upstream from the CSMRI site, SW-2 is downstream from the site, and SW-3 is located adjacent to the Clear Creek bank in the vicinity of monitor well CSMRI-8B, approximately 30 feet to the north. Sampling at surface water location SW-3 began in the second quarter of 2010 at the request of CDPHE. The purpose of this surface water location is to detect any impact of the lower floodplain area upon Clear Creek.

All surface-water concentrations of tested parameters detected at the CSMRI site from stations SW-1, SW-2, and SW-3 are similar. Water quality results for these locations are presented in Table 2-4 (radioisotopes), Table 2-5 (metals), and Table 2-6 (anions and cations). Established surface water quality standards were not exceeded for any tested analyte at any surface water sample location. Dissolved uranium concentrations at SW-3 remain similar to both the upstream and downstream surface water locations and have never exceeded 2.2 μg/L.

4. Future Activities

Source material characterization and removal activities were conducted in October and November 2010. The stockpiled soil has been characterized and was removed from the CSMRI site in December 2011.

Installation of replacement and new groundwater monitor wells was conducted in early January 2011. The lengthened and new monitor wells have been integrated into the quarterly sampling schedule. Sampling of these wells and of the existing wells will continue, and the analytical results will be assessed to determine trends in analyte concentrations in groundwater.

5. References

Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 41, *The Basic Standards for Ground Water*. Amended: January 14, 2008, Effective: May 31, 2008.

New Horizons Environmental Consultants, Inc. Remedial Investigation/Feasibility Study and Proposed Plan, Colorado School of Mines Research Institute Site, Golden, CO, January 21, 2004.

Stoller 2010. Final Work Plan, Environmental Assessment and Characterization, Colorado School of Mines Research Institute Site, Flood Plain Area, Golden, Colorado, Prepared by The S.M. Stoller Corporation For Colorado School of Mines, August 2010.

USGS Surface Water website: http://nwis.waterdata.usgs.gov

Table 2-1
Summary of Radioisotopes in Groundwater

Sample Station	Sample Date	Ra-226 (pCi/L)		Ra-228 (pCi/L)	
		Result	Uncertainty	Result	Uncertainty
CSMRI-1	3/14/12	0.67	±0.4	1.69	±0.62
CSMRI-1B	3/15/12	0.52	±0.43	0.62	±0.34
CSMRI-2	3/15/12	0.93	±0.55	1.99	±0.71
CSMRI-4	3/13/12	0.19	±0.28	0.76	±0.4
CSMRI-5	3/13/12	0.54	±0.33	0.28	±0.35
CSMRI-6C	3/13/12	0.69	±0.4	1.35	±0.53
CSMRI-7C	3/14/12	0.22	±0.22	1.13	±0.48
CSMRI-8B	3/13/12	0.58	±0.36	1.11	±0.47
CSMRI-9	3/14/12	0.15	±0.22	0.67	±0.41
CSMRI-10	3/14/12	0.38	±0.31	0.55	±0.32
CSMRI-11B	3/13/12	2.04	±0.81	0.77	±0.36
CSMRI-12	3/13/12	10.7	±2.9	2.04	±0.68
CSNRI-13	3/13/12	0.51	±0.35	0.77	±0.36
CSMRI-14	3/14/12	7.5	±2.1	0.54	±0.32
MCL*		Total Ra = 5			

*Maximum Contaminant Level – National Primary Drinking Water Regulations
pCi/L = picoCuries per Liter

Table 2-2
Summary of Metals in Groundwater

Sample Station	Sample Date	Ag (mg/L)	As (mg/L)	Ba (mg/L)	Ca (mg/L)	Cd (mg/L)	Cr (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	Pb (mg/L)	U (µg/L)	V (mg/L)
CSMRI-1	3/14/12	NT	NT	NT	65	NT	NT	NT	2.9	21	41	NT	2.6	NT
CSMRI-1B	3/15/12	NT	NT	NT	120	NT	NT	NT	6.4	48	49	NT	12	NT
CSMRI-2	3/15/12	NT	NT	NT	76	NT	NT	NT	5.8	35	20	NT	0.69	NT
CSMRI-4	3/13/12	NT	NT	NT	160	NT	NT	NT	16	64	63	NT	77	NT
CSMRI-5	3/13/12	NT	NT	NT	110	NT	NT	NT	4.3	45	58	NT	20	NT
CSMRI-6C	3/13/12	NT	NT	NT	100	NT	NT	NT	5	42	49	NT	12	NT
CSMRI-7C	3/14/12	NT	NT	NT	110	NT	NT	NT	7.7	52	63	NT	4.2	NT
CSMRI-8B	3/13/12	NT	NT	NT	160	NT	NT	NT	16	60	61	NT	380	NT
CSMRI-9	3/14/12	NT	NT	NT	120	NT	NT	NT	4.7	55	53	NT	50	NT
CSMRI-10	3/14/12	NT	NT	NT	110	NT	NT	NT	4.1	45	52	NT	19	NT
CSMRI-11B	3/13/12	NT	NT	NT	110	NT	NT	NT	4.4	45	51	NT	18	NT
CSMRI-12	3/13/12	NT	NT	NT	140	NT	NT	NT	12	45	49	NT	380	NT
CSMRI-13	3/13/12	NT	NT	NT	130	NT	NT	NT	5.4	59	57	NT	58	NT
CSMRI-14	3/14/12	NT	NT	NT	26	NT	NT	NT	3.4	14	49	NT	1.4	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	1	0.003	0.1 or 1	0.01
MCL*		NE	0.010	2	NE	0.005	0.1	0.002	NE	NE	NE	0.015	30	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations
NE – Not Established
NT – Not Tested
mg/L – milligrams per liter
µg/L- micrograms per liter

Table 2-3
Summary of Anions and Cations in Groundwater

Sample Station	Sample Date	Bicarbonate as $CaCO_3$ (mg/L)	Carbonate as $CaCO_3$ (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Chloride (mg/L)	Total Dissolved Solids (mg/L)	Dissolved Organic Carbon (mg/L)	Ferric Iron (mg/L)	Ferrous Iron (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
CSMRI-1	3/14/12	86	ND	86	140	440	ND	NT	NT	1.2	ND	74	NT
CSMRI-1B	3/15/12	280	ND	280	120	710	3.2	NT	NT	3.6	ND	140	NT
CSMRI-2	3/15/12	290	ND	290	23	410	ND	NT	NT	ND	ND	67	NT
CSMRI-4	3/13/12	260	ND	260	220	910	2.2	ND	ND	ND	ND	230	ND
CSMRI-5	3/13/12	290	ND	290	140	700	1.5	ND	ND	4.2	ND	110	ND
CSMRI-6C	3/13/12	280	ND	280	130	610	1.8	NT	NT	3.5	ND	77	NT
CSMRI-7C	3/14/12	390	ND	390	97	680	ND	NT	NT	ND	ND	110	NT
CSMRI-8B	3/13/12	340	ND	340	140	920	3.1	ND	ND	1.8	ND	240	ND
CSMRI-9	3/14/12	350	ND	350	130	720	1.6	NT	NT	5.6	ND	100	NT
CSMRI-10	3/14/12	290	ND	290	140	650	1.5	NT	NT	4.4	ND	88	NT
CSMRI-11B	3/13/12	280	ND	280	160	660	1.3	NT	NT	4.0	ND	81	NT
CSMRI-12	3/13/12	270	ND	270	120	780	2.3	0.24	ND	ND	ND	220	ND
CSMRI-13	3/13/12	320	ND	320	160	790	1.4	ND	ND	4.9	ND	150	ND
CSMRI-14	3/14/12	190	ND	190	3.6	280	1.6	NT	NT	ND	ND	65	NT
Reporting Limits		10 or 20	10 or 20	10 or 20	0.2, 1, 2 or 4	10	1	0.20	0.20	0.50	0.50	1, 5, or 10	0.050

mg/L – milligrams per liter
ND – Not Detected
NT – Not Tested

Table 2-4
Summary of Radioisotopes in Surface Water

Sample Station	Sample Date	Ra-226 (pCi/L)		Ra-228 (pCi/L)	
		Result	Uncertainty	Result	Uncertainty
SW-1	3/14/12	0.13	±0.27	0.32	±0.28
SW-2	3/14/12	0.03	±0.26	0.57	±0.32
SW-3	3/14/12	1.41	±0.62	0.3	±0.28
MCL*		Total Ra = 5			

*Maximum Contaminant Level – National Primary Drinking Water Regulations
pCi/L = picoCuries per Liter

Table 2-5
Summary of Metals in Surface Water

Sample Station	Sample Date	Ag (mg/)L	As (mg/L)	Ba (mg/L)	Ca (mg/)L	Cd (mg/L)	Cr (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	Pb (mg/L)	U (µg/L)	V (mg/L)
SW-1	3/14/12	NT	NT	NT	43	NT	NT	NT	2.8	9.6	19	NT	1.9	NT
SW-2	3/14/12	NT	NT	NT	42	NT	NT	NT	3	9.7	20	NT	1.8	NT
SW-3	3/14/12	NT	NT	NT	41	NT	NT	NT	2.9	9.4	20	NT	1.8	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	1	0.003	0.1	0.01
MCLs*		0.01	0.010	2	NE	0.005	0.1	0.002	NE	NE	NE	0.015	30	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations
NE – Not Established
NT – Not Tested
mg/L = milligrams per liter
µg/L = micrograms per liter

Table 2-6
Summary of Anions and Cations in Surface Water

Sample Station	Sample Date	Bicarbonate as CaCO$_3$ (mg/L)	Carbonate as CaCO$_3$ (mg/L)	Total Alkalinity as CaCO$_3$ (mg/L)	Chloride (mg/L)	Total Dissolved Solids (mg/L)	Dissolved Organic Carbon (mg/L)	Ferric Iron (mg/L)	Ferrous Iron (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Sulfate (mg/L)
SW-1	3/14/12	47	ND	47	34	260	1.1	NT	NT	ND	ND	110
SW-2	3/14/12	49	ND	49	35	260	1.2	NT	NT	ND	ND	100
SW-3	3/14/12	49	ND	49	35	250	1.2	NT	NT	ND	ND	99
Reporting Limits		5	5	5	0.4	10	1	NT	NT	0.50	0.50	2

mg/L – milligrams per liter
ND – Not Detected
NT – Not Tested

Table 2-7
CSMRI Historical Groundwater Data (Previous Consultants)

(All results in picoCuries per liter)

Well ID (d)	Analyte	1/1991 (a)	6/1991 (a)	3/1999 (b)	6/1999 (b)	10/1999 (b)	2/2003 (c)	4/2003 (c)	7/2003 (c)	10/2003 (c)
CSMRI-1	Ra-226			0.1	0.3	0.2	<0.55	<0.45	ND (<0.38)	ND (<0.31)
	U Total			2.09	2.59	1.44	2.4	2.9	0.87	1.4
	Th-230			0.4	0.2	0.2	<0.19	0.21	ND (<0.13)	<0.15
CSMRI-2	Ra-226		1.9	1.9	1.4	1.4	1.4	2.8	2.1	1.7
	U Total	11	5.7	0.55	1.46	0.71	1.5	1.3	1.9	1.3
	Th-230		0	0.1	0.1	0.9	<0.17	0.43	0.20	0.31
CSMRI–3	Ra-226		0.6	1.5	1.2	1.6	<0.75	<0.81	ND (<0.49)	<0.98
	U Total	17	10.4	8.41	12.4	10	12	12	9	10
	Th-230		0	0.3	0.3	1.1	<0.12	ND (<0.15)	ND (<0.17)	ND (<0.14)
CSMRI-4	Ra-226		1	<0.4	0.6	0.4	<0.85	<0.42	<0.32	ND (<0.64)
	U Total	86	57.3	23.4	58.6	33.7	16	34.2	53	19
	Th-230		0	0.7	0.3	0.4	<0.099	ND (<0.15)	ND (<0.17)	ND (<0.12)
CSMRI-5	Ra-226		0.6	2.4	3.3	2.7	ND (<0.49)	1.1	2.6	1.59
	U Total	14	16.8	3.6	3.6	4	2.8	2.3	2.7	3.3
	Th-230		0	0.2	0.2	1.4	0.062	ND (<0.14)	ND (<0.19)	ND (<0.13)

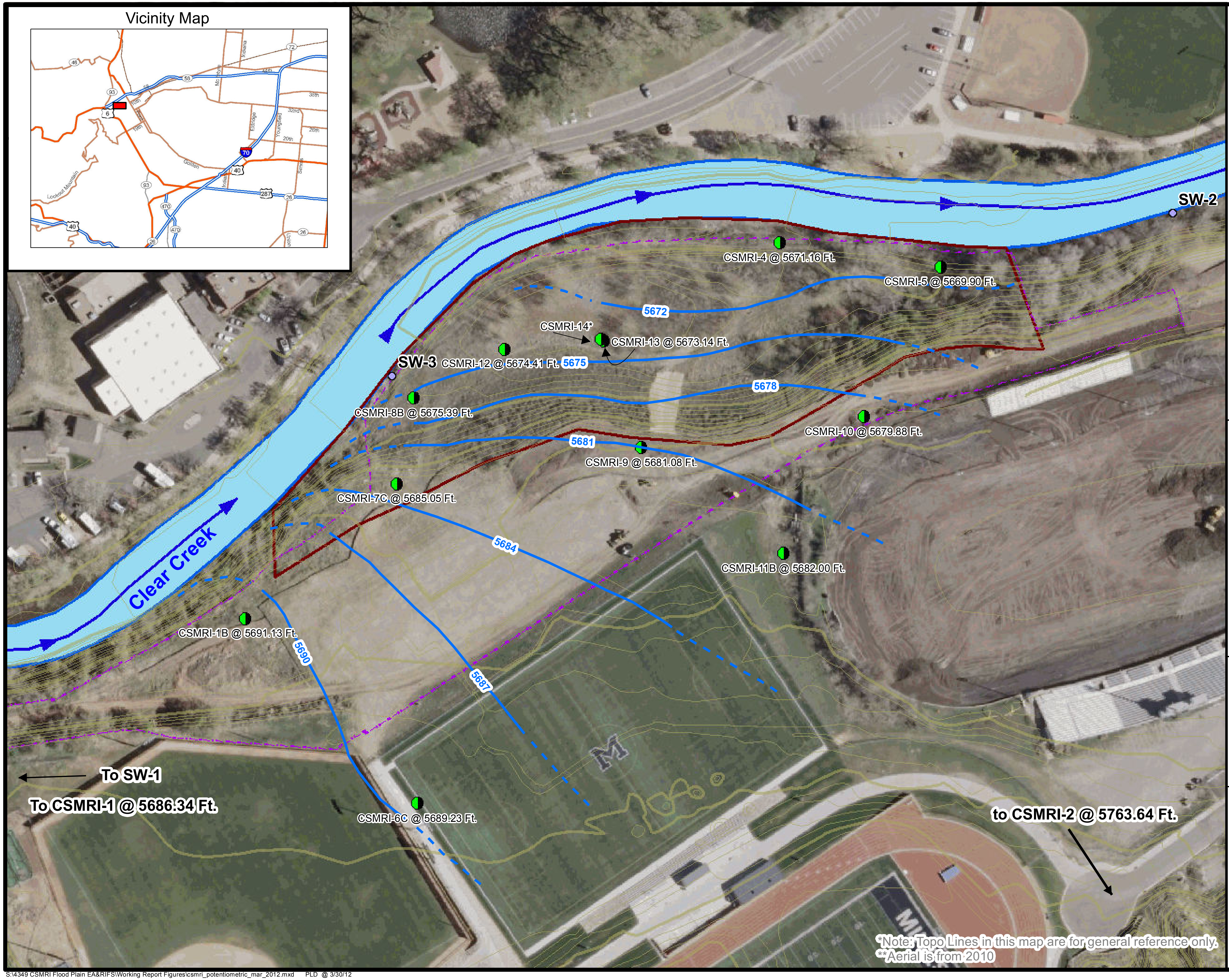
Notes: ND = Not Detected

a - Samples collected by Grant and Associates and analyzed by Barringer Labs

b - Samples collected by URS Greiner Woodward Clyde and analyzed by CORE Labs

c - Samples collected by New Horizons Environmental Consultants and analyzed by Paragon Analytics; Total U activity (pCi/L) calculated from concentration (μg/L) reported by Paragon.

d - Well Identification numbers changed from the 1991 data to the 1999 data. Data presented account for this change



Explanation

Potent. GW Contours (3Ft) March 2012

- Potentiometric Contour
- Inferred Contour
- Monitor Wells
- Surface Water Sample Location
- Fences

Contours 2009

- Topography (2Ft Intervals)
- Topography (10Ft Intervals)
- Flood Plain Characterization Area

*CSMRI-14 (Foxhills Fm, Not Used)
Water Elevation: 5673.92 Ft.

N
W E
S

0 50 100 200 Feet

Figure 1

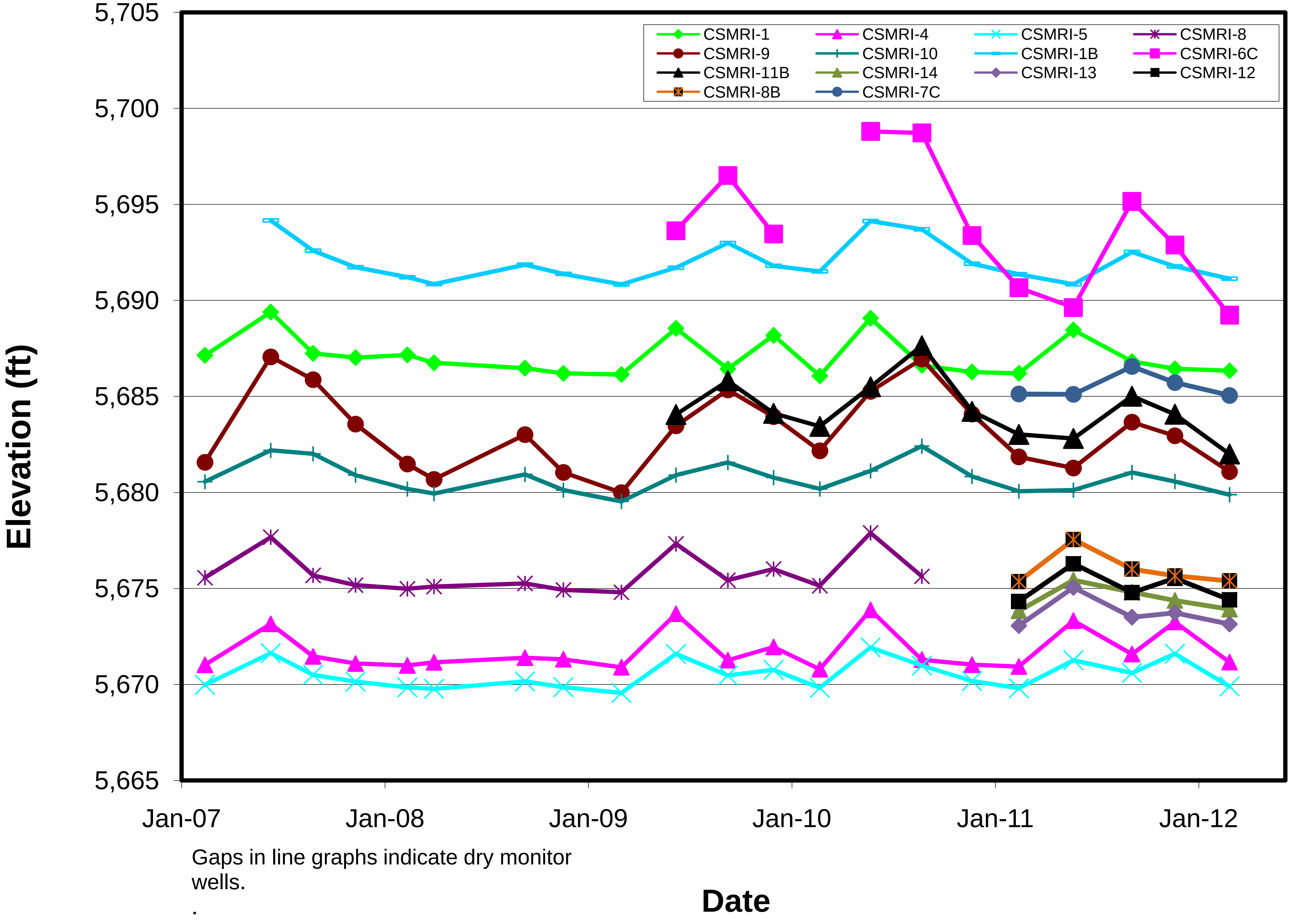
Groundwater Potentiometric Elevation Map - March 2012

CSMRI
Flood Plain
Quarterly Report

Stoller

S:\4349 CSMRI Flood Plain EA&RIFS\Working Report Figures\csmri_potentiometric_mar_2012.mxd PLD @ 3/30/12

Figure 2
CSMRI
All Wells Hydrograph
2007 - 2012



Gaps in line graphs indicate dry monitor wells.
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Figure 3
CSRMI-2
Hydrograph
2004 - 2012

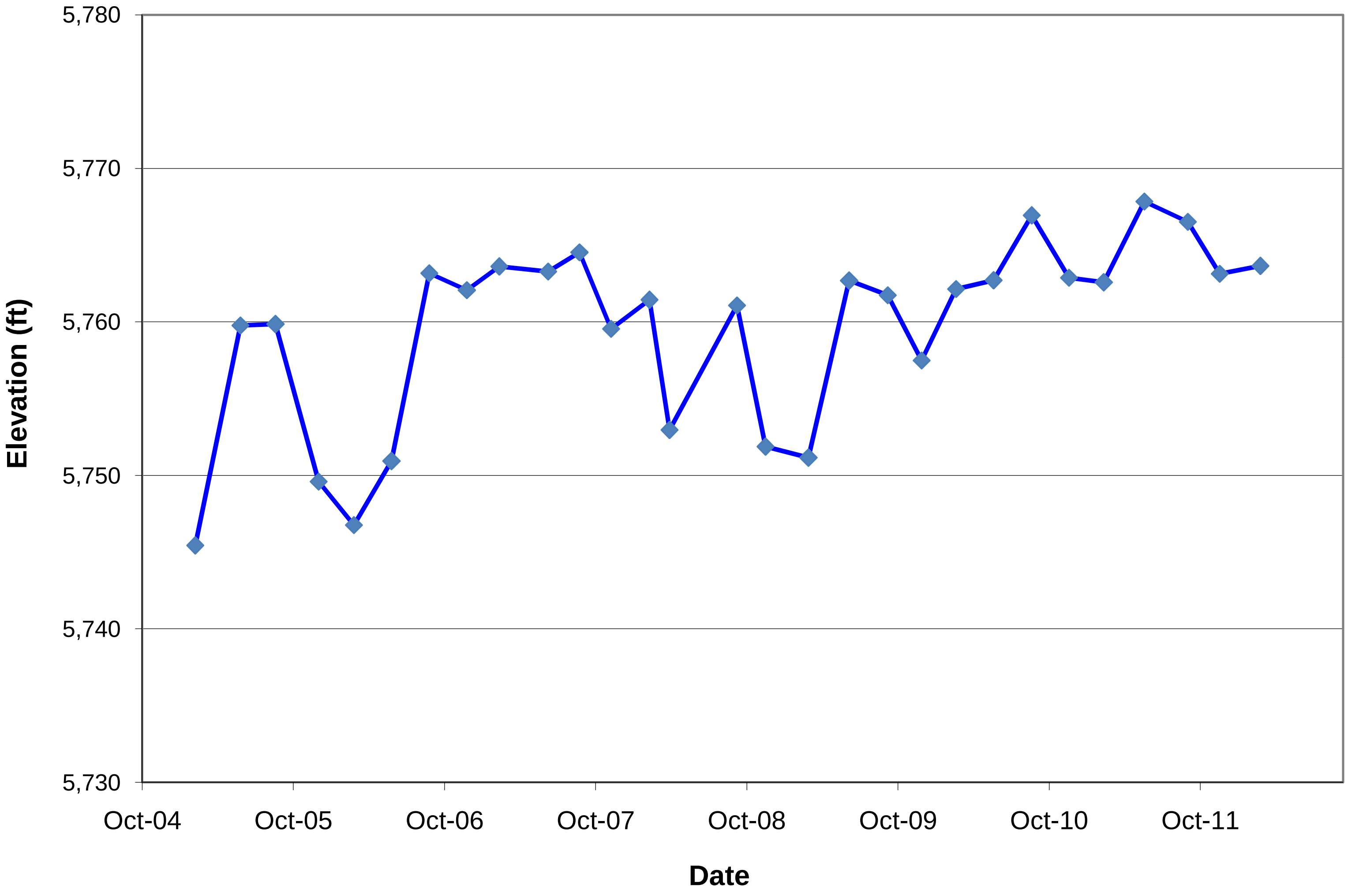


Figure 4

Clear Creek

Gauging Graph

January – March 2012

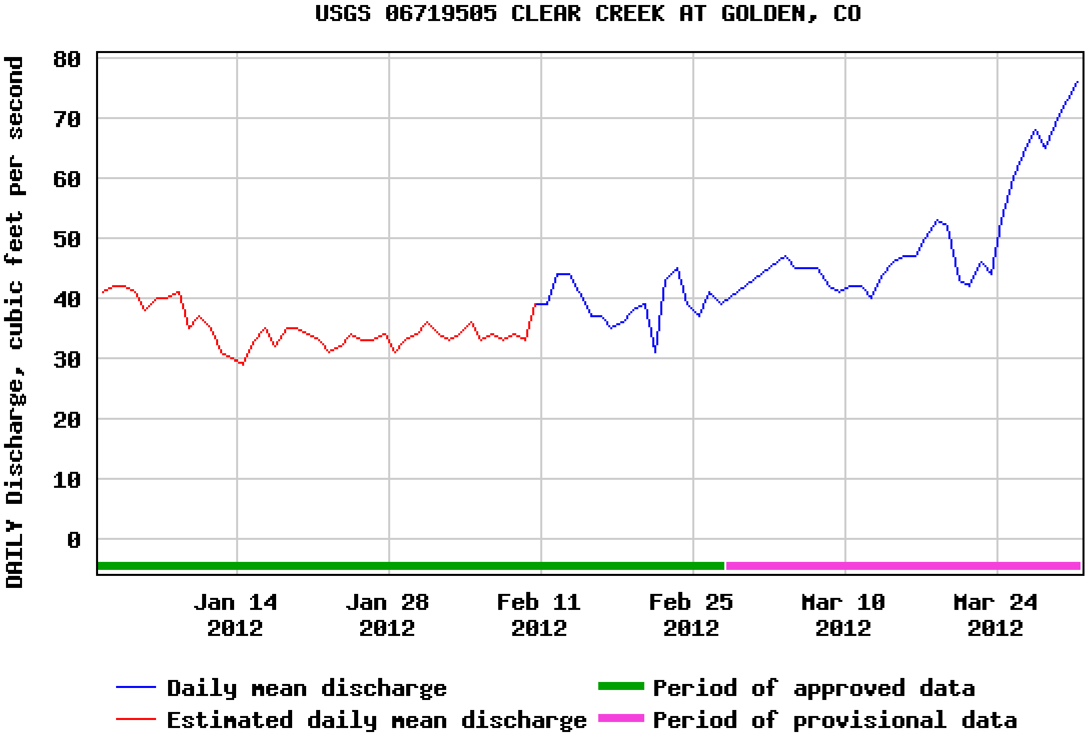


Figure 5
CSMRI-4
Historical Total Uranium Concentration
1991 - 2012

Figure 6
CSMRI-4
Uranium Concentration and Potentiometric Elevation
2005 - 2012

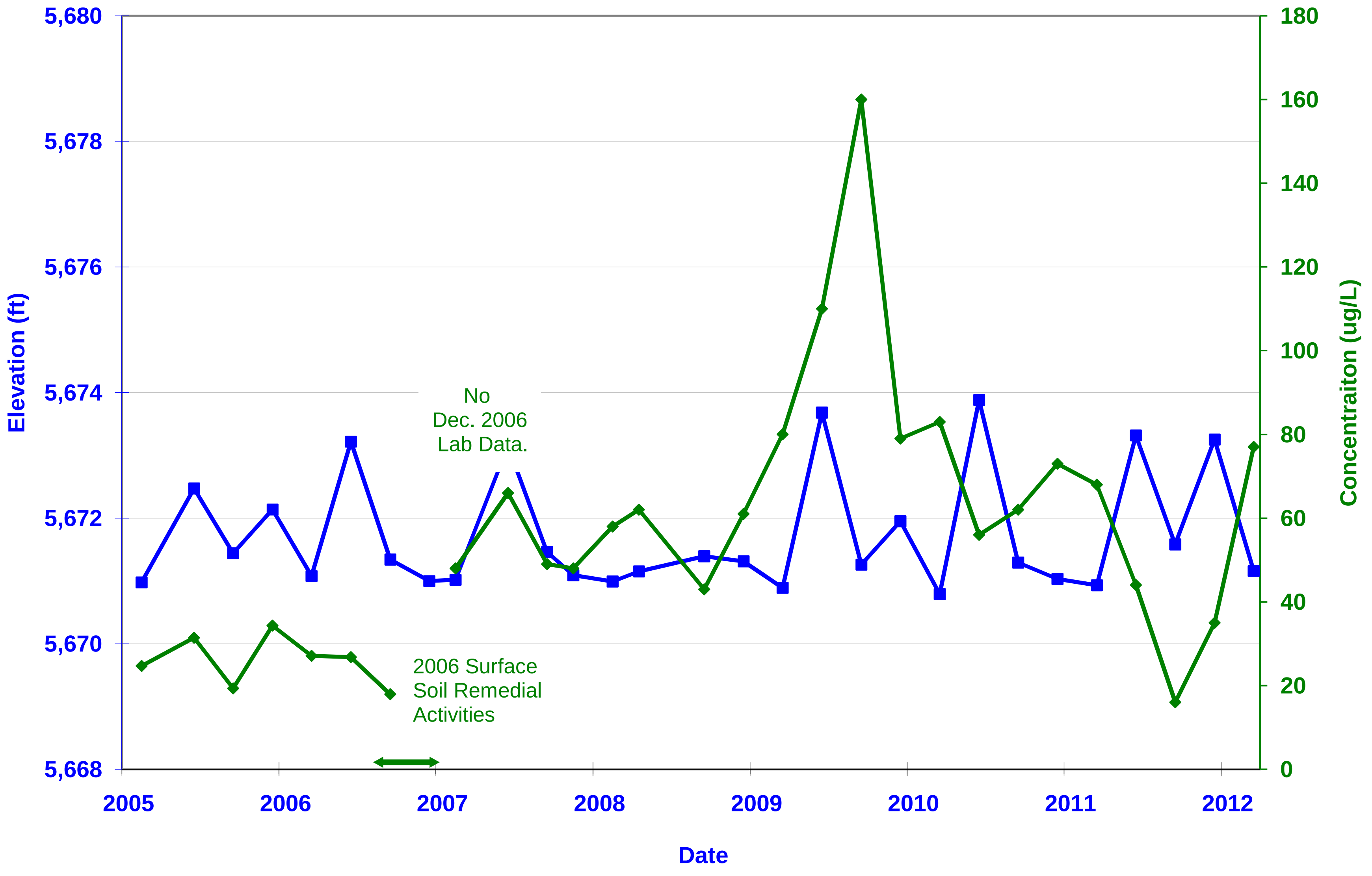


Figure 7
CSMRI-9
Uranium Concentration And Potentiometric Elevation
2007 - 2012

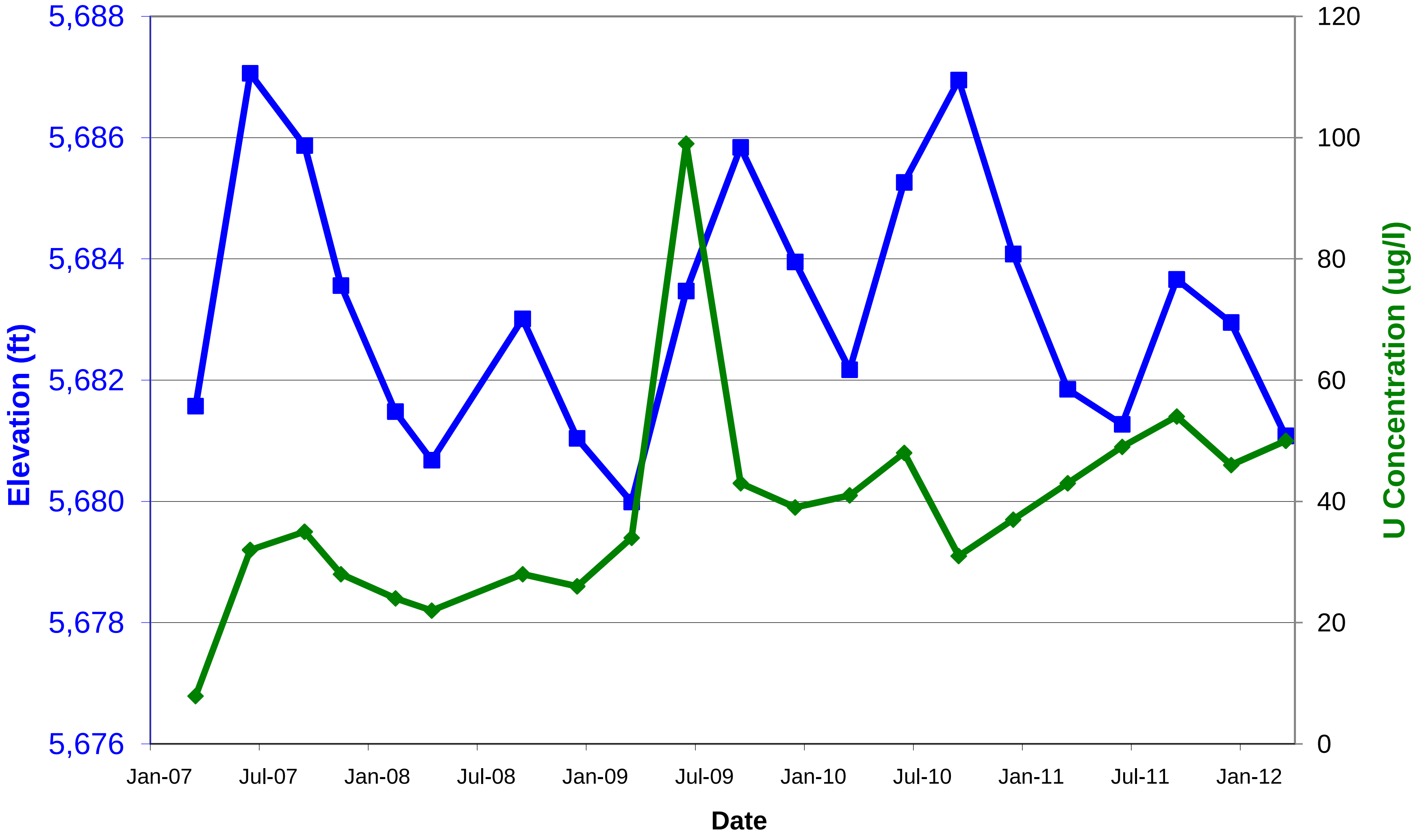
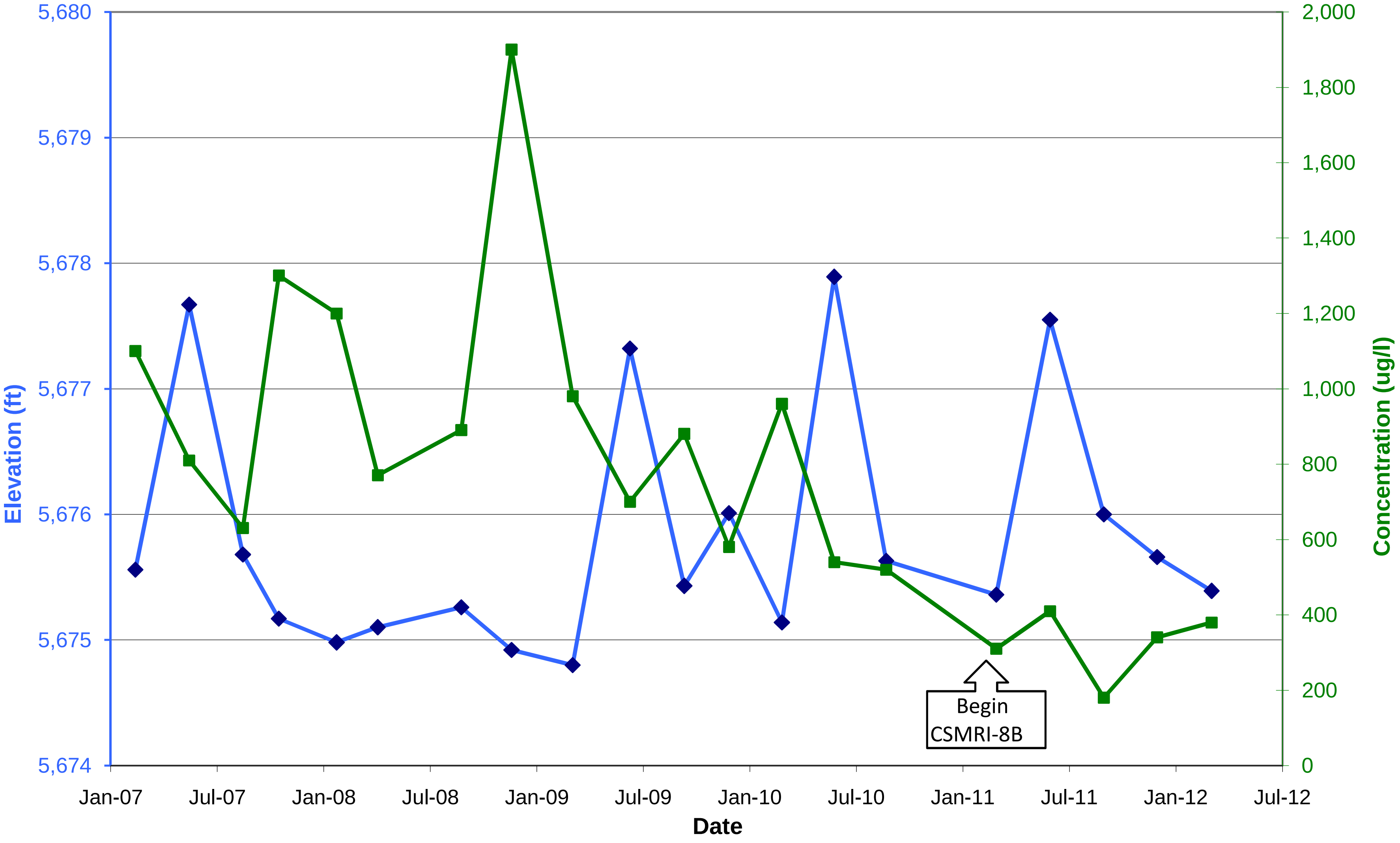


Figure 8
CSMRI-8 - 8B
Uranium Concentration and Potentiometric Elevation
2007 - 2012



Appendix A
Groundwater Sampling Procedures

Groundwater Sampling

1.0 Purpose

This procedure describes actions to be used to sample groundwater from monitoring wells and piezometers. Monitoring wells are generally sampled on a semiannual, quarterly, or monthly basis, or by special request in support for specific projects. All wells are to be sampled using this procedure unless superseded by specific site, facility, or client procedures.

This procedure describes equipment decontamination and transport, site preparation, detection and sampling of immiscible layers, water level measurements, well purging, sample collection, field and analytical parameters, quality assurance/quality control (QA/QC) requirements, and documentation that shall be used for field data collection.

2.0 Scope

This document describes acceptable methods for the sampling of wells and piezometers.

3.0 Responsibilities and Qualifications

Personnel performing groundwater sampling procedures are required to have completed the initial 40-hour OSHA classroom training that meets the Department of Labor requirements at 29 CFR 1910.120(e)(3)(i), and must maintain a current training status by completing the appropriate annual 8-hour OSHA refresher courses. Personnel must also have read the appropriate project, site, or facility Health and Safety Plan(s). Prior to engaging in groundwater sampling activities, personnel must have a complete understanding of the procedures described within this procedure and, if necessary, will be given specific training regarding these procedures by other personnel experienced in the methods described within this procedure.

4.0 Groundwater Sampling Procedures

4.1 Introduction

Many monitoring wells are constructed of either 2-inch stainless steel, or 2- or 4-inch flush threaded PVC casing. Some piezometers are completed as monitoring wells, and they are usually constructed of ¾-inch inside diameter, flush threaded PVC casing. Some wells have been constructed to incorporate a sump below the well screen. Because these vary in length, the well construction diagrams should be consulted to determine the sump lengths for specific wells. Most piezometers are constructed with a flush threaded cap at the bottom of the well screen. However, the well construction diagrams should also be consulted for information about specific piezometers.

Procedures for groundwater sampling are designed to obtain a sample that is representative of the formation water beneath the site in question. Since an analysis of the quality of formation water is desired, standing water within the well must be purged before sampling. Also, a measure of the static water elevations is important to determine the effect of seasonal horizontal and vertical flow gradient changes during site characterization activities.

Groundwater sampling procedures can be initiated after sampling personnel take the required water level measurements and purge the well in accordance with this procedure. Methods for accomplishing each of these activities are included in this procedure in the following sequence:

- Collection of immiscible layers samples, if present
- Well purging
- Groundwater sampling using a bailer

- Groundwater sampling using a peristaltic pump
- Groundwater sampling with a bladder pump

4.2 General Equipment Requirements

Down-hole sampling equipment shall be constructed of inert material such as polytetrafluoroethylene (Teflon®) or stainless steel. This equipment shall be assessed on an individual basis prior to use in the field.

The following is a primary list of well sampling and associated equipment:

- Bailers – Teflon®, stainless steel, or other appropriate inert materials
- Teflon® coated stainless steel cable with reels
- Peristaltic pumps and tubing
- Water level measuring devices – sufficiently accurate to measure water levels to the nearest 0.01 foot
- Graduated purge water containers
- Plastic sheeting
- Distilled or deionized water
- Decontamination equipment and supplies
- Organic vapor detector (OVD)
- Gloves (nitrile)
- Calculator and watch
- Sample containers precleaned to EPA specifications
- pH paper
- Custody tape
- Coolers with sufficient blue ice to cool samples to 4°C
- Preservatives (trace metals grade)
- Disposable in-line 0.45-micron membrane filters
- Logbooks and field forms
- Black waterproof pens
- Portable laboratory equipment for measuring field parameters for pH, temperature, specific conductance, and turbidity
- Total alkalinity reagent
- Beakers and graduated cylinders

Additional equipment may be required to meet project or client health and safety standards, to perform specialized sampling, or to meet personnel and equipment decontamination requirements.

4.3 Equipment Decontamination and Transport

Equipment associated with the tasks involved in groundwater sampling shall be decontaminated upon arrival at the sampling location. All sampling equipment shall be decontaminated between sample locations. Decontamination frequency shall be increased appropriately as field conditions dictate.

Transportation of all equipment shall be performed in a manner that eliminates any possibility of cross-contamination. Calibration solutions, fuel, decontamination solutions and wastewater, and all other sources of contamination shall be segregated from sampling equipment during transport. Purge water being transported to holding areas shall be kept in closed containers.

If the decontamination of downhole equipment is not performed at the well, used downhole equipment shall be wrapped in plastic sheeting and/or segregated from clean equipment to eliminate the possibility of cross contamination. The equipment shall then be decontaminated as soon as possible.

4.3.1 Routine Field Decontamination

Decontamination of delicate equipment and the routine decontamination of sampling equipment prior to use at each well shall consist of the following steps:

- Vigorously scrub the equipment with a brush and solution of phosphate-free laboratory grade detergent (e.g., Liquinox) and distilled water.
- Rinse the equipment thoroughly with approved distilled water.
- If the decontaminated equipment is not immediately packaged to eliminate any adhesion of airborne impurities, perform an additional final rinse, or decontamination and rinse, immediately prior to actual sampling operations.

4.3.2 Routine Decontamination of Sampling Pumps

The external surfaces of all non-dedicated pumping equipment shall be decontaminated as described in Subsection 4.3.1. Internal surfaces shall be decontaminated according to the following procedures, except under special situations where the pump(s) must be disassembled and the internal parts cleaned separately (see Subsection 4.3.3). For routine decontamination, the following procedures shall be followed.

- Pump several pump volumes of a solution of a phosphate-free laboratory grade detergent (e.g., Liquinox) and water through the equipment.
- Displace the soap solution immediately by pumping approved distilled water, equivalent to three or more volumes of the pump storage capacity, through the equipment.
- If any detergent solution remains in the pump, continue pumping distilled water through the system until the detergent is no longer visibly present. Sudsing is the common indicator used to determine incomplete rinsing.

4.3.3 Unusual Decontamination Requirements

When equipment becomes grossly contaminated, such as from the collection of immiscible layer samples (see Subsection 4.5), routine decontamination of sampling equipment is not considered sufficient and thus is not allowed. This situation and other unusual equipment decontamination problems shall be reported to the field site supervisor. Under certain circumstances, a pump can be disassembled and the parts cleaned separately using approved solvents (i.e., hexane, alcohol, etc.). If specific instructions are required, the field site supervisor shall consult with a management representative for proper decontamination procedures.

4.3.4 Disposition of Decontamination Water

All water generated during the decontamination of equipment used for the sampling of wells shall be containerized in either a satellite container or in the purge water container in the groundwater sampling vehicle. It will then be disposed of according to the procedure designated in Subsection 4.6.3 of this procedure.

4.4 Site Preparation

Sheet plastic may be used to protect clean equipment from contacting contaminated surfaces. Plastic bags and sheeting, along with the segregation of clean and dirty equipment, can be used to reduce the chances of cross contamination. If a mechanical bailer retrieval system is used, the amount of plastic appropriate for protection of sampling equipment may be lessened. The sampling crew members are responsible for determining the amount of plastic sheeting required.

Disposable nitrile gloves, or gloves made of other approved materials, shall be used at all times when handling sampling equipment. Gloves shall be changed between each site and as often as necessary to ensure the integrity of clean sampling equipment.

4.5 Collection of Immiscible Layer Samples

When specified in the project sampling plan, or when the well to be sampled contains immiscible layers, immiscible phases must be collected before purging activities begin. The method of choice for collecting light non-aqueous phase liquids (LNAPLS) is a bottom valve bailer or peristaltic pump. Dense non-aqueous phase liquids (DNAPL) or “sinkers” shall be collected with a bottom double check valve bailer or peristaltic pump.

In all cases, the bailer shall be carefully lowered into the well so that agitation of the immiscible layer is minimal. Any bailer used to collect immiscible layers shall be dedicated to the well that is sampled. Peristaltic pumps shall be equipped entirely with silicon, or other chemical compatible tubing, when sampling immiscible layers. The project manager shall be responsible for determining the type materials to be used for specific projects. Dedicated equipment used for collecting immiscible layers shall be decontaminated prior to and after use as described in Subsection 4.3 of this procedure, if removed from the well.

Immiscible layer sampling shall be performed as follows.

- Remove dedicated bailers from the well and decontaminate as specified in Subsection 4.3 of this procedure. Decontaminate dedicated pump tubing, if used, prior to use.
- For LNAPLs, carefully lower the bailer intake or sampling port to the midpoint of the immiscible layer and allow it to fill while it is held at this level. The bailer must be lowered into the immiscible layer slowly so that minimal agitation of the immiscible layer occurs. Peristaltic pump intakes must also be lowered to the midpoint of the immiscible layer.
- If a DNAPL layer is being sampled, use either the double check valve bailer or peristaltic pump. Lower the bailer into the well until bottom is encountered. Lower peristaltic pump intakes also to the well bottom. Care must be taken not to immerse the pump intake into accumulated sediments.
- Do not allow the bailer or line to touch the ground at any time or allow the ground to come in contact with other physical objects that might introduce contaminants into the well.
- Decontaminate all equipment immediately after sampling is completed. Suspend dedicated bailers in the well from the well cap above the high water level. Discard silicon tubing used with peristaltic pumps.

4.6 Well Purging

Purging stagnant water from a well is required so that the collected sample is representative of the formation groundwater. The device used (bailer or pump) depends upon aquifer properties, individual well construction, and data quality objectives. Wells that contain immiscible layers will not be purged unless specified in the site-specific work plan. Any well scheduled for purging and sampling that subsequently is found to contain immiscible layers must be reported to the site supervisor or project manager. The project manager shall be notified immediately prior to continued activities.

Before obtaining water level elevations or initiating purge activities, obtain the following information in reference to the well to be sampled, and enter the applicable information on the sample collection log.

- Location code (well number)
- Previous purge volume (information only)
- Depth to top of screen (bailed wells only)
- Well sample number
- Report Identification Number (RIN)
- Sample event number

Record the location code (well number), date, sampling team members, visitors, well condition, and any other pertinent information on the sample collection log. Enter the well number, time well is opened, and other information regarding the field activities on the Field Activity Daily Log.

The field instruments shall be standardized (to check calibration) and the results recorded on the sample collection form.

Measure the depth to the top of the water column and the total depth of the well in order to determine the height of the water column in the well. Calculate the well casing volume using the well casing inner diameter and the height of the water column in the well. The formula for calculating the volume in gallons of water in the well casing is as follows:

$(\pi r^2 h)\ 7.481$ = gallons; where

$\pi = 3.142$

r = inside radius of the well pipe in feet

h = linear feet of water in well

7.481 = gallons per cubic foot of water

1 gallon = 3785 ml

Calculations of the volume of water in typical well casings may be done as follows:

a. 2" diameter well:

0.16 gal./ft x (linear ft of water) = gallons of water

b. 4" diameter well:

0.65 gal./ft x (linear ft of water) = gallons of water

c. 3/4" diameter well:

87 ml./ft x (linear ft of water) = milliliters of water

4.6.1 Purging Duration

Purging shall be considered complete if any of the following conditions are met.

1. Purging is complete if at least three casing volumes of water are removed from the well, and the last three consecutive pH, specific conductance, and temperature measurements do not deviate by more than the following: 1) pH = ±0.1 pH units; 2) Specific Conductance = ±10% and; 3) temperature ±0.5°C. A turbidity measurement will be taken for every other purge sample for wells that are purged using a bailer. For wells that are equipped with a dedicated bladder pump, the turbidity will be measured each time the parameters are taken. The purge rate should be such that the turbidity is maintained at 5 NTU units or less (if possible). If the readings are not stabilized after three volumes, continue purging until stabilization or until five volumes have been removed. Field parameter measurements shall be collected after every half-casing volume (approximate) is removed from the well. When casing volumes are less than 1-liter, parameter measurements will be collected after each whole casing volume is removed. If readings do not stabilize after five well volumes have been recovered, obtain additional guidance from the project manager concerning the proper course of action.
2. A well is considered dewatered when only a few milliliters of water (or none) can be recovered each time the bailer is lowered into the well. When this occurs, a 10-minute recharge rate will be calculated (linearly). If, at the end of the 10-minute period, the well has not recovered sufficiently to continue the purge in thirty minutes, the purge is considered completed. If, at the end of the 10-minute period, there is sufficient water to collect the VOA samples, the samples may be collected at that time. If the well has not recovered sufficient water during the 10 minutes, and depending upon the well history, the samplers may elect to return to the well the same day (preferably within two hours), check the water level, and collect the VOA samples (first), and other samples as feasible. If the sample team cannot return the same day, the well will be checked in 24 hours to determine if sample collection is feasible. If an extended period of time is required to collect samples, the procedures in Subsection 4.8.1 shall be followed. The well will not require an additional purge before sampling.

Wells that dewater (have a slow recharge rate as specified in 2 above) will not be restricted by parameter stabilization requirements. Sampling of these wells will follow the protocol established in Subsection 4.8.

4.6.2 Purging Methods

Wells will be purged by either bailing or pumping. When purging a well, the rate of water withdrawal during purging should not exceed the rate of withdrawal at which the well was developed (if known). All purge times (initiation and completion) and the rate of purging will be recorded on the field log sheets.

4.6.2.1 Bailing

Generalized procedures for purging a well with a bailer are as follows.

- Prepare the sampling site as discussed in Subsection 4.4. Use properly decontaminated equipment to determine the static water level of the well. Measure the total depth of the well. Use this information to determine the volume of water in the well casing.

- Decontaminate all dedicated bailers prior to initiating purging as described in Subsection 4.3 of this procedure.
- Use a mechanical reel equipped with Teflon® coated stainless steel cable attached to a bailer for bailing and sampling operations. Lower the bailer slowly into the well until water is encountered. Minimize agitation of the well water. Avoid lowering the bailer to the bottom of the well so sediments accumulated in the bottom do not become suspended. For wells that dewater, do not allow the bailer to strike the well bottom with force. Raise and lower the bailer carefully to limit surge energy and ensure that cable does not come in contact with any potentially contaminated surfaces. Do not allow the cable to drag along the well casing or against other objects that will cause fraying. Monitor the amount of water purged.

Wells with significant levels of contamination may have dedicated bailers installed. Dedicated bailer systems shall consist of a Teflon® bailer with check valve or double check valve for DNAPLS and a 5-foot leader of Teflon® coated stainless steel cable. Bailer sampling attachments and the stainless steel reel cable will not be dedicated to individual wells.

Dedicated bailers will be decontaminated at the conclusion of sampling activities and suspended from the well cap above the high water table. If the well interval above the high water table is not adequate to allow for storage in the casing, the dedicated bailers will be stored in labeled and sealed plastic bags at the equipment trailer.

4.6.2.2 Pumping

Pump designs that meet the following criteria are allowed for purging.

- The pump is constructed of a material that does not introduce a source of contamination to the well.
- The pump drive system does not introduce a source of contamination into the well.
- All downhole parts to the pump can be easily decontaminated.
- A return check system that does not allow pumped water to return to the well is integral in the pump design.
- The pump is easily used and does not require excessive amounts of time to install, use, remove, and decontaminate.

The pumps currently in use to purge groundwater include peristaltic pumps and dedicated submersible bladder pumps. A procedure for the use of each style of pump is specific to its applications. User manuals, which accompany each pump, shall be referenced for operating procedures.

Basic operating procedures common to all pumps are as follows.

- Prepare the sampling site as described in Subsection 4.4 regardless of the type of pump being used.
- Use properly decontaminated equipment to determine the static water level and the total depth of the well. This information is utilized to determine the volume of water in the well casing.

- For wells with dedicated pumps, calculate the minimum purge volume using the pump storage volume and the volume of the discharge tubing. A total depth of a 2-inch well cannot be taken without the removal of the pump.
- Position a dedicated pump near the bottom of the well or according to the information on the well construction form. Monitor the discharge rates and the amount of water purged during purging. The pumping rate for purging can be higher than the pumping rate for sampling, however, the water level in the well should be monitored during purging to avoid excessive water level drawdown.
- Ensure that any tubing that enters the well casing is composed of inert material. Disposable silicon tubing will be used in the drive mechanism of peristaltic pumps and discarded after each well is purged. The air supply for all air-driven pumps (dedicated bladder pumps) will be free of oil (i.e., no hydrocarbon containing substances will be added to the compressor).

4.6.3 Disposition of Purge Water

All water removed from a well during sampling operations shall be collected either in a satellite container or the purge water collection container in the groundwater sampling vehicle. The water from these containers will then be transferred to another approved collection container on the sampling or project site. When the collection container is filled, or is near capacity, it will be transported for disposition or treatment in accordance with approved project plans.

4.7 Measurement of Field Parameters

The following field parameters will be measured during groundwater purging operations unless otherwise specified by the project manager or the approved project work plans.

Parameter	Relative Precision	Minimum Calibration
pH	0.01 pH units	Daily
Conductivity	10 μS/cm	Daily
Temperature	0.1 °C	Weekly
Total Alkalinity (unfiltered)	1 mg/l	None
Turbidity (photometric)	2 FTU (or NTU)	Specified purge samples (bailed wells) Daily (dedicated bladder pump wells)

The measuring equipment shall be stored and handled in a manner that will maintain the integrity of the equipment. Appropriate field manuals will accompany each instrument in the field. Each instrument will also be given an identification number. All logbook and field form references to individual instruments will refer to this number for ease of identification.

Field parameters will be measured at the following intervals.

- Conductivity, pH, temperature, and turbidity shall be measured from the first water removed from the well when initiating well purging procedures. For bailed wells, the initial bail of water will be carefully removed from the well and the water transferred to a sample beaker by decanting the bailer through a bottom control valve. For wells purged with a peristaltic pump, similarly collect the first water removed in a sample beaker and then measure parameters. For wells with dedicated pumps, measure the parameters of the first recovered water that is collected in the continuous sampler.

- During purging operations, conductivity, pH, and temperature shall be measured for every half-casing volume (one half of the initial casing volume as calculated on the sample collection log form) of water removed from the well (because of the accuracy of the graduated containers for the purge water, the purge volume will be estimated as close as feasible). For wells that have half volumes less than the volume of a sample bailer (approximately 1 liter), only measure parameters after each full casing volume of water is removed from the well. Turbidity will be measured on every other sample recovered for parameters for bailed wells, or wells purged with a peristaltic pump. All parameters, including turbidity, will be measured at predetermined intervals while purging wells with dedicated pumps.
- During purging, if a well is dewatered prior to the measurement of the final required set of parameters, then conductivity, pH, temperature, and turbidity shall be measured immediately before the start of sample collection. These parameters may be delayed until sampling is completed if, at the discretion of the sampling crew, the well recharge has provided insufficient water volume to collect all the samples and also measure parameters. If there is insufficient water for samples and field parameters, the parameters will not be measured.
- Total alkalinity measurements shall be collected only once upon completion of purging. For wells that do not dewater and sample collection proceeds to completion immediately after purging, alkalinity will be measured after the completion of all other final purge field parameters. Wells that dewater and require repeated visits for the collection of samples will have alkalinity measured subsequent to the collection of the sample for inorganic water chemistry. Alkalinity will not be measured if sufficient water is not available.
- For micro purged wells, a purge is considered completed when the parameters have stabilized.
- Whenever a method used to remove well water is changed, a set of field parameters shall be recorded from water removed with the new method.

4.8 Groundwater Sampling

Techniques used to withdraw groundwater samples from a well shall be based on consideration of the parameters of interest. The order of collection, collection techniques, choice of sample containers, preservatives, and equipment are all critical to ensuring that samples are not altered or contaminated. The preferred methods for collection of groundwater samples are either bailing and/or the use of bladder pumps.

Sites shall be prepared prior to sampling as described in Subsection 4.4. All necessary and appropriate information will be recorded on the sample collection log and on the Field Activity Daily Log.

4.8.1 Sample Collection

The following discussion involves collection of groundwater samples using bailers and peristaltic or bladder pumps. Regardless of the collection method, care shall be taken not to alter the chemical nature of the sample during the collection activity by agitating the sample or allowing prolonged contact with the atmosphere. To minimize the potential for altering the sample and to maximize the available water, the following sample collection sequence is preferred.

- Radiation Screening
- VOC
- Nitrate/Nitrite, as N
- Dissolved Metals – TAL, with Cs, Li, Sr, Sn, Mo, Si
- $^{239/240}$ Plutonium, ^{241} Americium
- $^{233/234}$U, ^{235}U, ^{238}U
- Gross alpha and beta
- $^{89/}$Strontium
- ^{137}Cesium
- ^{226,228}Radium
- Tritium
- Total Metals – TAL, with Cs, Li, Sr, Sn, Mo, Si
- TDS, CL, F, SO^4, CO3, HCO^3
- TSS
- BNA
- Pesticides/PCB
- Cyanide
- Orthophosphate

VOC samples shall be collected first and as soon as possible after the well has been purged. If a well is purged using a peristaltic pump, then all other samples shall be collected prior to removing the pump from the well. The VOC sample will then be collected using a bailer.

For wells that dewater, if a sufficient volume of water for VOC sample collection has still not accumulated within 48 hours after the completion of purging, VOCs will not be collected for that well. Other samples may be collected using a maximum of five attempts to recover sufficient sample water for analysis. This procedure is discussed in the following paragraph.

The containers used for sample collection from poor producing wells may differ from those used for high yield wells in some instances due to constraints on obtaining enough sample to fill sample containers. In some instances smaller containers may be utilized, or analyte samples normally collected in separate containers may be combined into a single container. Well histories can be used to identify which wells may require a modified sample suite and an extended sampling period. These wells will initially be sampled for a period of 48 hours after the completion of purging, with the exception of VOC sample collection, which is discussed in the previous paragraphs. The completion of purging will be considered 0 hour. At the end of 48 hours, any partial sample will be measured. The accumulated sample will be compared to the minimum volume requirement identified in Table 1 and the allowed sample holding time. If the minimum volume requirement for the target analyte has not been achieved, then sampling may continue as determined from the well recharge history. All analyte samples that have only minimum sample volumes collected, and all uncollected samples will be documented on the sample collection log.

Table 1

Sample Containers and Preservatives for Groundwater Samples

Parameter	Minimum Container[1]	Preservative	Holding Time
Radiation Screen	120 ml poly	None	NA
VOC - CLP	3 – 40 ml amber glass	Cool to 4° C	4 Days
BNA	1 L amber glass	Cool to 4° C	7 Days
Pesticides/PCB	1 L amber glass	Cool to 4° C	7 Days
TSS	125 ml poly	Cool to 4° C	7 Days
TDS, Cl, F, SO_4, CO_3, HCO_3	1 L poly	Cool to 4° C	7 Days
Dissolved Metals - CLP, with Cs, Li, Sr, Sn, Mo, Si	1 L poly	*Filtered, HNO_3 to pH <2, Cool to 4° C	6 Months
TOC	125 ml poly	H_2SO_4 < pH2, Cool to 4° C	28 Days
COD	125 ml poly	H_2SO_4 < pH2, Cool to 4° C	28 Days
Total Metals - CLP with Cs, Li, Sr, Sn, Mo, Si	1 L poly	Unfiltered, HNO_3 to pH <2, Cool to 4° C	6 Months
Orthophosphate	250 ml poly	Filtered, Cool to 4° C	2 Days
Nitrate / Nitrite as N	250 ml poly	H_2SO_4 to pH <2, Cool to 4° C	28 Days
Cyanide	1 L poly	NaOH to pH >12, Cool to 4° C	14 Days
Gross Alpha / Beta	550 ml poly	HNO_3 to pH <2	6 Months
$^{233/234}U$, ^{235}U, ^{238}U	100 ml poly	Filtered, HNO_3 to pH <2	6 Months
$^{239/240}Pu$	1 L poly	HNO_3 to pH <2	6 Months
^{241}Am	1 L poly	HNO_3 to pH <2	6 Months
$^{89/90}Sr$	700 ml poly	Filtered, HNO_3 to pH <2	6 Months
$^{226/228}Ra$	750 ml poly	Filtered, HNO_3 to pH <2	6 Months
^{137}Cs	2.5 L poly	Filtered, HNO_3 to pH <2	6 Months

[1] The volume listed is the minimum amount required for analysis. Actual sample volumes may be slightly higher and some parameters may be combined in a single container.

* Some samples may not require filtering if taken from a well with a dedicated pump and turbidity of 5 NTU or less.

The order of sample collection may be changed at the discretion of the sampling team. Changes in the order shall be based on the predicted volume of water that will be recovered and the priority stated in the controlling document. The sampling team shall document their sample selections on the sample collection log.

Sample containers shall be stored away from sunlight and cooled to 4ºC prior to filling. Immediately after collection, samples requiring cooling shall be cooled to 4ºC. A chilled cooler shall be used as the storage container. Whenever a sample bottle that requires chilling is not being physically handled, it will be placed in the cooler to prevent heating or freezing, exposure to sunlight, and possible breakage.

VOC samples shall be collected using a bailer equipped with a bottom-decanting control valve or directly from the pump discharge line on wells equipped with bladder pumps. The procedures for collecting VOC samples are discussed in Subsections 4.8.1.1 and 4.8.1.2 of this procedure.

VOC vials shall never be filled and stored below capacity because of insufficient quantities of water in the well. Except for the VOC vials, adequate air space should be left in the sample bottles to allow for expansion.

Samples shall be placed in the appropriate containers and packed with ice in coolers as soon as practical. VOC samples will be stored in the cooler in an inverted position immediately after collection. When sampling is complete, the well cap shall be replaced and locked.

Sampling tools, instruments, and equipment shall be protected from sources of contamination before use and decontaminated after use as specified in Subsection 4.3. *Liquids from decontamination operations will be handled in accordance with the procedures in Subsection 4.6.3 of this procedure*. Sample containers shall also be protected from sources of contamination. Sampling personnel shall wear chemical-resistant gloves (e.g., nitrile) when handling samples, and the gloves will be disposed of between well sites.

4.8.1.1 Groundwater Sampling Using a Bailer

This subsection describes the use of a bailer for collecting groundwater samples that may be used to obtain physical, chemical, or radiological data.

A bailer attached to a Teflon® coated stainless steel cable is carefully lowered into the well. After filling within the well, the bailer is withdrawn by rewinding the bailer line, and the bailer contents are drained into the appropriate containers. Certain recommendations and/or constraints should be observed when using bailers for sampling groundwater monitoring wells, as follows.

- Use only bottom-filling Teflon® bailers or bailers made of other inert materials.
- Ensure that bailers are attached to a Teflon® coated stainless steel line that is pre-wound on a reel.
- Do not use bailers constructed with adhesive joints.
- Lower the bailer slowly to the interval from which the sample is to be collected.

VOC samples shall be collected using a bailer equipped with a bottom-decanting control valve. The first water through the valve assembly will be discarded into the purge water container. Vials will be filled by dispensing water through the control valve along the inside edge of the slightly tilted sample vial. Care shall be taken to eliminate aeration of the sample water. The vials will be filled beyond capacity so the resulting meniscus will produce an airtight seal when capped. The capped vial will be checked for trapped air by lightly tapping the vial in an inverted position. If air becomes trapped in the vial, the sample water shall be discarded, and the vial refilled. If two consecutive attempts to fill a VOC vial result in trapped air bubbles, the vial shall be discarded.

The remainder of the sampling water shall be collected in a stainless steel container from which the remaining sample bottles will be filled. Samples requiring filtration shall be filtered and then containerized.

4.8.1.2 Groundwater Sampling Using a Peristaltic Pump

Use of peristaltic pumps shall generally be limited to collecting sample aliquots for radionuclides, metals, and other species that are not subject to volatilization and degassing. Peristaltic pumps shall never be used to collect VOCs or other volatile species in routine wells, although such samples may be collected for special screening applications. All downhole tubing shall be Teflon® except in areas of special concern (e.g., where immiscible layers exist) where special tubing, such as stainless steel or Viton®, may be required. If so, the project manager will make this determination. Only the portion of tubing that is inserted into the mechanical drive shall be made of silicon. This drive portion of the tubing shall be discarded after each use.

4.8.1.3 Groundwater Sampling Using a Downhole Bladder Pump

Some wells are equipped with dedicated downhole bladder pumps for purging and sampling. These are wells that will normally produce an adequate amount of water during a single visit to complete the required sampling suite. The equipment required to purge and sample a well consists of a pump control unit, a portable air compressor, a continuous sampler for measuring the field parameters, and the necessary sample containers, graduated cylinders, and container(s) to collect the purge and excess water. The following precautions should be observed during the sampling operation.

- Locate the compressor used to power the pump downwind from the well to eliminate the contamination of equipment and samples with exhaust.
- If the flow-through cell will not maintain a full sample chamber (tends to drain back), then clean the check valve on the pump if it is fouled, or replace the pump.
- Calculate the minimum purge volume using the procedure in Section 4.6. Note that a purge is considered completed only when the groundwater parameters have stabilized.
- Upon completion of purging, initiate sampling with the collection of the VOC sample(s). The pump should operate with minimum interruptions while the full sample suite is collected. Allowing the pump to stop for an extended period of time will cause the water trapped in the discharge lines to equilibrate to ambient temperatures, which is not acceptable. During sampling, the pump can be slowed to any rate that allows efficient sampling while also maintaining stable field parameters.
- Measure groundwater parameters periodically during sample collection and record them on the sample collection log to document conditions during sampling.
- Because micropurging is the method used for sampling, adjust the flow rate to limit the drawdown in the well. Also adjust the rate such that the turbidity is below 5 NTU for sampling. If this criterion is met, the samples need not be filtered.
- Operate the pump, pump control unit, and the flow-through cell according to the manufacturer’s recommendations.

4.8.1.4 Groundwater Sampling Using a Push Type Sampler

This portion of this procedure describes the use of a Geoprobe® Screen Point 15 Groundwater Sampler, or similar type equipment, for collecting groundwater samples at predetermined depths. These samples may be used to obtain physical, chemical, or radiological analyses.

A Geoprobe® Screen Point 15 Groundwater Sampler, or equivalent tool, is driven to a predetermined depth by a push type-sampling rig. The Screen Point 15 Groundwater Sampler is equipped with a 41-inch retractable screen and expendable drive point. It can then be partially or fully withdrawn (up to 41 inches) to expose a portion or the entire deployed well screen. After groundwater enters the exposed screen, a sample is collected using either the procedures in Subsection 4.8.1.1, Groundwater Sampling Using a Bailer, or in Section 4.8.1.2, Groundwater Sampling Using a Peristaltic Pump. Note that these samples are collected only for screening purposes because the sampling tool hole has not been completed as a well.

The method for obtaining QC samples using the push type-sampling tool is provided in Subsection 4.8.4.1 for groundwater sampling. Duplicate groundwater samples shall be collected only if there is enough water to collect two full suites of analytes without dewatering the annulus. If insufficient water is available for the collection of a planned QC sample, it shall be explained and documented in the field log book, and the project manager informed. If insufficient water is available for two full suites of analytes, it may be come necessary to prioritize the analyte list. The prioritization sequence should be described in the project-specific work plan.

4.8.2 Sample Filtering and Preservation

Samples for dissolved metals, Gross Alpha/Beta, $^{233/234}$Uranium, ^{235}Uranium, ^{238}Uranium, $^{89/90}$Strontium, ^{137}Cesium, ^{226}Radium, ^{228}Radium, and orthophosphate shall be filtered in the field at the well location during the sampling event through a disposable 0.45-micrometer membrane filter. If a peristaltic or bladder pump is used, a disposable filter may be attached directly to the sample delivery line so that the sample is filtered directly into the sample container as it exits the delivery line. Discharge pressure shall be gauged so it does not exceed 50 psi. Alternatively, sample water may be collected in a stainless steel container and filtered with a peristaltic pump. Before sample collection, 100 to 200 milliliters of sample water shall be passed through the filter in order to rinse the filter and filtration apparatus of possible contaminating substances.

Preservatives shall be added to the sample bottles prior to the introduction of the filtered sample water. The preservative shall be added in aliquots appropriate to the size of the bottle.

After sample collection has been completed, the pH of preserved samples shall be checked as follows.

- Pour a small amount of sample from the sample bottle directly onto approved pH paper. Use care so that the threaded neck of the bottle does not contact the pH paper. Do not, under any circumstances, insert the pH paper into the sample bottle.
- Check the pH paper against the supplied color chart. If the appropriate pH has not been achieved, add additional preservative to the sample in 5 ml aliquots and repeat the pH test after each addition.

4.8.3 QA/QC Samples

The frequency and types of field QA/QC samples collected during groundwater sampling are described in project-specific work plans or quality assurance plan documents. These documents detail the applicable criteria for collecting QA/QC samples.

4.8.3.1 Duplicates

Duplicate samples shall be collected only from wells that produce enough water to collect two full suites of analytes without dewatering. Wells that produce sufficient water shall be incorporated into the sampling program such that the required duplicate frequency can be maintained.

Wells scheduled for duplicate sample collection shall be sampled as described in Subsection 4.8 of this procedure, and in relevant sections of project-specific work plans and/or quality assurance documents. Field duplicates are collected following the same sampling procedures used to obtain the real samples. With the exception of VOCs, the typical procedure for a location is to collect the real and duplicate of each sample at the same time, in two equal portions, with each portion going to the laboratory in separate containers. This is accomplished by alternately filling two sample bottles one half at a time to minimize heterogeneity. Note that real and duplicate VOC samples shall be collected independently to reduce the possibility of volatilization of the sample.

When a well with a dedicated pump is being used for sample collection, all samples shall be collected in the normal order, with duplicate VOC samples being collected first. The remaining samples will be sampled as described above.

If a well is being used for matrix spike (MS) and matrix spike duplicate (MSD) samples, the duplicate shall be collected after collection of the MS and MSD.

All duplicate samples shall be given a sample number different from the original sample and the information recorded on the sample collection log and/or the field QC sample collection log.

4.8.3.2 Matrix Spike and Matrix Spike Duplicate

MS and MSD samples shall be collected only from wells that produce enough water to collect the required suites of analytes without dewatering. MS and MSD samples are not collected on a routine basis, but will be collected if so designated in a site-specific sampling plans, or if requested by the project manager.

MS and MSD samples shall be collected as follows.

- Purge the well as described in Subsection 4.6 of this procedure..
- After completion of purging, collect VOC samples. Collect the real sample followed by the MS and MSD. Collect these samples in immediate succession.
- Collect the remaining samples not requiring filtering. For each sample parameter, collect the original sample, MS, and MSD concurrently. Fill the original sample bottle one-third full followed by the MS and MSD sample bottles, which are also filled one-third full. Rotate each bottle in the sequence, filling in one-third full until all three bottles are full. For analytes not requiring an MSD, collect only the original sample and the MS.
- After the real sample, MS, and MSD (where appropriate) are collected for one parameter, repeat the process for the next parameter.
- Similarly, collect samples requiring filtering. When a bailer is used, fill a stainless steel bucket with sample water. As samples are collected and the reservoir of water in the bucket is depleted, add more water with discretion. When a pump is used, attach the filter directly to the discharge line. Fill

sample bottles as described above, partially filling the original sample, MS, and MSD in rotating sequence until each parameter bottle is full.

- Radiochemistry samples may have more than one bottle for each parameter group. In this case, include all required bottles in the rotating sequence.
- Field parameter measurements are not be required for MS and MSD samples.
- Retain the original sample number for MS and MSD samples. However, add a suffix of MS or MSD to the sample number to correspond with each QA/QC sample. Record all information on the field QC groundwater sample collection log.

4.8.3.3 Replicates and Splits

Replicate and split samples shall be collected in the same manner as described for the MS and MSD. Seek instruction from the project manager for replicates and splits exceeding three samples. Record all information will be recorded on the groundwater sample collection logs.

4.8.3.4 Field Equipment Rinses

Wells scheduled for equipment rinsate samples shall be sampled as described in Subsection 4.8 of this procedure, and field equipment rinses shall be collected as described in this Subsection and in relevant portions of project-specific QC documents and work plans. Field equipment rinses shall be collected in a manner designed to reflect sampling techniques. All equipment used during sampling will be fully decontaminated as described in Subsection 4.3, then rinsed with distilled or deionized water. The rinse water will then be collected in bottles identical to those used for the original sample, and assigned a separate sample number. Analytes requiring filtration will be filtered using a new filter and tubing as required for the real sample. All information will be recorded on groundwater sample collection logs.

4.8.3.4.1 Bailed Wells

After completion of sampling, all equipment shall be decontaminated. Prior to leaving the well location, the equipment rinse will then be collected as follows.

- Fill the bailer with distilled or deionized water by pouring the water into the top opening.
- Decant the rinse water to the VOC vials through the bottom valve just as was done during sample collection.
- For the remaining unfiltered samples, fill the bailer with distilled or deionized water each time additional rinsate is needed. Transfer the rinsate to sample bottles or to a stainless steel bucket and then to sample containers in the same manner used during collection.
- Collect filtered samples in an identical manner as the real samples. Fill the bailer with distilled or deionized water. Then transfer the rinse water to a stainless steel bucket. Filter the rinse water in the bucket through a new disposable filter.

- Preserve rinse samples in the same manner as the real samples.

4.8.3.4.2 Pumped Wells

Rinsate samples are not routinely collected from wells that are equipped with dedicated bladder pumps because the samples from these wells are collected directly from the pump discharge line. However, wells sampled using peristaltic pumps for sampling may be selected for rinsate sampling, with equipment used in sample collection (down hole tubing, filter tubing and the stainless steel bucket used for sample water collection, etc.) being decontaminated prior to rinsate sampling. The tubing at the pump head will be replaced, and a new filter used for filtered analytes. To collect the samples, distilled or deionized water will be poured into the decontaminated stainless steel bucket and pumped, using the decontaminated tubing, into the sample containers. The equipment used to collect the real VOC samples will also be decontaminated, rinsed, and used to collect the VOC rinse samples. All samples will be preserved at the same pH levels as the real samples.

4.8.3.5 Distilled Water Blanks

Distilled water sample blanks are not submitted on a routine basis, but will be made up if so designated in a site-specific sampling plan. Samples of the distilled or deionized water used for the final decontamination of equipment will be transferred directly to sample bottles to determine any baseline contamination the water may have introduced into the samples. Five-gallon bottles of the distilled or deionized water will be opened in a controlled area, such as the bottle storage room, and then poured directly into the appropriate sample bottle. A Teflon®, glass, or stainless steel funnel may be used to help control flows into small mouth bottles. Blank samples will be preserved to the appropriate pH required for each analyte. All information will be recorded on groundwater sample collection logs.

4.9 Sample Handling and Control

Pre-cleaned sample containers will be obtained from a contract analytical sample container source. Preserving solution will be added to the bottles by a laboratory, the sample manager or qualified sampling personnel. The bottles will be labeled to indicate the preservative added.

The sampling containers, preservation requirements, and holding times for the various types of analyses are shown in Table 1. Groundwater samples will be properly labeled so that they can be easily identified. The sample numbering system will be assigned by project-specific sampling plan documents. A sample identification (ID) number will be assigned to each sample suite. The sample ID number will contain the following information as part of a nine to twelve character, alpha-numeric code:

Character(s)	Description	Code
1 and 2	Project ID	GW
3 through 7	Sample Number	00001 to 99999
8 and 9	Subcontractor ID	Alpha (e.g. TE = Tierra Environmental Consultants)
10, 11, and 12	QA/QC	MS for matrix spike, MSD for matrix spike duplicate

In addition to a sample number, each well sampled will be assigned a current Record Identification Number (RIN), an event number (specific to the RIN), and bottle numbers that are specific to the RIN and event number.

5.0 Records

All field activities shall be recorded on a Field Activity Daily Log or Groundwater Sample Collection Log. Additional logs may be required to record QC samples and for recording well status. Refer to specific project, site, or facility work plans for further information. Summary information of the day's activities or other pertinent information should always be recorded on the field forms. Under some circumstances, the project manager may assign a bound field logbook to the field personnel that will remain in their custody during all sampling activities. The cover of each logbook shall contain the following information at a minimum:

- Name of the organization to which the book is assigned
- Book number
- Project name
- Start and end dates

Logbook pages shall be sequentially numbered and marked with the book number before any data are recorded. All data and information pertinent to field sampling shall be recorded in the logbook or on the field forms that identify all required data entries. Enough detail must be included in the documentation to reconstruct the sampling event. Field form entries shall include the following minimum information:

- Date and time
- Names of field personnel
- Names of all visitors
- Location of field activities
- Description of sampling sites including weather conditions
- All field observations and comments
- Field parameters
- Sample identification information
- References to all prepared field activity forms and chain-of-custody records

Field logbooks, when required on specific projects, shall normally be kept only by the field sampling team leaders and the site supervisor and shall typically be used only to summarize field activities and to document project information not required by the procedure field forms.

Permanent ink shall be used for all entries in the logbooks and on the field forms. Mistakes shall be crossed out with a single line, initialed, and dated. Unused pages or partial pages shall be voided by drawing a line through the blank sections and initialing and dating the mark. Any deviation from this procedure shall require documentation in the site supervisor’s logbook.

The field activity daily log narrative should create a chronological record of the sampling team's activities, including the time and location of each activity. Descriptions of problems encountered, personnel contacted, deviations from the procedure, and visitors on site shall also be included. The weather conditions, date, signature of the person responsible for entries, and the number of field activity daily log sheets used to record media team activities for a given day shall also be included.

The Groundwater Levels Measurement/Calculations Form and the Chain of Custody Record (see *Containing, Preserving, Handling, and Shipping Soil and Water Samples*) shall also be completed for each site. All blank fields on the forms must be completed or voided.

6.0 References

Environmental Protection Agency, 1982, Test Methods for Evaluating Solid Waste, SW-846, Volume II. Field Methods, 2nd edition.

Environmental Protection Agency, 1986a, Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, EPA Region IV Environmental Service Division.

Environmental Protection Agency, September 1986b, RCRA Ground Water Monitoring Technical Enforcement Guidance Document, OSWER-9950.1.

Environmental Protection Agency, 1987a, A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001. 1987.

Environmental Protection Agency, 1987b, Data Quality Objectives for Remedial Activities, Development Process, EPA/540/G-87/003.

Environmental Protection Agency, December 1988, User's Guide to the Contract Laboratory Program.

APPENDIX A

STANDARD GROUNDWATER FORMS

Appendix B
Sample Collection Forms

Stoller

Sample Location: CSMRI-1
Date: 3/14/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	25.05	(ft)	(+.28)	TD =	25.33	(ft)
Initial Water Volume =	2.76		(gal)	Depth to Water =	8.08	(ft)
3X Water Volume =	8.28		(gal)	Water Column =	17.25	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1332	2.76	7.90	7.75	767	16.08	173	470	Clear
1335	5.52	7.44	6.51	745	15.49	177	261	brown
1338	8.28	6.66	7.29	719	14.02	180	221	↓
								NCM

Volume Purged: (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	1340	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	1340	ALS
Anions	500 mL Plastic	none	3/14/12	1340	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	1340	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	1340	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	1340	TA
					NCM

Comments:

Stoller

Sample Location: CSMRT-1B
Date: 3/13/12, 3/14/12, 3/15/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	23.41	(ft)	(+.28)	TD =	23.69	(ft)
Initial Water Volume =	0.43		(gal)	Depth to Water =	21.01	(ft)
3X Water Volume =	1.29		(gal)	Water Column =	2.68	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
0847	0.43	10.49	6.45	—	9.74	33	870	brown
	0.86							
	1.29							

Volume Purged: 0.75 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/15/12	1045	ALS
Cations	500 mL Plastic	HNO_3	3/15/12	1045	ALS
Anions	500 mL Plastic	none	3/15/12	1045	ALS
DOC	125 mL Amber	H_2SO_4	3/15/12	1045	ALS
NO_2, NO_3	1 L Plastic	none	3/15/12	1045	TA
Total Dissolved Solids	1 L Plastic	none	same bottle		TA
			as above		

Comments:
Combined NO_2, NO_3 and TDS in one bottle

Stoller

Sample Location: CSMRI-2
Date: 3/14/12, 3/15/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	95.10	(ft)	(+.28)	TD =	95.38	(ft)
Initial Water Volume =	6.32		(gal)	Depth to Water =	55.91	(ft)
3X Water Volume =	18.96		(gal)	Water Column =	39.47	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1230	3.16	13.90	7.49	961	9.82	161	1000+	Grey
1236	6.32	13.51	7.42	1560	8.79	158	1000+	Grey
1243	9.48	13.66	7.27	612	-10.37	157	1000+	Grey
	12.64							
	15.80							
	18.96							NM

Volume Purged: 10.50 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/15/12	1130	ALS
Cations	500 mL Plastic	HNO_3	3/15/12	1130	ALS
Anions	500 mL Plastic	none	3/15/12	1130	ALS
DOC	125 mL Amber	H_2SO_4	3/15/12	1130	ALS
NO_2, NO_3	1 L Plastic	none	3/15/12	1130	TA
Total Dissolved Solids	1 L Plastic	none	3/15/12	1130	TA
					NCM

Comments:

Stoller

Sample Location:	CSMRI-4
Date:	3/13/12
Project Name:	Colorado School of Mines
Project Number:	4349-430
Sample Type:	[✓ GW] SW EB Dup
Sampler:	Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	17.32	(ft)	(+.28)	TD =	17.60	(ft)
Initial Water Volume =	1.68		(gal)	Depth to Water =	7.09	(ft)
3X Water Volume =	~~1.68~~ PD 5.04		(gal)	Water Column =	10.51	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1137	1.68	7.00	7.26	1770	17.01	149	319	Clear
1140	3.36	6.50	7.17	1650	16.75	148	205	Clear
1143	5.04	6.11	7.12	1620	16.09	149	90	Clear

Volume Purged: 5.04 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/13/12	1200	ALS
Cations	500 mL Plastic	HNO_3	3/13/12	1200	ALS
Anions	500 mL Plastic	none	3/13/12	1200	ALS
DOC	125 mL Amber	H_2SO_4	3/13/12	1200	ALS
NO_2, NO_3	1 L Plastic	none	3/13/12	1200	TA
Total Dissolved Solids	1 L Plastic	none	3/13/12	1200	TA
Ferrous Iron	1 L Plastic	none	3/13/12	1200	TA
Ferric Iron	500 mL Plastic	HNO_3	3/13/12	1200	TA
Sulfide	250 mL Plastic	ZnAc	3/13/12	1200	TA

Comments:

Stoller

Sample Location:	CSMRI-5
Date:	3/13/12
Project Name:	Colorado School of Mines
Project Number:	4349-430
Sample Type:	[✓ GW] SW EB Dup
Sampler:	Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	10.99	(ft)	(+.28)	TD =	11.27	(ft)
Initial Water Volume =	0.73		(gal)	Depth to Water =	6.71	(ft)
3X Water Volume =	2.19		(gal)	Water Column =	4.56	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1232	0.73	9.54	7.48	1280	15.45	162	765	Clear
~~1230~~ 1235	1.46	8.73	7.24	1280	16.45	162	1000+	grey
1238	2.19	8.32	7.21	1280	16.22	163	748	do

Volume Purged: 2.19 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/13/12	1240	ALS
Cations	500 mL Plastic	HNO_3	3/13/12	1240	ALS
Anions	500 mL Plastic	none	3/13/12	1240	ALS
DOC	125 mL Amber	H_2SO_4	3/13/12	1240	ALS
NO_2, NO_3	1 L Plastic	none	3/13/12	1240	TA
Total Dissolved Solids	1 L Plastic	none	3/13/12	1240	TA
Ferrous Iron	1 L Plastic	none	3/13/12	1240	TA
Ferric Iron	500 mL Plastic	HNO_3	3/13/12	1240	TA
Sulfide	250 mL Plastic	ZnAc	3/13/12	1240	TA

Comments:

Stoller

Sample Location: CSMRI-6C
Date: 3/13/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	39.75	(ft)	(+.28)	TD =	40.03	(ft)
Initial Water Volume =	1.00		(gal)	Depth to Water =	33.80	(ft)
3X Water Volume =	3.00		(gal)	Water Column =	6.23	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	[✓ °C] °F	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
0902	1.00	11.87	5.90	—	11.84	218	1000+	brown
0903	2.00	11.87	6.90	—	10.47	182	1000+	↓
0907	3.00	11.90	7.17	1090	10.80	148	1000+	↓
								NCM

Volume Purged: 3.0 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/13/12	0915	ALS
Cations	500 mL Plastic	HNO_3	3/13/12	0915	ALS
Anions	500 mL Plastic	none	3/13/12	0915	ALS
DOC	125 mL Amber	H_2SO_4	3/13/12	0915	ALS
NO_2, NO_3	1 L Plastic	none	3/13/12	0915	TA
Total Dissolved Solids	1 L Plastic	none	3/13/12	0915	TA
					NCM

Comments: conductivity meter was not working for the first two readings.

Stoller

Sample Location: CSMRI-7C
Date: 3/13/12, 3/14/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	24.09	(ft)	(+.28)	TD =	24.37	(ft)
Initial Water Volume =	3.18 ↓ NZM	(gal)		Depth to Water =	17.70	(ft)
3X Water Volume =	1.06	(gal)		Water Column =	6.67	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
0932	1.06	10.35	6.67	–	11.56	221	1000+	brown
0935	2.12	10.50	6.98	1260	11.93	35	1000+	↓
~~0935~~	~~3.18~~			~~1260~~	~~11.9~~		~~1000+~~	
								NZM

NZM

Volume Purged: 2.5 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	0845	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	0845	ALS
Anions	500 mL Plastic	none	3/14/12	0845	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	0845	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	0845	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	0845	TA
					NZM

Comments: conductivity meter not working for first reading

Stoller	Sample Location: CSMRI-9R
	Date: 3/13/12
	Project Name: Colorado School of Mines
	Project Number: 4349-430
	Sample Type: [✓ GW] SW EB Dup
	Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	10.07	(ft)	(+.28)	TD =	10.35	(ft)
Initial Water Volume =	0.40		(gal)	Depth to Water =	7.83	(ft)
3X Water Volume =	1.20		(gal)	Water Column =	2.52	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C], °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1025	0.40	7.26	7.54	1540	12.13	123	1000+	brown
1028	0.80	6.15	7.29	1610	15.19	92	1000+	↓
1031	1.20	5.91	7.37	1620	15.46	74	1000+	↓
								NCM

Volume Purged: 1.20 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/13/12	1035	ALS
Cations	500 mL Plastic	HNO_3	3/13/12	1035	ALS
Anions	500 mL Plastic	none	3/13/12	1035	ALS
DOC	125 mL Amber	H_2SO_4	3/13/12	1035	ALS
NO_2, NO_3	1 L Plastic	none	3/13/12	1035	TA
Total Dissolved Solids	1 L Plastic	none	3/13/12	1035	TA
Ferrous Iron	1 L Plastic	none	3/13/12	1035	TA
Ferric Iron	500 mL Plastic	HNO_3	3/13/12	1035	TA
Sulfide	250 mL Plastic	ZnAc	3/13/12	1035	TA
					NCM

Comments:

Stoller

Sample Location:	CSMRI - 9
Date:	3/14/12
Project Name:	Colorado School of Mines
Project Number:	4349-430
Sample Type:	[✓ GW] SW EB Dup
Sampler:	Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD = 33.04	(ft)	(+.28)	TD = 33.32		(ft)
Initial Water Volume = 1.07		(gal)	Depth to Water = 26.63		(ft)
3X Water Volume = 3.21		(gal)	Water Column = 6.69		(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	(°C, °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1002	1.07	12.53	6.79	1270	10.58	173	1000+	Brown
1004	2.14	12.55	6.73	1290	10.56	174	1000+	Brown
1006	3.21	12.57	6.81	1320	9.68	174	1000+	Brown
								NCM

Volume Purged: 3.21 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	1010	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	1010	ALS
Anions	500 mL Plastic	none	3/14/12	1010	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	1010	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	1010	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	1010	TA
					NCM

Comments:

Stoller

Sample Location:	CSMRI-10
Date:	3/14/12
Project Name:	Colorado School of Mines
Project Number:	4349-430
Sample Type:	[✓ GW] SW EB Dup
Sampler:	Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	27.86	(ft)	(+.28)	TD =	28.14	(ft)
Initial Water Volume =	0.60		(gal)	Depth to Water =	24.42	(ft)
3X Water Volume =	1.80		(gal)	Water Column =	3.72	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp ([✓ °C]/°F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
0924	0.60	10.60	6.41	1200	11.13	176	1000+	Grey
0927	1.20	10.67	6.50	1200	10.83	171	679	↓
0930	1.80	10.95	6.58	1200	10.67	170	568	

Volume Purged: 1.8 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	0935	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	0935	ALS
Anions	500 mL Plastic	none	3/14/12	0935	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	0935	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	0935	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	0935	TA

Comments:

Stoller

Sample Location: CSMRI-11B
Date: 3/13/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	37.39	(ft)	(+.28)	TD =	37.67	(ft)
Initial Water Volume =	3.72 ↑ NCM	(gal)		Depth to Water =	29.91	(ft)
3X Water Volume =	1.24 ↓	(gal)		Water Column =	7.76	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C], °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
0953	1.24	12.33	7.16	1510	13.05	126	1000+	brown
0956	2.48	12.35	7.06	1230	11.71	114	1000+	↓
0959	3.72	12.28	7.12	1290	11.99	124	1000+	↓
								NCM

Volume Purged: 3.72 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/13/12	1005	ALS
Cations	500 mL Plastic	HNO_3	3/13/12	1005	ALS
Anions	500 mL Plastic	none	3/13/12	1005	ALS
DOC	125 mL Amber	H_2SO_4	3/13/12	1005	ALS
NO_2, NO_3	1 L Plastic	none	3/13/12	1005	TA
Total Dissolved Solids	1 L Plastic	none	3/13/12	1005	TA
					NCM

Comments:

Stoller

Sample Location: CSMRI-12
Date: 3/13/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	10.08	(ft)	(+.28)	TD =	10.36	(ft)
Initial Water Volume =	0.96		(gal)	Depth to Water =	4.37	(ft)
3X Water Volume =	2.88		(gal)	Water Column =	5.99	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1050	0.96	6.90	7.52	1220	16.25	50	710	Brown
1053	1.92	6.29	7.35	1310	16.57	47	1000+	Brown
1056	2.88	6.23	7.31	1350	16.46	45	1000+	Grey

Volume Purged: 2.88 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/13/12	1110	ALS
Cations	500 mL Plastic	HNO_3	3/13/12	1110	ALS
Anions	500 mL Plastic	none	3/13/12	1110	ALS
DOC	125 mL Amber	H_2SO_4	3/13/12	1110	ALS
NO_2, NO_3	1 L Plastic	none	3/13/12	1110	TA
Total Dissolved Solids	1 L Plastic	none	3/13/12	1110	TA
Ferrous Iron	1 L Plastic	none	3/13/12	1110	TA
Ferric Iron	500 mL Plastic	HNO_3	3/13/12	1110	TA
Sulfide	250 mL Plastic	ZnAc	3/13/12	1110	TA

Comments:

Stoller

Sample Location: CSMRI-13
Date: 3/13/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	10.12 (ft)	(+.28)	TD =	10.40	(ft)
Initial Water Volume =	0.98	(gal)	Depth to Water =	4.33	(ft)
3X Water Volume =	2.94	(gal)	Water Column =	6.07	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
11	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1111	0.98	6.56	7.38	1490	16.75	129	1000+	Grey
1114	1.96	6.43	7.17	1360	16.29	129	1000+	Brown
1117	2.94	6.25	7.20	1320	16.14	98	1000+	Brown

Volume Purged: 2.94 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/13/12	1140	ALS
Cations	500 mL Plastic	HNO_3	3/13/12	1140	ALS
Anions	500 mL Plastic	none	3/13/12	1140	ALS
DOC	125 mL Amber	H_2SO_4	3/13/12	1140	ALS
NO_2, NO_3	1 L Plastic	none	3/13/12	1140	TA
Total Dissolved Solids	1 L Plastic	none	3/13/12	1140	TA
Ferrous Iron	1 L Plastic	none	3/13/12	1140	TA
Ferric Iron	500 mL Plastic	HNO_3	3/13/12	1140	TA
Sulfide	250 mL Plastic	ZnAc	3/13/12	1140	TA

Comments:

Stoller

Sample Location: CSMRI-14
Date: 3/13/12, 3/14/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: [✓ GW] SW EB Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	56.98	(ft)	(+.28)	TD =	57.26	(ft)
Initial Water Volume =	8.63		(gal)	Depth to Water =	3.28	(ft)
3X Water Volume =	25.86		(gal)	Water Column =	53.98	(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1310	4.31	12.65	7.99	487	15.58	143	309	Clear
1320	8.62	12.60	8.04	445	14.42	128	938	Grey
1331	12.93	12.36	8.20	431	13.89	-72	1000+	Grey
	17.24							
	21.55							
	25.86							

Volume Purged: 13.50 (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	1015	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	1015	ALS
Anions	500 mL Plastic	none	3/14/12	1015	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	1015	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	1015	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	1015	TA

Comments: well dewatered @ 13.5 gal on 3/13/12

Stoller

Sample Location: SW-1

Date: 3/14/12

Project Name: Colorado School of Mines

Project Number: 4349-430

Sample Type: GW [✓ SW] EB Dup

Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	(ft)	(+.28)	TD =	(ft)	
Initial Water Volume =	NM	(gal)	Depth to Water =	(ft)	
3X Water Volume =		(gal)	Water Column =	(ft)	NM

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1352	n/A	6.31	8.07	484	14.79	152	83.7	clear
								NM

Volume Purged: n/A (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	1400	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	1400	ALS
Anions	500 mL Plastic	none	3/14/12	1400	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	1400	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	1400	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	1400	TA
					NM

Comments:

Stoller

Sample Location:	SW-2
Date:	3/14/12
Project Name:	Colorado School of Mines
Project Number:	4349-430
Sample Type:	GW [✓ SW] EB Dup
Sampler:	Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =		(ft) (+.28)	TD =		(ft)
Initial Water Volume =	NCM	(gal)	Depth to Water =		(ft) NCM
3X Water Volume =		(gal)	Water Column =		(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C] °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
0940	n/A	2.8	7.32	451	14.96	146	314	Clear
								NCM

Volume Purged: n/A (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	0950	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	0950	ALS
Anions	500 mL Plastic	none	3/14/12	0950	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	0950	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	0950	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	0950	TA
					NCM

Comments:

Stoller	Sample Location: SW - 3
	Date: 3/14/11
	Project Name: Colorado School of Mines
	Project Number: 4349-430
	Sample Type: GW [✓ SW] EB Dup
	Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	(ft)	(+.28)	TD =	(ft)
Initial Water Volume = NZM		(gal)	Depth to Water =	(ft)
3X Water Volume =		(gal)	Water Column =	(ft) NZM

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	([✓ °C]/°F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
1020	N/A	3.88	7.95	498	15.81	194	256	Clear
								NZM

Volume Purged: N/A (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/14/12	1020	ALS
Cations	500 mL Plastic	HNO_3	3/14/12	1020	ALS
Anions	500 mL Plastic	none	3/14/12	1020	ALS
DOC	125 mL Amber	H_2SO_4	3/14/12	1020	ALS
NO_2, NO_3	1 L Plastic	none	3/14/12	1020	TA
Total Dissolved Solids	1 L Plastic	none	3/14/12	1020	TA
					NZM

Comments:

Stoller

Sample Location: Equipment Blank
Date: 3/15/12
Project Name: Colorado School of Mines
Project Number: 4349-430
Sample Type: GW SW [✓ EB] Dup
Sampler: Nick Malczyk, Pete Dalen

Purge Volume Calculations

Measured TD =	(ft)	(+.28)	TD =		(ft)
Initial Water Volume =	ncm	(gal)	Depth to Water =	ncm	(ft)
3X Water Volume =		(gal)	Water Column =		(ft)

Purge Volumes and Field Water Quality Measurements

Time	Volume	Temp	pH	Conductivity	DO	ORP	Turbidity	Appearance
	(gal)	(°C, °F)	(SU)	(uS/cm)	(mg/L)	(mV)	(NTU)	
								ncm

Volume Purged: n/A (gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	Lab
Ra-226, -228, Diss. Uranium	1 gallon Cube	HNO_3	3/15/12	1115	ALS
Cations	500 mL Plastic	HNO_3	3/15/12	1115	ALS
Anions	500 mL Plastic	none	3/15/12	1115	ALS
DOC	125 mL Amber	H_2SO_4	3/15/12	1115	ALS
NO_2, NO_3	1 L Plastic	none	3/15/12	1115	TA
Total Dissolved Solids	1 L Plastic	none	3/15/12	1115	TA
					ncm

Comments:

Appendix C
Surface Water Sampling Procedures

Surface Water Sampling

1.0 Scope and Objective

1.1 Scope

This procedure provides instructions and establishes requirements for the collection and documentation of surface water samples by Stoller personnel. This procedure applies to the collection of surface water samples from streams, rivers, ponds, lakes, seeps, impoundments, and other surface sources.

1.2 Objective

The objective of this procedure is to establish a uniform method for the collection of surface water samples that provides representative samples in a safe and responsible manner.

2.0 Definitions

Composite Sample – A sample that is comprised of roughly equal amounts of water collected from a set of sample locations known as a sample group.

Grab Sample – A single sample collected at one sampling point over a short period of time. Grab sample results are representative of the sample location at the time of sample collection. Also called a catch sample.

Peristaltic Pump – A self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement which causes water to be drawn through the tubing. The peristaltic pump is limited to sampling at depths of less than 25 feet.

3.0 Responsibilities and Qualifications

3.1 Project Manager

The Project Manager is responsible for ensuring that surface water samples are properly and safely collected. This will be accomplished through staff training and by maintaining quality control (QC). At a minimum, project management shall:

3.1.1 Verify that personnel have reviewed, and are familiar with, site-specific work plans which address surface water sampling, this procedure, and any associated procedures.

3.1.2 Ensure that hazards are identified and analyzed with respect to collecting surface water samples, and develop and implement controls to minimize hazards.

3.1.3 Provide personnel with training in the operation of surface water sampling equipment and the requirements of this procedure.

3.1.4 Periodically review field generated documentation associated with surface water sampling to ensure compliance with project requirements and implement corrective action if necessary.

3.1.5 Receive feedback from field sampling personnel in order to continually improve surface water sampling process.

3.2 Site Supervisor

The Site Supervisor is responsible for directing and overseeing all field activities, including sampling, to ensure that site-specific plan requirements are met in a safe and efficient manner within the established safety envelope.

3.3 Field Sampling Personnel

Field sampling personnel are responsible for the proper sample collection and documentation of the sampling event in accordance with this procedure. At a minimum, field sampling personnel have the responsibility to:

3.3.1 Familiarize themselves with site-specific work plans, surface water sampling procedures, potential hazards, and health and safety plan.

3.3.2 Implement the controls to minimize hazards.

3.3.3 Be familiar with sampling equipment and its proper use.

3.3.4 Properly complete field documentation.

3.3.5 Provide feedback to project manager in order to improve sampling process.

4.0 Equipment/Materials and Calibration

4.1 Equipment/Materials

A number of devices are available for the collection of surface water samples. These devices are constructed of a number of materials including, but not limited to: stainless steel, glass, Teflon®, Tygon®. The sampling and analytical requirements, as well as site characteristics, must be taken into account when determining the proper surface water sampling equipment to use. The site-specific work plans should identify the specific equipment to be used, and methods for safely using equipment.

4.2 Calibration

Equipment shall be calibrated in accordance with manufacturer's recommendations and calibration documentation shall be maintained in project files.

5.0 Method

5.1 Field Preparation

Field preparation requires the organization of sample containers, sample labels, and documentation in an orderly, systematic manner to promote consistency and traceability of all data.

5.1.1 General sampling areas will be predetermined to ensure coverage of the various impact scenarios and should be described in project-specific work plans. The location of each sampling point shall be surveyed or mapped and staked as described in Section 5.1.6 prior to sampling.

5.1.2 In flowing water, surface water sampling shall be conducted from downstream locations first, then proceed to upstream locations to avoid potential cross contamination from disturbing the substrate.

5.1.3 Prior to sampling and between sampling locations, sampling equipment shall be decontaminated.

5.1.4 Appropriate personal protective equipment shall be used, as specified in the project-specific health and safety plan.

5.1.5 All pertinent information (date, site name, identification number, and location) shall be recorded on a Field Activity Daily Log (FADL) and a Sample Collection Log, as appropriate. Field conditions, unusual circumstances, and weather conditions shall be noted.

5.1.6 Due to the nature of sampling an aqueous environment, additional steps are required to verify and mark sample locations. Depending on the project needs, it may be useful to use a Global Positioning System (GPS) to verify and mark the sample locations. Refer to *Field Mapping with a Global Positioning System* for details. The following steps shall be followed by the sampler in addition to the field preparation requirements described in Section 5.1.1.

5.1.6.1 Place a marker (stake) on the shore approximately perpendicular to the sampling location and mark the sample number on the stake.

5.1.6.2 If the sample location is accessible by foot, use a measuring tape to measure the distance between the marked point and the sample location station. Record the compass bearing from the sample location to the shore marker.

5.1.6.3 If the sample location is accessible only by boat, use a rangefinder to estimate the distance to the shore marker to obtain the most accurate measurement. Record the compass bearing from the sample location to the shore marker. It is recommended that the boat's position on the water be stabilized to prevent drifting.

5.1.6.4 Determine and record the distance and direction of each shore marker from a reference point shown on the topographic map and mark all points on a map or use a GPS, if available.

5.1.7 Quality Control samples, including field and source blanks, shall be collected in accordance with the project-specific work plan.

5.2 Surface Water Sample Collection Using a Transfer Container

The device most commonly used to collect grab surface water samples is a transfer container (beaker, flask, etc.) made of inert material such as glass, stainless steel or Teflon®. When sampling with a transfer container, the procedure is as follows:

5.2.1 Survey and clearly map sampling points as described in Section 5.1.6 prior to sampling. The sample should be collected as close to the mapped location as possible. If the collection point must be moved, the new location must be approved and documented.

5.2.2 Dip the transfer container into the surface water. Always use a clean, properly decontaminated transfer container at each sample location.

5.2.3 Filter the sample if required.

5.2.4 Fill the sample bottle, allowing the sample stream to flow gently down the inside of the bottle with minimal turbulence.

5.2.5 Cap the bottle and handle the sample according to the procedures outlined in Project *Sample Shipping*.

5.2.6 Label the sample and document the sampling event.

5.3 Surface Water Sample Collection Using a Peristaltic Pump

A device used to collect composite surface water samples is a peristaltic pump. Samples to be analyzed for volatile organic analysis cannot be composited. When sampling with a peristaltic pump, the procedure is as follows:

5.3.1 Survey and clearly map sampling points as described in Section 5.1.6 prior to sampling. The sample should be collected as close to the mapped location as possible. If a collection point must be moved, the new location must be approved and documented.

5.3.2 Attach the appropriate tubing to the peristaltic pump. Always use new tubing at each sample location. Do not try to decontaminate and reuse tubing.

5.3.3 If filtering is required, attach the filtering device to the discharge end of the tubing.

5.3.4 Lower the intake end of the tubing into the water and begin pumping. If the pump is computerized, program the pump to collect the sample at the desired intervals and flow rate. If the pump is not programmable, record the discharge rate (compute discharge rate by dividing an amount of water collected by the time it took to collect it). Collect the sample at the desired interval.

5.3.5 Fill the sample bottle, allowing the sample stream to flow gently down the inside of the bottle with minimal turbulence. The programmable pump will perform this automatically.

5.3.6 Cap the bottle and handle the sample according to the procedures outlined in Project *Sample and Shipping*.

5.3.7 Label the sample and document the sampling event.

6.0 Required Inspection/Acceptance Criteria

None.

7.0 Records

The following records generated as a result of implementation of this procedure shall be maintained in a safe manner and submitted to project central files for storage and disposition.

Field Activity Daily Log

Sample Collection Log

Chain of Custody

8.0 References

8.1 Others

U.S. Environmental Protection Agency. 1987. *EPA Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14. Washington, DC.

U.S. Environmental Protection Agency. 1988. *EPA Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01. Washington, DC.

American Public Health Association, American Water Works Association, Water Pollution Control Federation. 1985. *Standard Methods for the Examination of Water and Wastewater*, 16th Edition, American Public Health Association, Washington, DC.

Appendix D
Data Validation Reports

DATA VALIDATION REPORT

To:	Nick Malczyk
From:	John Garrett
Date:	April 10, 2012
Project/Site:	Colorado School of Mines
Project No.:	4349-430
SDG No.:	1203202 Inorganic Wet Chemistry

This report presents the inorganic anions data validation for the data obtained for eighteen CSMRI water samples collected on March 13, 2012, March 14, 2012, and March 15, 2012 and submitted to ALS Laboratory Group on March 16, 2012 for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the inorganic anions results that were obtained by preparation method MCAWW, May 1994, and EMSL Rev 2.1 Alkalinity, Bicarbonate, and Carbonate by Method 310.1 ALS SOP 1106R10, Sulfate, and Chloride by Method 300.0 Rev 2.1 ALS SOP 1113R12 from ALS Laboratory Group. (Fort Collins, CO). The water samples were analyzed for Bicarbonate, Carbonate, Total Alkalinity, on March 21, 2012 and Sulfate, and Chloride on March 19, 2012. All analyses were conducted by ALS Laboratory Group. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-1	1203202-1	Water	March 14, 2012
CSMRI-1B	1203202-2	Water	March 15, 2012
CSMRI-2	1203202-3	Water	March 15, 2012
CSMRI-4	1203202-4	Water	March 13, 2012
CSMRI-5	1203202-5	Water	March 13, 2012
CSMRI-6C	1203202-6	Water	March 13, 2012
CSMRI-7C	1203202-7	Water	March 14, 2012
CSMRI-8B	1203202-8	Water	March 13, 2012
CSMRI-9	1203202-9	Water	March 14, 2012
CSMRI-10	1203202-10	Water	March 14, 2012
CSMRI-11B	1203202-11	Water	March 13, 2012
CSMRI-12	1203202-12	Water	March 13, 2012
CSMRI-13	1203202-13	Water	March 13, 2012
CSMRI-14	1203202-14	Water	March 14, 2012
SW-1	1203202-15	Water	March 14, 2012
SW-2	1203202-16	Water	March 14, 2012
SW-3	1203202-17	Water	March 14, 2012
Equipment Blank	1203202-18	Water	March 15, 2012

Data validation was conducted in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

The Inorganic data were evaluated based on the following parameters:

∗ Data Completeness
∗ Holding Times and Preservation
∗ Initial and Continuing Calibration Verification
∗ Contract Required Detection Limit (CRDL)
* Preparation/ Initial (ICB)/ and Continuing (CCB) Calibration Blanks
∗ Interference Check Sample (ICSA) Results
∗ Matrix Spike Results
∗ Duplicate Sample Results
∗ Laboratory Control Samples (LCS) Results
* Serial Dilution Sample Results
∗ Compound Quantitation and Reporting Limits (full validation only)

∗ All criteria were met for this parameter

Data Completeness

The data package was complete. No results were qualified as a result of the missing data.

Holding Times and Preservation

The water samples were received intact at cooler temperatures 3.8ºC and 5.4ºC. The samples were field filtered and pH <2 at time of receipt.

Initial and Continuing Calibration Verification

Initial and Continuing Calibration Verification standards were analyzed at the required frequency and all were within the required 90-110%. No action was necessary.

Contract Required Detection Limit (CRDL)

All CRDL %Rs CRI %Rs were within 80-120% limits. No action was necessary.

Preparation and Initial/ Continuing Calibration Blanks

Preparation and Initial/Continuing Calibration Blank analyses were performed at the required frequency. Preparation and Initial/ Continuing Calibration Blanks are evaluated to assess the level of contamination in the preparation and analytical processes.

Preparation and Initial/ Continuing Calibration Blanks were prepared and analyzed at the required frequencies.

All of the blanks that were analyzed had concentrations that were below their respective Reporting Limits (RLs).

However, if blank results were above the Instrument Detection Limits (IDLs) and below the RLs, it caused the associated sample results to be qualified for contamination as estimated and non-detected **[UJ 107]**. If blank results were below the negate IDL and above the negate RL, it caused the associated sample results to be qualified for negative contamination as estimated **[J 107]**. No sample results were qualified due to blank contamination.

Matrix Spike/Matrix Spike Duplicate Results

MS/MSD analyses were performed at the required frequency. All MS/MSD percent recoveries were within 75-125% limits.

The chloride concentration was above the analytical range in the native sample CSMRI-1 and MS/MSD recoveries could not be evaluated. The associated LCS, ICV, and CCV results were within control limits and no action was necessary.

Duplicate Sample Analysis

Duplicate analyses were performed at the required frequency. All original sample/duplicate sample and MS/MSD differences were less than 20% RPD or less than the RDL for results less than (5)(RDL). No actions were necessary.

Laboratory Control Samples

LCS analyses were performed at the required frequency. The laboratory analyzed laboratory control samples for all analytes. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

All %Ds were less than 10% for all analytes.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

Samples 1203202-1 through 1203202-13 and 1203202-15 through 1203202-17 were analyzed at a dilution in order to bring chloride and sulfate concentrations into analytical range of the IC. The laboratory elevated the reporting limits accordingly.

Reduced aliquots were used for samples 1203202-1 through 1203202-14 for alkalinity, bicarbonate, and carbonate with elevated reporting limits.

The chloride concentration was above the analytical range in the native sample CSMRI-1B and MS/MSD recoveries could not be evaluated. The associated LCS, ICV, and CCV results were within control limits and no action was necessary.

The results as reported are accepted without qualification.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is “rejected.” Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To: Nick Malczyk
From: John Garrett
Date: April 11, 2012
Project/Site: Colorado School of Mines
Project No.: 4349-430
SDG No.: 1203202 Metals

This report presents the inorganic metals data validation for the data obtained for eighteen water samples collected on March 13, 2012, March 14, 2012, and March 15, 2012 and submitted to ALS Laboratory Group on March 16, 2012 for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the inorganic metals results that were obtained by SW-846, 3rd edition, Method 6010B and ALS Laboratory Group SOP 834R8 for trace metals by Inductively Coupled Plasma (ICP) atomic emission spectrometry analysis, Dissolved Uranium by Method 6020A ALS Laboratory Group Procedure SOP 827R8 by Inductively Coupled Plasma mass spectrometry (ICP-MS) for SDG 1203202 by ALS Laboratory Group (Fort Collins, CO). The Dissolved ICP metals were extracted on March 21, 2012 and analyzed on March 22, 2012 and Uranium by ICP-MS were extracted and analyzed on March 22, 2012. All analyses were conducted by ALS Laboratory Group. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-1	1203202-1	Water	March 14, 2012
CSMRI-1B	1203202-2	Water	March 15, 2012
CSMRI-2	1203202-3	Water	March 15, 2012
CSMRI-4	1203202-4	Water	March 13, 2012
CSMRI-5	1203202-5	Water	March 13, 2012
CSMRI-6C	1203202-6	Water	March 13, 2012
CSMRI-7C	1203202-7	Water	March 14, 2012
CSMRI-8B	1203202-8	Water	March 13, 2012
CSMRI-9	1203202-9	Water	March 14, 2012
CSMRI-10	1203202-10	Water	March 14, 2012
CSMRI-11B	1203202-11	Water	March 13, 2012
CSMRI-12	1203202-12	Water	March 13, 2012
CSMRI-13	1203202-13	Water	March 13, 2012
CSMRI-14	1203202-14	Water	March 14, 2012
SW-1	1203202-15	Water	March 14, 2012
SW-2	1203202-16	Water	March 14, 2012
SW-3	1203202-17	Water	March 14, 2012
Equipment Blank	1203202-18	Water	March 15, 2012

Data validation was conducted in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

The metals data were evaluated based on the following parameters:

∗ Data Completeness
∗ Holding Times and Preservation
∗ Initial and Continuing Calibration Verification
∗ Contract Required Detection Limit (CRDL)
Preparation/ Initial (ICB)/ and Continuing (CCB) Calibration Blanks
∗ Interference Check Sample (ICSA) Results
∗ Matrix Spike Results
∗ Duplicate Sample Results
∗ Laboratory Control Samples (LCS) Results
Serial Dilution Sample Results
∗ Compound Quantitation and Reporting Limits (full validation only)

∗ All criteria were met for this parameter

Data Completeness

The data package was complete except for the missing CRDL (2B) and IDL (10) QC Summary Forms. No results were qualified as a result of the missing data.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met with the following exception:

The water samples were received intact at cooler temperature of 3.8ºC and 5.4ºC. The samples were field filtered and pH <2 at time of receipt.

Initial and Continuing Calibration Verification

Initial and Continuing Calibration Verification standards were analyzed at the required frequency and all were within the required 90-110% limits for ICP. No action was necessary.

Contract Required Detection Limit (CRDL)

No CRDL or CRI standard recovery summary forms (EPA Form 2b) were included in the data package. The reviewer obtained the %Rs from the instrument raw data. All CRDL %Rs for ICP were within 80-120% limits. No action was necessary.

Preparation and Initial/ Continuing Calibration Blanks

Preparation and Initial/Continuing Calibration Blank analyses were performed at the required frequency. Preparation and Initial/ Continuing Calibration Blanks are evaluated to assess the level of contamination in the preparation and analytical processes.

Preparation and Initial/ Continuing Calibration Blanks were prepared and analyzed at the required frequencies.

All of the blanks that were analyzed had concentrations that were below their respective Reporting Limits (RLs).

However, if blank results were above the Instrument Detection Limits (IDLs) and below the RLs, it caused the associated sample results to be qualified for contamination as estimated and non-detected **[UJ 107]**. If blank results were below the negative IDL and above the negative RL, it caused the associated sample results to be qualified for negative contamination as estimated **[J 107]**. No sample results were qualified due to blank contamination.

Interference Check Sample (ICSA) Results

Interference Check Samples were prepared and analyzed at the required frequencies. No action was necessary.

Matrix Spike/Matrix Spike Duplicate Results

MS/MSD analyses were performed at the required frequency. All ICP and ICP-MS percent recoveries were within 75-125% limits.

Duplicate Sample Analysis

Duplicate analyses were performed at the required frequency. All ICP and ICP-MS original sample/duplicate sample and MS/MSD differences were less than 20% RPD or less than the RDL for results less than (5)(RDL).

Laboratory Control Samples

LCS analyses were performed at the required frequency. The laboratory analyzed laboratory control samples for all metals. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

All Serial Dilutions %Ds were less than 10% and all acceptance criteria were met with the exception of Sodium in sample CSMRI-1 at 13% which at greater than 50X the IDL is qualified as Estimated (J).

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

No CRDL or CRI standard recovery summary forms (EPA Form 2b) were included in the data package. The reviewer obtained the results from the raw data. No action was necessary.

The Serial Dilution for Sodium in sample CSMRI-1 was 13% and greater than 50X the IDL is qualified as Estimated (J).

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R	-	Reported value is "rejected." Resampling or reanalysis may be necessary to verify the presence or absence of the compound.
J	-	The associated numerical value is an estimated quantity because the Quality Control criteria were not met.
U J	-	The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.
U	-	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
NR	-	Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To: Nick Malczyk
From: John Garrett
Date: April 10, 2012
Project/Site: Colorado School of Mines
Project No.: 4349-430
SDG No.: 1203202 DOC

This report presents the Dissolved Organic Carbon data validation for the data obtained for eighteen CSMRI water samples collected on March 13, 2012, March 14, 2012, and March 15, 2012 and submitted to ALS Laboratory Group on March 16, 2012 for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of Dissolved Organic Carbon results that were obtained by MCAWW, May 1994, Method 415.1, SOP 670R14 from ALS Laboratory Group (Fort Collins, CO). The water samples were analyzed March 22, 2012. All analyses were conducted by ALS Laboratory Group. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-1	1203202-1	Water	March 14, 2012
CSMRI-1B	1203202-2	Water	March 15, 2012
CSMRI-2	1203202-3	Water	March 15, 2012
CSMRI-4	1203202-4	Water	March 13, 2012
CSMRI-5	1203202-5	Water	March 13, 2012
CSMRI-6C	1203202-6	Water	March 13, 2012
CSMRI-7C	1203202-7	Water	March 14, 2012
CSMRI-8B	1203202-8	Water	March 13, 2012
CSMRI-9	1203202-9	Water	March 14, 2012
CSMRI-10	1203202-10	Water	March 14, 2012
CSMRI-11B	1203202-11	Water	March 13, 2012
CSMRI-12	1203202-12	Water	March 13, 2012
CSMRI-13	1203202-13	Water	March 13, 2012
CSMRI-14	1203202-14	Water	March 14, 2012
SW-1	1203202-15	Water	March 14, 2012
SW-2	1203202-16	Water	March 14, 2012
SW-3	1203202-17	Water	March 14, 2012
Equipment Blank	1203202-18	Water	March 15, 2012

Data validation was conducted in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (CLP).

The Dissolved Organic Carbon data were evaluated based on the following parameters:

- ∗ Data Completeness
- ∗ Holding Times and Preservation
- ∗ Initial and Continuing Calibration Verification
- ∗ Contract Required Detection Limit (CRDL)
- * Preparation/ Initial (ICB)/ and Continuing (CCB) Calibration Blanks
- ∗ Interference Check Sample (ICSA) Results
- ∗ Matrix Spike Results
- ∗ Duplicate Sample Results
- ∗ Laboratory Control Samples (LCS) Results
- * Serial Dilution Sample Results
- ∗ Compound Quantitation and Reporting Limits (full validation only)

∗ **All criteria were met for this parameter**

Data Completeness

The data package was complete. No results were qualified as a result of the missing data.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met.

The water samples were received intact at cooler temperatures 3.8ºC and 5.4ºC. The samples were field filtered and pH <2 at time of receipt.

Initial and Continuing Calibration Verification

Initial and Continuing Calibration Verification standards were analyzed at the required frequency and all were within the required 90-110%. No action was necessary.

Contract Required Detection Limit (CRDL)

All CRDL %Rs CRI %Rs were within 80-120% limits. No action was necessary.

Preparation and Initial/ Continuing Calibration Blanks

Preparation and Initial/Continuing Calibration Blank analyses were performed at the required frequency. Preparation and Initial/ Continuing Calibration Blanks are evaluated to assess the level of contamination in the preparation and analytical processes.

Preparation and Initial/ Continuing Calibration Blanks were prepared and analyzed at the required frequencies.

All of the blanks that were analyzed had concentrations that were below their respective Reporting Limits (RLs).

However, if blank results were above the Instrument Detection Limits (IDLs) and below the RLs, it caused the associated sample results to be qualified for contamination as estimated and non-detected **[UJ 107]**. If blank results were below the negate IDL and above the negate RL, it caused the associated sample results to be qualified for negative contamination as estimated **[J 107]**. No sample results were qualified due to blank contamination.

Matrix Spike/Matrix Spike Duplicate Results

Due to insufficient sample volume a MS and MSD were not performed.

Duplicate Sample Analysis

The laboratory analyzed a LSC and LCSD in lieu of client sample duplicate. The duplicate analyses were performed at the required frequency. All original sample/duplicate sample and MS/MSD differences were less than 20% RPD or less than the RDL for results less than (5)(RDL). No actions were necessary.

Laboratory Control Samples

LCS analyses were performed at the required frequency. The laboratory analyzed laboratory control samples for all analytes. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

No dilutions were required.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

The overall data are acceptable as reported.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is “rejected.” Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To:	Nick Malczyk
From:	John Garrett
Date:	April 11, 2012
Project/Site:	Colorado School of Mines
Project No.:	4349-430
SDG No.:	1203202 Radium-226

This report presents the radiological data validation for the data obtained during the field activities for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the radiological results that were obtained by ALS Laboratory Group Procedure SOP 783R9 for Radium-226 by Radon Emanation Counting for SDG 1203202 from ALS Laboratory Group (Fort Collins, CO). This report consists of eighteen water samples for the Colorado School of Mines/4349-430 project collected on March 13, 2012, March 14, 2012, and March 15, 2012 and submitted to ALS Laboratory Group on March 16, 2012 for the above referenced work assignment. The samples were analyzed for Radium-226 by Radon Emanation Counting Method 903.1 on March 28, 2012. The analysis was conducted by ALS Laboratory Group. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-1	1203202-1	Water	March 14, 2012
CSMRI-1B	1203202-2	Water	March 15, 2012
CSMRI-2	1203202-3	Water	March 15, 2012
CSMRI-4	1203202-4	Water	March 13, 2012
CSMRI-5	1203202-5	Water	March 13, 2012
CSMRI-6C	1203202-6	Water	March 13, 2012
CSMRI-7C	1203202-7	Water	March 14, 2012
CSMRI-8B	1203202-8	Water	March 13, 2012
CSMRI-9	1203202-9	Water	March 14, 2012
CSMRI-10	1203202-10	Water	March 14, 2012
CSMRI-11B	1203202-11	Water	March 13, 2012
CSMRI-12	1203202-12	Water	March 13, 2012
CSMRI-13	1203202-13	Water	March 13, 2012
CSMRI-14	1203202-14	Water	March 14, 2012
SW-1	1203202-15	Water	March 14, 2012
SW-2	1203202-16	Water	March 14, 2012
SW-3	1203202-17	Water	March 14, 2012
Equipment Blank	1203202-18	Water	March 15, 2012

Data validation was conducted in accordance with the Analytical Services Statement of Work for the following modules: Gas Proportional Counting Module RC04-v2, October 1, 2002 and U.S. DOE Quality Systems for Analytical Services Revision 2.6 (QSAS).

The radiological data were evaluated based on the following parameters:

- Data Completeness
- Holding Times and Preservation
- Instrument Initial Calibrations
- Instrument Performance Checks
- Preparation Blanks
- Duplicate Sample Results
- Laboratory Control Samples (LCS) Results
- Laboratory Control Samples Duplicate (LCSD) Results
- Compound Quantitation and Reporting Limits (full validation only)

Data Completeness

The data package was complete as per ALS Laboratory Group Procedure SOP 783R9 for Radium-226 by Radon Emanation Counting Method 903.1.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met. However, holding time requirements are not applicable to radiochemistry analyses unless the isotopes of interest have short half-lives. The holding times for Radium-226 were met. No action was necessary.

Calibrations

The instruments were calibrated at the required frequency.

Initial Calibration

All instruments were calibrated properly using NIST traceable SRM.

Instrument Performance Checks

All isotopes were within criteria.

Preparation Blanks

Preparation/Method Blanks were performed at the required frequency. Radium-226 was not detected in the Method Blank above the MDC or the RDL.

Duplicate Sample Analysis

Due to limited sample volume a LCS and LCSD were prepared in lieu of a sample Duplicate. Duplicate analyses were performed at the required frequency. All isotopic activities for Radium-226 originals and duplicate analysis were within the limits of the statistical test for equivalency.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicates were not performed for the samples in this SDG.

Laboratory Control Samples

LCS analyses were performed at the required frequency. All recoveries were within 75-125% limits. No calculation errors or transcription errors were found.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

Overall, the data are of good quality and are usable as reported by the laboratory without qualification. All results are considered non-detected.

The laboratory reported that the ICP-AES measurement of the added barium carrier prior to chemical separation. Several samples showed barium concentrations less than zero. The laboratory manually adjusted the values to 0.0 in order to avoid a low bias. All QC criteria were within control limits and no action was necessary. The data are not affected.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is “rejected.” Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalysis.

DATA VALIDATION REPORT

To: Nick Malczyk
From: John Garrett
Date: April 11, 2012
Project/Site: Colorado School of Mines
Project No.: 4349-430
SDG No.: 1203202 Radium-228

This report presents the radiological data validation for the data obtained during the field activities for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the radiological results that were obtained by ALS Laboratory Group PA SOP 724R11 for Radium-228 by gas flow proportional counting for SDG 1203202 from ALS Laboratory Group (Fort Collins, CO). This report consists of eighteen water samples for the Colorado School of Mines/4349-430 project collected on March 13, 2012, March 14, 2012, and March 15, 2012 and submitted to ALS Laboratory Group on March 16, 2012 for the above referenced work assignment. The samples were analyzed for Radium-228 by Radon gas flow proportional counting (GFPC) on March 27, 2012 and March 29, 2012. All analyses were conducted by ALS Laboratory Group. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-1	1203202-1	Water	March 14, 2012
CSMRI-1B	1203202-2	Water	March 15, 2012
CSMRI-2	1203202-3	Water	March 15, 2012
CSMRI-4	1203202-4	Water	March 13, 2012
CSMRI-5	1203202-5	Water	March 13, 2012
CSMRI-6C	1203202-6	Water	March 13, 2012
CSMRI-7C	1203202-7	Water	March 14, 2012
CSMRI-8B	1203202-8	Water	March 13, 2012
CSMRI-9	1203202-9	Water	March 14, 2012
CSMRI-10	1203202-10	Water	March 14, 2012
CSMRI-11B	1203202-11	Water	March 13, 2012
CSMRI-12	1203202-12	Water	March 13, 2012
CSMRI-13	1203202-13	Water	March 13, 2012
CSMRI-14	1203202-14	Water	March 14, 2012
SW-1	1203202-15	Water	March 14, 2012
SW-2	1203202-16	Water	March 14, 2012
SW-3	1203202-17	Water	March 14, 2012
Equipment Blank	1203202-18	Water	March 15, 2012

Data validation was conducted in accordance with the Analytical Services Statement of Work for the following modules: Gas Proportional Counting Module RC04-v2, October 1, 2002 and U.S. DOE Quality Systems for Analytical Services Revision 2.6 (QSAS).

The radiological data were evaluated based on the following parameters:

- Data Completeness
- Holding Times and Preservation
- Instrument Initial Calibrations
- Instrument Performance Checks
- Preparation Blanks
- Duplicate Sample Results
- Laboratory Control Samples (LCS) Results
- Laboratory Control Samples Duplicate (LCSD) Results
- Compound Quantitation and Reporting Limits (full validation only)

Data Completeness

The data package was complete as per ALS Laboratory Group Procedure SOP 724R11 for Radium-228 by Gas Flow Proportional Counting for SDG 1203202.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met. However, holding time requirements are not applicable to radiochemistry analyses unless the isotopes of interest have short half-lives. The holding times for Radium-228 were met. No action was necessary.

Calibrations

The instruments were calibrated at the required frequency.

Initial Calibration

All instruments were calibrated properly using NIST traceable SRM.

Instrument Performance Checks

All isotopes were within criteria.

Preparation Blanks

Preparation/Method Blanks were performed at the required frequency. Radium-228 was not detected in the Method Blank above the MDC or the RDL.

Duplicate Sample Analysis

Due to limited sample volume a LCS and LCSD were prepared in lieu of a sample Duplicate. All isotopic activities for Radium-228 analyses were within the limits of the statistical test for equivalency. No action was required.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicates were not performed for the samples in this SDG, nor were any required.

Laboratory Control Samples

LCS analyses were performed at the required frequency. All recoveries for the reanalyzed samples were within 75-125% limits. No calculation errors or transcription errors were found.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

The laboratory reported that the ICP-AES measurement of the added barium carrier prior to chemical separation had a concentration of less than the concentration added. The laboratory manually adjusted the values to the known concentration to calculate the chemical yield in order to avoid a low bias in all samples including the QC. All samples reported barium concentrations less than that known to be added. The results as reported are accepted without qualification.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is “rejected.” Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To:	Nick Malczyk
From:	John Garrett
Date:	April 13, 2012
Project/Site:	Colorado School of Mines
Project No.:	4349-430
SDG No.:	280-26562-1 (J6562-1) Wet Chemistry

This report presents the Wet Chemistry data verification for the data obtained for seven CSMRI water samples collected on March 13, 2012 and submitted to TestAmerica Laboratories, Inc. on March 13, 2012 for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the Wet Chemistry results that were obtained by MCAWW Method 300.0 Anions Nitrate as N and Nitrite as N, Total Dissolved Solids by method SM 2540 C, and Ferric Iron by method SM 3500 and Ferrous Iron by method SM 3500-FE D from TestAmerica Laboratories, Inc. (Arvada, CO). The water samples were analyzed for Nitrate as N and Nitrite as N on March 13, 2012, Total Dissolved Solids on March19, 2012, Ferrous Iron on March 14, 2012, and Ferric Iron on March 20, 2012. All analyses were conducted by TestAmerica Laboratories, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-6C	280-26562-1	Water	March 13, 2012
CSMRI-11B	280-26562-2	Water	March 13, 2012
CSMRI-8B	280-26562-3	Water	March 13, 2012
CSMRI-12	280-26562-4	Water	March 13, 2012
CSMRI-13	280-26562-5	Water	March 13, 2012
CSMRI-4	280-26562-6	Water	March 13, 2012
CSMRI-5	280-26562-7	Water	March 13, 2012

Data verification was conducted in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

The Wet Chemistry data were evaluated based on the following parameters:

- Data Completeness
- Holding Times and Preservation
- Preparation Blanks
- Matrix Spike Results
- Duplicate Sample Results
- Laboratory Control Samples (LCS) Results
- **All criteria were met for this parameter**

Data Completeness

The data package was complete for a standard deliverables only SDG (no Raw Data).

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met.

The water samples were received by the laboratory at 3.7°C and 2.8°C.

Preparation Blanks

Preparation Blanks are evaluated to assess the level of contamination in the preparation and analytical processes.

Preparation Blanks were prepared and analyzed at the required frequencies.

All of the blanks that were analyzed had concentrations that were below their respective Reporting Limits (RL's).

However, if blank results were above the Instrument Detection Limits (IDL's) and below the RL's, it caused the associated sample results to be qualified for contamination as estimated and non-detected **[UJ 107]**. If blank results were below the negative IDL and above the negative RL, it caused the associated sample results to be qualified for negative contamination as estimated **[J 107]**. No sample results were qualified due to blank contamination.

Matrix Spike/Matrix Spike Duplicate Results

All MS/MSD percent recoveries were within 75-125% limits. No action was necessary.

Duplicate Sample Analysis

All original sample/duplicate sample and MS/MSD differences were less than 20% RPD or less than the RDL for results less than (5)(RDL). No actions were necessary.

Laboratory Control Samples

The laboratory analyzed laboratory control samples for all analytes. All recoveries were within 80-120% limits. No action was necessary.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

All data were acceptable without qualification as received by the laboratory.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is “rejected.” Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

Appendix E
Results of Analyses CD

Appendix F
Chains of Custody

ALS Laboratory Group

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Chain-of-Custody

Form 202r8

WORKORDER #			
SAMPLER	N Malczyk	DATE	3/16/12
SITE ID		TURNAROUND	Standard
PAGE	1 of 8	DISPOSAL	[✓ By Lab] or Return to Client

PROJECT NAME	CO School of Mines	SAMPLER	N Malczyk
PROJECT No.	4349-430	SITE ID	
		EDD FORMAT	
		PURCHASE ORDER	
COMPANY NAME	Stoller	BILL TO COMPANY	
SEND REPORT TO	Nick Malczyk	INVOICE ATTN TO	
ADDRESS	105 Technology Dr #190	ADDRESS	
CITY / STATE / ZIP	Broomfield, CO 80021	CITY / STATE / ZIP	
PHONE	(303) 546-4313	PHONE	
FAX	(303) 443-1408	FAX	
E-MAIL	nmalczyk @ stoller.com	E-MAIL	

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	Radium-226, -228	Dissolved Uranium	Cations	Anions	DOC
	CSMRI-1	W	3/14/12	1340	1	2		X	X			
	CSMRI-1	W	3/14/12	1340	1	2				X		
	CSMRI-1	W	3/14/12	1340	1	—					X	
	CSMRI-1	W	3/14/12	1340	1	3						X
	CSMRI-1B	W	3/15/12	1045	1	2		X	X			
	CSMRI-1B	W	3/15/12	1045	1	2				X		
	CSMRI-1B	W	3/15/12	1045	1	—					X	
	CSMRI-1B	W	3/15/12	1045	1	3						X
	CSMRI-2	W	3/15/12	1130	1	2		X	X			
	CSMRI-2	W	3/15/12	1130	1	2				X		

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments: All samples were filtered
Anions – HCO_3, CO_3, Alkalinity, Cl, SO_4
Cations - Ca, Mg, K, Na

QC PACKAGE (check below)	
☐	LEVEL II (Standard QC)
☐	LEVEL III (Std QC + forms)
☒	LEVEL IV (Std QC + forms + raw data)
☐	

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Malczyk	3/16/12	1000
RECEIVED BY				
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		SAMPLER	N Melczyk	DATE	3/16/12
PROJECT NAME	CO School of Mines	SITE ID		TURNAROUND	Standard
PROJECT No.	4349-430	EDD FORMAT			
		PURCHASE ORDER			
COMPANY NAME	Stoller	BILL TO COMPANY			
SEND REPORT TO	~~Robert~~ MM Nick Melczyk	INVOICE ATTN TO			
ADDRESS	see page 1	ADDRESS			
CITY / STATE / ZIP	↓	CITY / STATE / ZIP			
PHONE	↓	PHONE			
FAX	↓	FAX			
E-MAIL	↓	E-MAIL			

WORKORDER #

PAGE 2 of 8

DISPOSAL [✓ By Lab] or Return to Client

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	Radium-226, 228	Dissolved Uranium	Cations	Anions	DOC
	CSMRI-2	W	3/15/12	1130	1	–					X	
	CSMRI-2	W	3/15/12	1130	1	3						X
	CSMRI-4	W	3/13/12	1200	1	2		X	X			
	CSMRI-4	W	3/13/12	1200	1	2				X		
	CSMRI-4	W	3/13/12	1200	1	–					X	
	CSMRI-4	W	3/13/12	1200	1	3						X
	CSMRI-5	W	3/13/12	1240	1	2		X	X			
	CSMRI-5	W	3/13/12	1240	1	2				X		
	CSMRI-5	W	3/13/12	1240	1	–					X	
	CSMRI-5	W	3/13/12	1240	1	3						X

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments:

see page 1

QC PACKAGE (check below)	
	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
X	LEVEL IV (Std QC + forms + raw data)

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Melczyk	3/16/12	1000
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WORKORDER #

		SAMPLER	N Malczyk	DATE	3/16/12	PAGE	3 of 8
PROJECT NAME	CO School of Mines	SITE ID		TURNAROUND	Standard	DISPOSAL	[✓ By Lab] or Return to Client
PROJECT No.	4349 -430	EDD FORMAT					
	see page 1	PURCHASE ORDER					
COMPANY NAME		BILL TO COMPANY					
SEND REPORT TO		INVOICE ATTN TO					
ADDRESS		ADDRESS					
CITY / STATE / ZIP		CITY / STATE / ZIP					
PHONE		PHONE					
FAX		FAX					
E-MAIL		E-MAIL					

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	Radium-226, -228	Dissolved Uranium	Cations	Anions	DOC
	CSMRI-6C	W	3/13/12	0915	1	2		X	X			
	CSMRI-6C	W	3/13/12	0915	1	2				X		
	CSMRI-6C	W	3/13/12	0915	1	–					X	
	CSMRI-6C	W	3/13/12	0915	1	3						X
	CSMRI-7C	W	3/14/12	0845	1	2		X	X			
	CSMRI-7C	W	3/14/12	0845	1	2				X		
	CSMRI-7C	W	3/14/12	0845	1	–					X	
	CSMRI-7C	W	3/14/12	0845	1	3						X
	CSMRI-8B	W	3/13/12	1035	1	2		X	X			
	CSMRI-8B	W	3/13/12	1035	1	2				X		

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments: see page 1

QC PACKAGE (check below)	
	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
X	LEVEL IV (Std QC + forms + raw data)

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Malczyk	3/16/12	1000
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

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WORKORDER #

SAMPLER N Malczyk
DATE 3/16/12
PAGE 4 of 8
SITE ID
TURNAROUND Standard
DISPOSAL [✓ By Lab] or Return to Client

PROJECT NAME CO School of Mines
PROJECT No. 4349-430
see page 1
COMPANY NAME
SEND REPORT TO
ADDRESS
CITY / STATE / ZIP
PHONE
FAX
E-MAIL

EDD FORMAT
PURCHASE ORDER
BILL TO COMPANY
INVOICE ATTN TO
ADDRESS
CITY / STATE / ZIP
PHONE
FAX
E-MAIL

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	Radium-226, -228	Dissolved Uranium	Cations	Anions	DOC
	CSMRI-8B	W	3/13/12	1035	1	–					X	
	CSMRI-8B	W	3/13/12	1035	1	3						X
	CSMRI-9	W	3/14/12	1010	1	2		X	X			
	CSMRI-9	W	3/14/12	1010	1	2				X		
	CSMRI-9	W	3/14/12	1010	1	–					X	
	CSMRI-9	W	3/14/12	1010	1	3						X
	CSMRI-10	W	3/14/12	0935	1	2		X	X			
	CSMRI-10	W	3/14/12	0935	1	2		no	~~X~~	X		
	CSMRI-10	W	3/14/12	0935	1	–					X	
	CSMRI-10	W	3/14/12	0935	1	3						X

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments: see page 1

QC PACKAGE (check below)	
	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
X	LEVEL IV (Std QC + forms + raw data)

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Malczyk	3/16/12	1000
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WORKORDER #:

		SAMPLER	N Malczyk	DATE	3/16/12	PAGE	5 of 8
PROJECT NAME	CO School of Mines	SITE ID		TURNAROUND	Standard	DISPOSAL	[✓ By Lab] or Return to Client
PROJECT No.	4349-4130	EDD FORMAT					
	see page 1	PURCHASE ORDER					
COMPANY NAME		BILL TO COMPANY					
SEND REPORT TO		INVOICE ATTN TO					
ADDRESS		ADDRESS					
CITY / STATE / ZIP		CITY / STATE / ZIP					
PHONE		PHONE					
FAX		FAX					
E-MAIL		E-MAIL					

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	Radium-226-228	Dissolved Uranium	Cations	Anions	DOC
	CSMRI-11B	W	3/13/12	1005	1	2		X	X			
	CSMRI-11B	W	3/13/12	1005	1	2				X		
	CSMRI-11B	W	3/13/12	1005	1	-					X	
	CSMRI-11B	W	3/13/12	1005	1	3						X
	CSMRI-12	W	3/13/12	1110	1	2		X	X			
	CSMRI-12	W	3/13/12	1110	1	2				X		
	CSMRI-12	W	3/13/12	1110	1	-					X	
	CSMRI-12	W	3/13/12	1110	1	3						X
	CSMRI-13	W	3/13/12	1140	1	2		X	X			
	CSMRI-13	W	3/13/12	1140	1	2				X		

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments: see page 1

QC PACKAGE (check below)	
	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
X	LEVEL IV (Std QC + forms + raw data)

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Malczyk	3/16/12	1000
RECEIVED BY				
RELINQUISHED BY				
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RELINQUISHED BY				
RECEIVED BY				

ALS Laboratory Group

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

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WORKORDER #	
SAMPLER	N Malcryk
DATE	3/16/12
PAGE	6 of 8
TURNAROUND	Standard
DISPOSAL	[✓ By Lab] or Return to Client
PROJECT NAME	CO School of Mines
PROJECT No.	4349-430
	see page 1
COMPANY NAME	
SEND REPORT TO	
ADDRESS	
CITY / STATE / ZIP	
PHONE	
FAX	
E-MAIL	
SITE ID	
EDD FORMAT	
PURCHASE ORDER	
BILL TO COMPANY	
INVOICE ATTN TO	
ADDRESS	
CITY / STATE / ZIP	
PHONE	
FAX	
E-MAIL	

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	Radium-226, 228	Dissolved Uranium	Cations	Anions	DOC
	CSMRI-13	U	3/13/12	1140	1	-					X	
	CSMRI-13	W	3/13/12	1140	1	3						X
	CSMRI-14	W	3/14/12	1015	1	2		X	X			
	CSMRI-14	W	3/14/12	1015	1	2				X		
	CSMRI-14	W	3/14/12	1015	1	-					X	
	CSMRI-14	W	3/14/12	1015	1	3						X
	SW-1	W	3/14/12	1400	1	2		X	X			
	SW-1	W	3/14/12	1400	1	2				X		
	SW-1	W	3/14/12	1400	1	-					X	
	SW-1	W	3/14/12	1400	1	3						X

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments: see page 1

QC PACKAGE (check below)	
	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
X	LEVEL IV (Std QC + forms + raw data)

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Malcryk	3/16/12	1000
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

ALS Laboratory Group

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

Form 202r8

WORKORDER #:

		SAMPLER	N Malczyk	DATE	3/16/12	PAGE	7 of 8
PROJECT NAME	CO School of Mines	SITE ID		TURNAROUND	Standard	DISPOSAL	[✓ By Lab] or Return to Client
PROJECT No.	4349-430	EDD FORMAT					
	see page 1	PURCHASE ORDER					
COMPANY NAME	↓	BILL TO COMPANY					
SEND REPORT TO		INVOICE ATTN TO					
ADDRESS		ADDRESS					
CITY / STATE / ZIP		CITY / STATE / ZIP					
PHONE		PHONE					
FAX		FAX					
E-MAIL		E-MAIL					

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	Radium-226, -228	Dissolved Uranium	Cations	Anions	DOC
	SW-2	W	3/14/12	0950	1	2		X	X			
	SW-2	W	3/14/12	0950	1	2				X		
	SW-2	W	3/14/12	0950	1	–					X	
	SW-2	W	3/14/12	0950	1	3						X
	SW-3	W	3/14/12	1020	1	2		X	X			
	SW-3	W	3/14/12	1020	1	2				X		
	SW-3	W	3/14/12	1020	1	–					X	
	SW-3	W	3/14/12	1020	1	3						X
	Equipment Blank	W	3/15/12	1115	1	2		X	X			
	Equipment Blank	W	3/15/12	1115	1	2				X		

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments: see page 1

QC PACKAGE (check below)

- ☐ LEVEL II (Standard QC)
- ☐ LEVEL III (Std QC + forms)
- ☒ LEVEL IV (Std QC + forms + raw data)

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Malczyk	3/16/12	1000
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

ALS Laboratory Group

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

Form 202r8

		SAMPLER	N Malczyk	DATE	3/16/12	PAGE	8 of 8
PROJECT NAME	CO School of Mines	SITE ID		TURNAROUND	Standard	DISPOSAL	[✓ By Lab] or Return to Client
PROJECT No.	4349-430	EDD FORMAT					
	see page 1	PURCHASE ORDER					
COMPANY NAME		BILL TO COMPANY					
SEND REPORT TO		INVOICE ATTN TO					
ADDRESS		ADDRESS					
CITY / STATE / ZIP		CITY / STATE / ZIP					
PHONE		PHONE					
FAX		FAX					
E-MAIL		E-MAIL					

WORKORDER #

Lab ID	Field ID	Matrix	Sample Date	Sample Time	# Bottles	Pres.	QC	~~Radium-226, 228~~ NEM	~~Dissolved Uranium~~ NEM	~~Cations~~ NEM	Anions	DOC															
	Equipment Blank	W	3/15/12	1115	1	–					X																
	Equipment Blank	W	3/15/12	1115	1	3						X															
																	NEM										

*Time Zone (Circle): EST CST [✓ MST] PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

For metals or anions, please detail analytes below.

Comments: see page 1

QC PACKAGE (check below)	
	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
☒	LEVEL IV (Std QC + forms + raw data)

Preservative Key: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaHSO4 7-Other 8-4 degrees C 9-5035

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Nick Malczyk	3/16/12	1000
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

Chain of Custody Record

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☒

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

4124 (0907)

Client: Stoller

Project Manager: Nick Malczyk

Date: 03/13/2012

Chain of Custody Number: 407095

Address: 105 Technology Dr #190

Telephone Number (Area Code)/Fax Number: (303) 546-4313

Lab Number:

Page 1 of 3

City: Broomfield

State: CO

Zip Code: 80021

Site Contact:

Lab Contact: Lisa Urell

Project Name and Location (State): CO School of Mines, Golden, CO

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

			Matrix					Containers & Preservatives							Analysis (Attach list if more space is needed)												Special Instructions/ Conditions of Receipt
Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH		NO2, NO3	TDS	Ferrous Fe	Ferric Fe	Sulfide								
CSMRI - 6C	3/13/12	0915		X				X							X												
CSMRI - 6C	3/13/12	0915		X				X								X											
CSMRI - 11B	3/13/12	1005		X				X							X												
CSMRI - 11B	3/13/12	1005		X				X								X											
CSMRI 8B	3/13/12	1035		X				X							X												
CSMRI 8B	3/13/12	1035		X				X								X											
CSMRI 8B	3/13/12	1035		X				X									X										
CSMRI 8B	3/13/12	1035		X						X								X									
CSMRI 8B	3/13/12	1035		X									X						X								
CSMRI 12	3/13/12	1110		X				X							X												
CSMRI 12	3/13/12	1110		X				X								X											
CSMRI 12	3/13/12	1110		X				X									X										

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other ______

QC Requirements (Specify)

1. Relinquished By: Date 3/13/12 Time 1520

1. Received By: Date 3/13/12 Time 1520

2. Relinquished By: Date Time

2. Received By: Date Time

3. Relinquished By: Date Time

3. Received By: Date Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain of Custody Record

4124 (0907)

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☒

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Client: Stoller

Project Manager: Nick Malczyk

Date: 03/13/2012

Chain of Custody Number: 407096

Address: 105 Technology Dr #190

Telephone Number (Area Code)/Fax Number: (303) 546-4313

Lab Number:

Page 2 of 3

City: Broomfield

State: CO

Zip Code: 80021

Site Contact:

Lab Contact: Lisa Harvill

Project Name and Location (State): CO School of Mines Golden, CO

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH		Analysis (Attach list if more space is needed): NO_2, NO_3	TDS	Ferrous Fe	Ferric Fe	Sulfide								Special Instructions/ Conditions of Receipt
(SMRI - 12	3/13/12	1110		X						X								X									
(SMRI - 12	3/13/12	1110		X									X						X								
~~(SMRI - 12~~	~~3/13/12~~	~~1110~~																									
(SMRI - 13	3/13/12	1140		X				X							X												
(SMRI - 13	3/13/12	1140		X				X								X											
(SMRI - 13	3/13/12	1140		X				X									X										
(SMRI - 13	3/13/12	1140		X						X								X									
(SMRI - 13	3/13/12	1140		X									X						X								
(SMRI - 4	3/13/12	1200		X				X							X												
(SMRI - 4	3/13/12	1200		X				X								X											
(SMRI - 4	3/13/12	1200		X				X									X										
(SMRI - 4	3/13/12	1200		X						X								X									

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

1. Relinquished By	Date: 3/13/12	Time: 1520	1. Received By	Date: 3/13/12	Time: 1520
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain of Custody Record

4124 (0907)

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☒

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Client: Stoller

Project Manager: Nick Aleksyk

Date: 03/13/2012

Chain of Custody Number: 407097

Address: 105 Technology Dr #190

Telephone Number (Area Code)/Fax Number: (303) 546-4313

Lab Number:

Page 3 of 3

City: Broomfield

State: CO

Zip Code: 80021

Site Contact:

Lab Contact: Lisa Urrell

Project Name and Location (State): CO School of Mines Golden, CO

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Matrix: Aqueous	Matrix: Sed.	Matrix: Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis (Attach list if more space is needed): NO2, NO3	TDS	Ferrous Fe	Ferric Fe	Sulfide	Special Instructions/ Conditions of Receipt
CSMRI-4	3/13/12	1260		X								X					X	
CSMRI-5	3/13/12	1240		X			X						X					
CSMRI-5	3/13/12	1240		X			X							X				
CSMRI-5	3/13/12	1240		X			X								X			
CSMRI-5	3/13/12	1240		X					X							X		
CSMRI-5	3/13/12	1240		X								X					X	

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

1. Relinquished By — Date: 3/13/12 — Time: 1520

1. Received By — Date: 3/13/12 — Time: 1540

2. Relinquished By — Date — Time

2. Received By — Date — Time

3. Relinquished By — Date — Time

3. Received By — Date — Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain of Custody Record

TAL-4124-280 (0508)

Sampler ID ____

Temperature on Receipt ____

Drinking Water? Yes ☐ No ☒

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Client: Stoller

Project Manager: Nick Malczyk

Date: 3/14/2012

Chain of Custody Number: 149402

Address: 105 Technology Dr #190

Telephone Number (Area Code)/Fax Number: (303) 546-4313

Lab Number:

Page 1 of 2

City: Broomfield

State: CO

Zip Code: 80021

Site Contact:

Lab Contact: Lisa Uriell

Project Name and Location (State): CO School of Mines Golden, CO

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix					Containers & Preservatives							Analysis (Attach list if more space is needed)												Special Instructions/ Conditions of Receipt
			Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH		NO2, NO3	TDS	~~Ferrous Fe~~ PD	~~Ferric Fe~~ PD	~~Sulfide~~ PD								
CSMRI - 7C	3/14/12	0845		X				X							X												
CSMRI 7C	3/14/12	0845		X				X								X											
CSMRI - 10	3/14/12	0935		X				X							X												
CSMRI - 10	3/14/12	0735		X				X								X											
SW - 2	3/14/12	0950		X				X							X												
SW - 2	3/14/12	0950		X				X								X											
CSMRI - 9	3/14/12	1010		X				X							X												
CSMRI - 9	3/14/12	1010		X				X								X											
CSMRI - 14	3/14/12	1015		X				X							X												
CSMRI - 14	3/14/12	1015		X				X								X											
SW - 3	3/14/12	1020		X				X							X												
SW - 3	3/14/12	1020		X				X								X											

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☒ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other ____

QC Requirements (Specify)

1. Relinquished By: Date 3/14/12 Time 1655

1. Received By: Date 3/14/12 Time 1655

2. Relinquished By: Date Time

2. Received By: Date Time

3. Relinquished By: Date Time

3. Received By: Date Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain of Custody Record

TAL-4124-280 (0508)

Sampler ID ______

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☒

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Client: Stoller

Project Manager: Nick Malczyk

Date: 3/14/12

Chain of Custody Number: 147995

Address: 105 Technology Dr #190

Telephone Number (Area Code)/Fax Number: (303) 546-4313

Lab Number:

Page 2 of 2

City: Broomfield

State: CO

Zip Code: 80021

Site Contact:

Lab Contact: Lisa Uriell

Project Name and Location (State): CO School of Mines Golden, CO

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH		Analysis (Attach list if more space is needed): NO2, NO3	TDS	~~Ferrous Fe~~	~~Ferric Fe~~	~~Sulfate~~								Special Instructions/ Conditions of Receipt
CSMRI-1	3/14/12	1340		X				X							X												
CSMRI-1	3/14/12	1340		X				X								X											
SW-1	3/14/12	1400		X				X							X												
SW-1	3/14/12	1400		X				X								X											

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

1. Relinquished By: Date 3/14/12 Time 1655

1. Received By: Date 3/14/12 Time 1655

2. Relinquished By: Date Time

2. Received By: Date Time

3. Relinquished By: Date Time

3. Received By: Date Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain of Custody Record

Sampler ID ______

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☒

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124-280 (0508)

Client: Stoller

Project Manager: Nick Malczuk

Date: 3/15/12

Chain of Custody Number: 147996

Address: 105 Technology Dr #190

Telephone Number (Area Code)/Fax Number: (303) 546-4313

Lab Number:

Page 1 of 1

City: Broomfield

State: CO

Zip Code: 80021

Site Contact:

Lab Contact: Lisa Uriell

Project Name and Location (State): CO School of Mines Golden, CO

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix					Containers & Preservatives							Analysis (Attach list if more space is needed)													Special Instructions/ Conditions of Receipt
			Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH		NO2, NO3	TDS	~~Ferrous Iron +~~	~~Ferrous Iron~~	~~Sulfide~~									
CSMRI-1B	3/15/12	1045		X				X							X	X												Due to lack of sample water TDS and NO2, NO3 were combined
Equipment Blank	3/15/12	1115		X				X							X													
Equipment Blank	3/15/12	1115		X				X								X												
CSMRI-2	3/15/12	1130		X				X							X													
CSMRI-2	3/15/12	1130		X				X								X												

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

1. Relinquished By — Date 2/15/12 — Time 1230

1. Received By — Date 3/15/12 — Time 122

2. Relinquished By — Date — Time

2. Received By — Date — Time

3. Relinquished By — Date — Time

3. Received By — Date — Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Appendix G

Historical Summary Tables

Table G-1
Historical Summary of Radioisotopes in Groundwater (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)
CSMRI-1	2/25/2005	-0.11	0.81	0.007	0.07	0.01	0.77	0.043	0.53
	6/14/2005	0.16	0.44	0.018	-0.021	0.012	0.43	0.011	0.217
	9/7/2005	0.1	0.63	0.068	0.167	0.114	0.85	0.053	0.43
	12/20/2005	-0.19	0.59	-0.045	0.32	0.014	0.94	0.073	0.46
	3/15/2006	-0.15	0.58	0.025	0.032	-0.004	1.76	0.11	0.92
	6/14/2006	0.42	0.05	0.15	-0.06	0.062	0.18	0.18	0.08
	9/13/2006	0.25	0.34	0.11	-0.079	0.027	0.45	0.051	0.25
	3/1/2007	0.32	0.78	0.052	-0.031	0.012	NT	NT	NT
	6/27/2007	0.51	0.91	0.17	0.064	-0.005	NT	NT	NT
	9/11/2007	-0.3	0.53	-0.031	0.019	0.001	NT	NT	NT
	11/27/2007	-0.2	0.72	0.71	0.101	0.02	NT	NT	NT
	2/27/2008	0.2	0.85	0.035	0.032	0.011	NT	NT	NT
	4/18/2008	-0.02	0.66	-0.03	-0.004	0.01	NT	NT	NT
	9/25/2008	0.26	0.88	NT	NT	NT	NT	NT	NT
	12/3/2008	0.32	1.39	NT	NT	NT	NT	NT	NT
	3/17/2009	0.09	0.96	NT	NT	NT	NT	NT	NT
	6/24/2009	0.19	0.16 J	NT	NT	NT	NT	NT	NT
	9/24/2009	2.64	1.01	NT	NT	NT	NT	NT	NT
	12/17/2009	0.39	0.96	NT	NT	NT	NT	NT	NT
	3/9/2010	0.11	0.38	NT	NT	NT	NT	NT	NT
	6/10/2010	0.1	0.93	NT	NT	NT	NT	NT	NT
	9/9/2010	0.13	0.85	NT	NT	NT	NT	NT	NT
	12/8/2010	0.37	0.96	NT	NT	NT	NT	NT	NT
	3/2/2011	0.41	0.91 UJ	NT	NT	NT	NT	NT	NT
	6/8/2011	0.4	0.8	NT	NT	NT	NT	NT	NT
	9/21/2011	0.25	1.19	NT	NT	NT	NT	NT	NT
	12/7/2011	0.09	1.34	NT	NT	NT	NT	NT	NT
	3/14/2012	0.67	1.69	NT	NT	NT	NT	NT	NT
CSMRI-1B	3/8/2007	0.13	1.19	-0.03	-0.09	0.02	NT	NT	NT
	6/26/2007	0.09	0.3	0.001	0.002	0.012	NT	NT	NT
	9/11/2007	-0.13	0.65	0.019	0.012	0.001	NT	NT	NT
	11/27/2007	0.11	1.16	0.004	0.06	0.016	NT	NT	NT
	2/28/2008	0.32	0.61	0.01	0.058	0.033	NT	NT	NT
	4/18/2008	0.03	0.72	-0.004	-0.046	0	NT	NT	NT
	9/24/2008	0.05	0.3	NT	NT	NT	NT	NT	NT
	12/5/2008	0.02	0.88	NT	NT	NT	NT	NT	NT
	3/18/2009	0.2	1.15	NT	NT	NT	NT	NT	NT
	6/24/2009	0.05	0.69 J	NT	NT	NT	NT	NT	NT
	9/25/2009	0.08	0.89	NT	NT	NT	NT	NT	NT
	12/17/2009	-0.03	0.98	NT	NT	NT	NT	NT	NT
	3/11/2010	0.09	0.42	NT	NT	NT	NT	NT	NT
	6/9/2010	0.23	-0.03 R	NT	NT	NT	NT	NT	NT
	9/8/2010	0.35	0.61	NT	NT	NT	NT	NT	NT
	12/8/2010	0.24	0.34	NT	NT	NT	NT	NT	NT
	3/3/2011	0.33	0.73	NT	NT	NT	NT	NT	NT
	6/9/2011	0.15	0.75	NT	NT	NT	NT	NT	NT
	9/21/2011	0.45	1.04	NT	NT	NT	NT	NT	NT
	12/7/2011	0.31	1.13	NT	NT	NT	NT	NT	NT
	3/15/2012	0.52	0.62	NT	NT	NT	NT	NT	NT
CSMRI-2	2/25/2005	0.8	1.85	0.07	-0.02	0.01	0.6	0.05	0.16
	6/14/2005	1.47	3	0.14	0.003	0.026	0.68	0.025	0.299
	9/7/2005	1.78	2.71	0.162	0.108	0.049	0.65	0.05	0.31
	12/20/2005	1.35	1.62	0.108	0.285	0.024	0.83	0.002	0.35
	3/15/2006	1.25	2.53	0.03	0.204	0.012	0.83	0.066	0.45
	6/14/2006	0.99	1.79	0.25	0.22	0.049	0.69	0.04	0.25
	9/13/2006	1.01	2.35	0.088	-0.039	-0.008	0.46	0.014	0.28
	3/8/2007	0.76	2.15	0.022	-0.01	0.011	NT	NT	NT
	6/28/2007	1.4	3.2	-0.075	-0.01	-0.007	NT	NT	NT
	9/11/2007	0.78	3.2	0.016	0.101	0.014	NT	NT	NT
	11/27/2007	0.45	2.05	0.037	0.035	0.006	NT	NT	NT
	2/28/2008	1.37	2.26	0.043	0.085	0.044	NT	NT	NT
	4/17/2008	1.08	1.89	0.041	-0.021	0.008	NT	NT	NT
	9/24/2008	0.97	1.41	NT	NT	NT	NT	NT	NT
	12/5/2008	1.1	1.88	NT	NT	NT	NT	NT	NT
	3/18/2009	2.37	2.68	NT	NT	NT	NT	NT	NT
	6/24/2009	0.78	2.64 J	NT	NT	NT	NT	NT	NT
	9/25/2009	0.63	2.12	NT	NT	NT	NT	NT	NT
	12/18/2009	1.02	1.6	NT	NT	NT	NT	NT	NT
	3/11/2010	2.4	1.16	NT	NT	NT	NT	NT	NT
	6/10/2010	0.27	2.25	NT	NT	NT	NT	NT	NT
	9/10/2010	0.29	1.52	NT	NT	NT	NT	NT	NT
	12/8/2010	0.98	2.16	NT	NT	NT	NT	NT	NT
	3/3/2011	1.59	1.45	NT	NT	NT	NT	NT	NT
	6/9/2011	0.25	1.64	NT	NT	NT	NT	NT	NT
	9/22/2011	0.77	1.69	NT	NT	NT	NT	NT	NT
	12/8/2011	0.57	1.93	NT	NT	NT	NT	NT	NT
	3/15/2012	0.93	1.99	NT	NT	NT	NT	NT	NT

Table G-1
Historical Summary of Radioisotopes in Groundwater (Stoller)

Sample Station	Sample Date	Ra-226	Ra-228	Th-228	Th-230	Th-232	U-234	U-235	U-238
		(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)
CSMRI-4	2/25/2005	-0.03	0.16	0.019	-0.009	0.013	9.7	0.53	8.2
	6/14/2005	0.26	0.34	0.013	0.014	0.005	11.4	0.49	10.6
	9/7/2005	0.17	0.78	-0.013	0.164	0.086	6.4	0.33	6.4
	12/20/2005	0.13	0.1	0.033	0.311	0.012	11.5	0.61	11.4
	3/15/2006	0	0.38	0.004	0.174	0.007	9	0.43	9
	6/15/2006	0.41	0.39	0.11	0.17	0.061	9.2	0.4	8.9
	9/13/2006	-0.05	0.79	0.056	-0.015	0.007	6.5	0.35	6
	3/8/2007	0.09	0.37	-0.034	-0.037	0.013	NT	NT	NT
	6/27/2007	0.07	0.87	0.011	0.035	0.004	NT	NT	NT
	9/11/2007	0.99	1.12	0.024	0.112	0.021	NT	NT	NT
	11/26/2007	0.33	0.73	0.029	0.149	0.016	NT	NT	NT
	2/27/2008	0.24	0.78	0.011	0.038	0.014	NT	NT	NT
	4/17/2008	0.11	0.71	0.017	-0.019	0.002	NT	NT	NT
	9/25/2008	0.32	0.8	NT	NT	NT	NT	NT	NT
	12/5/2008	0.09	0.97	NT	NT	NT	NT	NT	NT
	3/17/2009	0.54	0.56	NT	NT	NT	NT	NT	NT
	6/23/2009	0.21	0.89 J	NT	NT	NT	NT	NT	NT
	9/24/2009	0.11	0.73	NT	NT	NT	NT	NT	NT
	12/16/2009	0.21	0.68	NT	NT	NT	NT	NT	NT
	3/10/2010	8.6	0.57	NT	NT	NT	NT	NT	NT
	5/3/2010	0.38	NT	NT	NT	NT	NT	NT	NT
	6/8/2010	0.6	1.42	NT	NT	NT	NT	NT	NT
	9/10/2010	0.12	1.64	NT	NT	NT	NT	NT	NT
	12/7/2010	0.66	0.99	NT	NT	NT	NT	NT	NT
	3/1/2011	2.16	1.23	NT	NT	NT	NT	NT	NT
	6/8/2011	0.3	0.99	NT	NT	NT	NT	NT	NT
	9/20/2011	0.18	0.59	NT	NT	NT	NT	NT	NT
	12/6/2011	0.17	1.18	NT	NT	NT	NT	NT	NT
	3/13/2012	0.19	0.76	NT	NT	NT	NT	NT	NT
CSMRI-5	2/25/2005	1.06	0.53	0.009	0.007	0.034	1.22	0.056	0.93
	6/14/2005	2.51	0.44	-0.018	0.039	0.011	1.51	0.086	1.2
	9/7/2005	2.5	0.76	0.06	1.25	0.051	1.85	0.051	1.47
	12/20/2005	1.97	0.52	0.032	0.126	0.01	1.45	0.066	1.21
	3/15/2006	0.57	0.45	0.038	0.144	0.019	1.81	0.058	1.38
	6/15/2006	2.13	0.87	0.145	0.08	0.043	1.03	0.13	0.92
	9/13/2006	2.29	0.56	0.053	-0.053	0.005	3.18	0.17	2.32
	3/8/2007	1.78	0.39	-0.012	-0.061	0	NT	NT	NT
	6/27/2007	2.22	0.86	0.008	-0.023	0.013	NT	NT	NT
	9/11/2007	1.91	1.2	0.091	0.003	0.006	NT	NT	NT
	11/26/2007	1.52	0.49	0.004	-0.008	0.01	NT	NT	NT
	2/27/2008	1.05	0.17	-0.011	0.02	0.051	NT	NT	NT
	4/17/2008	1.37	0.64	0.068	0.029	0.017	NT	NT	NT
	9/25/2008	2.87	0.47	NT	NT	NT	NT	NT	NT
	12/4/2008	0.78	0.68	NT	NT	NT	NT	NT	NT
	3/17/2009	0.29	1.24	NT	NT	NT	NT	NT	NT
	6/23/2009	1.96	1.15 J	NT	NT	NT	NT	NT	NT
	9/24/2009	-0.15	0.85	NT	NT	NT	NT	NT	NT
	12/16/2009	1.28	0.44	NT	NT	NT	NT	NT	NT
	3/10/2010	3.9	0.4	NT	NT	NT	NT	NT	NT
	5/3/2010	0.83	NT	NT	NT	NT	NT	NT	NT
	6/8/2010	2.42	0.75	NT	NT	NT	NT	NT	NT
	9/10/2010	0.41	0.39	NT	NT	NT	NT	NT	NT
	12/7/2010	0.67	0.71	NT	NT	NT	NT	NT	NT
	3/1/2011	0.65	0.16 UJ	NT	NT	NT	NT	NT	NT
	6/8/2011	0.31	0.76	NT	NT	NT	NT	NT	NT
	9/20/101	0.82	0.93	NT	NT	NT	NT	NT	NT
	12/6/2011	0.27	0.88	NT	NT	NT	NT	NT	NT
	3/13/2012	0.54	0.28	NT	NT	NT	NT	NT	NT
CSMRI-6B	2/27/2007	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/2007	0.46	0.63	-0.009	-0.006	0.024	NT	NT	NT
	9/10/2007	0.15	0.91	0.046	0.025	0.023	NT	NT	NT
	11/27/2007	-0.02	0.77	-0.002	0.069	0.004	NT	NT	NT
	2/28/2008	0.26	1	-0.009	0.022	0.022	NT	NT	NT
	4/18/2008	0.36	0.88	-0.005	-0.022	0.021	NT	NT	NT
CSMRI-6C	7/11/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/2009	-0.11	1.81 J	NT	NT	NT	NT	NT	NT
	9/24/2009	0.09	1.39	NT	NT	NT	NT	NT	NT
	12/18/2009	NT	NT	NT	NT	NT	NT	NT	NT
	3/8/10 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	6/8/2010	0.34	1.48	NT	NT	NT	NT	NT	NT
	9/8/2010	0.11	0.97	NT	NT	NT	NT	NT	NT
	12/8/2010	NT	NT	NT	NT	NT	NT	NT	NT
	3/2/2011	0.11	1.22	NT	NT	NT	NT	NT	NT
	6/8/2011	0.29	0.8	NT	NT	NT	NT	NT	NT
	9/20/2011	0.45	1.05	NT	NT	NT	NT	NT	NT
	12/6/2011	0.11	0.78	NT	NT	NT	NT	NT	NT
	3/13/2012	0.69	1.35	NT	NT	NT	NT	NT	NT

Table G-1
Historical Summary of Radioisotopes in Groundwater (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)
CSMRI-7B	2/27/2007	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/2007	0.65	0.22	0.036	0.054	0.027	NT	NT	NT
	9/10/2007	NT	NT	NT	NT	NT	NT	NT	NT
	11/26/2007	NT	NT	NT	NT	NT	NT	NT	NT
	2/26/2008	NT	NT	NT	NT	NT	NT	NT	NT
	4/15/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	9/24/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	9/25/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	12/18/2009 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	3/8/10 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	6/10/2010	0.21	0.17 R	NT	NT	NT	NT	NT	NT
	9/10/2010	1.13	0.8 J	NT	NT	NT	NT	NT	NT
CSMRI-7C	3/2/2011	0.31	0.76	NT	NT	NT	NT	NT	NT
	6/8/2011	0.26	0.54	NT	NT	NT	NT	NT	NT
	9/21/2011	0.28	1.01	NT	NT	NT	NT	NT	NT
	12/7/2011	0	1.03	NT	NT	NT	NT	NT	NT
	3/14/2012	0.22	1.13	NT	NT	NT	NT	NT	NT
CSMRI-8	3/8/2007	0.7	1.06	0.072	-0.031	0.016	NT	NT	NT
	6/27/2007	0.8	0.4	0.039	0.046	0.008	NT	NT	NT
	9/10/2007	1.31	0.9	0.031	0.05	0.009	NT	NT	NT
	11/27/2007	1.27	1.2	-0.02	0.074	-0.003	NT	NT	NT
	2/27/2008	1.19	1.38	0.089	0.1	0.043	NT	NT	NT
	4/17/2008	0.39	0.71	-0.015	-0.053	0.009	NT	NT	NT
	9/25/2008	1.5	1.02	NT	NT	NT	NT	NT	NT
	12/5/2008	1.55	1.44	NT	NT	NT	NT	NT	NT
	3/18/2009	0.31	0.69	NT	NT	NT	NT	NT	NT
	6/23/2009	-0.28	0.73 J	NT	NT	NT	NT	NT	NT
	9/24/2009	0.39	1.25	NT	NT	NT	NT	NT	NT
	12/16/2009	0.26	0.37	NT	NT	NT	NT	NT	NT
	3/10/2010	0.89	1.12	NT	NT	NT	NT	NT	NT
	6/8/2010	0.45	0.68	NT	NT	NT	NT	NT	NT
	9/8/2010	0.28	0.46	NT	NT	NT	NT	NT	NT
CSMRI-8B	3/1/2011	0.31	0.88	NT	NT	NT	NT	NT	NT
	6/7/2011	0.21	1	NT	NT	NT	NT	NT	NT
	9/20/2011	0.5	1.16	NT	NT	NT	NT	NT	NT
	12/6/2011	0.4	1.04	NT	NT	NT	NT	NT	NT
	3/13/2012	0.58	1.11	NT	NT	NT	NT	NT	NT
CSMRI-9	2/27/2007	0.12	0.53	-0.017	0.04	0.027	NT	NT	NT
	6/26/2007	0.22	0.37	0.018	0.004	-0.015	NT	NT	NT
	9/10/2007	0.5	1.01	0.04	-0.043	0.012	NT	NT	NT
	11/26/2007	0.25	0.27	0.023	0.003	0.003	NT	NT	NT
	2/27/2008	0.11	0.24	0.047	0.037	0.041	NT	NT	NT
	4/15/2008	0.27	0.65	-0.004	0.015	0.022	NT	NT	NT
	9/24/2008	0.11	0.48	NT	NT	NT	NT	NT	NT
	12/5/2008	0.13	0.65	NT	NT	NT	NT	NT	NT
	3/16/2009	0.17	0.45	NT	NT	NT	NT	NT	NT
	6/22/2009	0	0.88 J	NT	NT	NT	NT	NT	NT
	9/24/2009	0.24	0.59	NT	NT	NT	NT	NT	NT
	12/16/2009	0.45	0.61	NT	NT	NT	NT	NT	NT
	3/11/2010	0.2	0.36	NT	NT	NT	NT	NT	NT
	6/9/2010	0.41	0.64	NT	NT	NT	NT	NT	NT
	9/8/2010	0.03	0.46	NT	NT	NT	NT	NT	NT
	12/7/2010	0.23	0.8	NT	NT	NT	NT	NT	NT
	3/1/2011	0.28	0.51 UJ	NT	NT	NT	NT	NT	NT
	6/7/2011	0.04	0.64	NT	NT	NT	NT	NT	NT
	9/21/2011	0.07	0.62	NT	NT	NT	NT	NT	NT
	12/7/2011	0.34	1.22	NT	NT	NT	NT	NT	NT
	3/14/2012	0.15	0.67	NT	NT	NT	NT	NT	NT

Table G-1
Historical Summary of Radioisotopes in Groundwater (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)
CSMRI-10	3/1/2007	0.19	0.63	0.014	-0.004	0.018	NT	NT	NT
	6/26/2007	0.26	0.43	-0.008	0.03	-0.005	NT	NT	NT
	9/10/2007	-0.04	0.48	0.103	0.05	0.005	NT	NT	NT
	11/26/2007	-0.05	0.57	0.068	0.141	0.031	NT	NT	NT
	2/26/2008	0.12	0.44	0.094	0.011	0.019	NT	NT	NT
	4/15/2008	0.03	0.56	-0.006	-0.05	0.005	NT	NT	NT
	9/24/2008	0.21	0.48	NT	NT	NT	NT	NT	NT
	12/4/2008	0.11	0.92	NT	NT	NT	NT	NT	NT
	3/16/2009	0.15	1.01	NT	NT	NT	NT	NT	NT
	6/22/2009	0.35	0.48 J	NT	NT	NT	NT	NT	NT
	9/25/2009	0.25	0.62	NT	NT	NT	NT	NT	NT
	12/16/2009	0.17	0.85	NT	NT	NT	NT	NT	NT
	3/11/2010	0.41	0.47	NT	NT	NT	NT	NT	NT
	6/9/2010	0.37	0.66	NT	NT	NT	NT	NT	NT
	9/8/2010	0.22	0.5	NT	NT	NT	NT	NT	NT
	12/7/2010	0.28	0.63	NT	NT	NT	NT	NT	NT
	3/1/2011	0.22	0.73 UJ	NT	NT	NT	NT	NT	NT
	6/7/2011	0.31	0.52	NT	NT	NT	NT	NT	NT
	9/21/2011	0.29	0.72	NT	NT	NT	NT	NT	NT
	12/7/2011	0.2	1.19	NT	NT	NT	NT	NT	NT
	3/14/2012	0.38	0.55	NT	NT	NT	NT	NT	NT
CSMRI-11	3/1/2007	0.16	0.46	0.051	0.085	0.007	NT	NT	NT
	6/26/2007	0.37	0.43	0.084	0	0.008	NT	NT	NT
	9/10/2007	-0.26	0.52	0.012	0.006	0.016	NT	NT	NT
	11/26/2007	0.16	0.87	0.089	0.099	-0.012	NT	NT	NT
	2/26/2008	0.28	-0.03	0.044	0.044	0.074	NT	NT	NT
	4/15/2008	0.35	0.75	-0.032	0.004	0.016	NT	NT	NT
CSMRI-11B	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/2009	0.52	NT	NT	NT	NT	NT	NT	NT
	9/25/2009	3.5	0.88	NT	NT	NT	NT	NT	NT
	12/18/2009	0.89	0.51	NT	NT	NT	NT	NT	NT
	3/8/2010	NT	NT	NT	NT	NT	NT	NT	NT
	6/8/2010	0.28	0.4	NT	NT	NT	NT	NT	NT
	9/8/2010	0.04	0.79	NT	NT	NT	NT	NT	NT
	12/8/2010	0.38	0.53	NT	NT	NT	NT	NT	NT
	3/2/2011	0.14	0.91 UJ	NT	NT	NT	NT	NT	NT
	6/7/2011	0.37	0.74	NT	NT	NT	NT	NT	NT
	9/20/2011	0.33	1.08	NT	NT	NT	NT	NT	NT
	12/6/2011	0.22	1.15	NT	NT	NT	NT	NT	NT
	3/13/2012	2.04	0.77	NT	NT	NT	NT	NT	NT
CSMRI-12	3/1/2011	0.69	1.24	NT	NT	NT	NT	NT	NT
	6/7/2011	0.27	1.27	NT	NT	NT	NT	NT	NT
	9/20/2011	0.46	1.75	NT	NT	NT	NT	NT	NT
	12/6/2011	0.09	2.84	NT	NT	NT	NT	NT	NT
	3/13/2012	10.7	2.04	NT	NT	NT	NT	NT	NT
CSMRI-13	3/2/2011	0.69	0.97 UJ	NT	NT	NT	NT	NT	NT
	6/7/2011	0.51	1.1	NT	NT	NT	NT	NT	NT
	9/20/2011	0.71	1.57	NT	NT	NT	NT	NT	NT
	12/6/2011	0.32	1.66	NT	NT	NT	NT	NT	NT
	3/13/2012	0.51	0.77	NT	NT	NT	NT	NT	NT
CSMRI-14	3/1/2011	0.3	0.67 UJ	NT	NT	NT	NT	NT	NT
	6/8/2011	0.32	0.62	NT	NT	NT	NT	NT	NT
	9/21/2011	0.27	1.13	NT	NT	NT	NT	NT	NT
	12/7/2011	0.15	1.53	NT	NT	NT	NT	NT	NT
	3/14/2012	7.5	0.54	NT	NT	NT	NT	NT	NT
MCL*		Total Ra = 5		NE	Th 230 + Th 232 = 60**		NE	NE	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations

**5 CCR 1002-41 Reg 41 – Colorado Groundwater Standards

pCi/l - picocuries per liter

J - Estimated

NE – Not Established

NT – not tested

µg/l – micrograms per liter

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(Results in milligrams per liter - U in micrograms per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	U	V	Zn
CSMRI-1	2/25/2005	ND	ND	ND	28	ND	ND	ND	2.8	9.4	ND	29	ND	ND	1.61	ND	0.032
	6/14/2005	ND	ND	ND	17	ND	ND	ND	2.3	5.1	ND	16	ND	ND	0.64	ND	0.032
	9/7/2005	ND	ND	0.055 (B)	21	ND	ND	ND	2.9	6.3	0.0021 (B)	25	ND	0.0041 (B)	1.3	ND	0.034
	12/20/2005	ND	ND	0.067 (B)	32	ND	ND	0.000034 (B)	2.9	10	ND	26	ND	ND	1.41	ND	0.052
	3/15/2006	ND	ND	0.064 (B)	33	ND	ND	0.00002 (B)	2.6	10	0.0013 (B)	24	ND	ND	2.8	ND	0.049
	6/14/2006	ND	ND	0.031 (B)	10	ND	ND	ND	1.9	3	0.0051 (B)	9.2	ND	0.0035 (B)	0.31	ND	0.015 (B)
	9/13/2006	ND	ND	0.061 (B)	20	ND	0.041 (B)	ND	2.7	6	0.0038 (B)	14	ND	ND	0.77	ND	0.03
	3/1/2007	ND	ND	0.081 (B)	39	0.00045 (B)	0.00063 (B)	0.000017 (B)	3	12	0.0059 (B)	26	ND	0.0066	1.2	ND	0.048
	6/27/2007	ND	ND	0.063 (B)	23	ND	ND	0.0000073 (B)	2.4	9	ND	21	ND	ND	0.88	ND	0.017 (B)
	9/11/2007	ND	ND	0.065 (B)	23	ND	0.00061 (B)	0.000011 (B)	2.5	7.2	0.002 (B)	14	ND	ND	0.72	ND	0.038
	11/27/2007	ND	ND	0.075 (B)	31	ND	ND	0.000029 (B)	2.5	9.7	0.0014 (B)	18	ND	ND	1.2	ND	0.049
	2/27/2008	ND	ND	0.08 (B)	36	ND	ND	ND	2.5	12	0.0013 (B)	22	ND	ND	1.5	ND	0.048
	4/18/2008	ND	ND	0.081 (B)	36	ND	ND	ND	2.7	11	0.0015 (B)	22	ND	ND	1.9	ND	0.057
	9/25/2008	NT	NT	NT	30	NT	NT	NT	3	9	NT	18	NT	NT	0.96	NT	NT
	12/3/2008	NT	NT	NT	39	NT	NT	NT	3.5	12	NT	25	NT	NT	1.5	NT	NT
	3/17/2009	NT	NT	NT	46	NT	NT	NT	3	14	NT	27	NT	NT	2	NT	NT
	6/24/2009	0.00078	0.0032	0.097	36	0.00016	0.00041	0.00002	3.3	13	32	0.0019	0.00035	NT	1.6	NT	NT
	9/24/2009	NT	NT	NT	48 (J)	NT	NT	NT	3.2	18 (J)	NT	45 (J)	NT	NT	2.4	NT	NT
	12/17/2009	NT	NT	NT	49	NT	NT	NT	3.4	16	NT	42	NT	NT	2.4	NT	NT
	3/9/2010	NT	NT	NT	52	NT	NT	NT	3	19	NT	42	NT	NT	2.9	NT	NT
	6/10/2010	ND	ND	0.11	51	ND	ND	0.000023 (B)	4.1	15	NT	42	ND	NT	2.4	ND	NT
	9/9/2010	NT	NT	NT	39	NT	NT	NT	4.5	14	NT	60	NT	NT	2	NT	NT
	12/8/2010	NT	NT	NT	48	NT	NT	NT	3.5	15	NT	38	NT	NT	2	NT	NT
	3/2/2011	NT	NT	NT	53	NT	NT	NT	2.9	16	NT	36	NT	NT	2.6	NT	NT
	6/8/2011	ND	ND	0.098 B	41	ND	ND	ND	2.5	12	NT	28 J	ND	NT	1.5 J	ND	NT
	9/21/2011	NT	NT	NT	34	NT	NT	NT	2.7	11	NT	20	NT	NT	0.91	ND	NT
	12/7/2011	NT	NT	NT	48	NT	NT	NT	2.7	15	NT	31	NT	NT	1.8	NT	NT
	3/14/2012	NT	NT	NT	65	NT	NT	NT	2.9	21	NT	41	NT	NT	2.6	NT	NT
CSMRI-1B	3/1/2007	ND	ND	0.098 (B)	130	ND	0.00014 (B)	0.000017 (B)	52	47	0.17	91	ND	0.0058	2.7	0.0009 (B)	ND
	6/26/2007	ND	ND	0.071 (B)	83	ND	ND	0.0000072 (B)	10	38	0.029	35	ND	ND	5	ND	ND
	9/11/2007	ND	ND	0.1	93	ND	ND	0.0000094 (B)	8.4	43	0.031	36	ND	ND	6.3	ND	0.0012 (B)
	11/27/2007	ND	ND	0.11	100	ND	ND	0.000029 (B)	9.4	46	0.024	42	ND	ND	6.9	0.00073 (B)	0.0039 (B)
	2/28/2008	ND	ND	0.11	97	ND	0.0015 (B)	ND	9.3	45	0.029	41	ND	0.0039 (B)	6.5	ND	0.0033 (B)
	4/18/2008	ND	ND	0.11	93	ND	ND	ND	9.1	43	0.027	39	ND	ND	6	0.00065 (B)	ND
	9/24/2008	NT	NT	NT	92	NT	NT	NT	7.3	39	NT	38	NT	NT	4	NT	NT
	12/5/2008	NT	NT	NT	95	NT	NT	NT	7.6	39	NT	40	NT	NT	4.6	NT	NT
	3/18/2009	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	8.1	NT	NT
	6/24/2009	0.00078	0.0032	0.14	140	0.00016	0.00041	0.000022	7.2	61	59	0.0019	0.00035	NT	15	NT	NT
	9/25/2009	NT	NT	NT	120 (J)	NT	NT	NT	7	55 (J)	NT	42 (J)	NT	NT	34	NT	NT
	12/17/2009	NT	NT	NT	120	NT	NT	NT	7.8	51	NT	48	NT	NT	16	NT	NT
	3/11/2010	NT	NT	NT	120	NT	NT	NT	6.4	51	NT	42	NT	NT	9.4	NT	NT
	6/9/2010	ND	ND	0.1	170	ND	ND	0.000023 (B)	4.8	85	NT	61	ND	NT	18	ND	NT
	9/8/2010	NT	NT	NT	140	NT	NT	NT	5.5	63	NT	53	NT	NT	18	NT	NT
	12/8/2010	NT	NT	NT	140	NT	NT	NT	6.5	57	NT	53	NT	NT	10	NT	NT
	3/3/2011	NT	NT	NT	130	NT	NT	NT	6.2	53	NT	50	NT	NT	9.4	NT	NT
	6/9/2011	ND	ND	0.12	140	0.00094 B	ND	ND	5.8	58	NT	53 J	ND	NT	10 J	ND	NT
	9/21/2011	NT	NT	NT	190	NT	NT	NT	8.3	91	NT	79	NT	NT	27	NT	NT
	12/7/2011	NT	NT	NT	110	NT	NT	NT	6.4	48	NT	50	NT	NT	16	NT	NT
	3/15/2012	NT	NT	NT	120	NT	NT	NT	6.4	48	NT	49	NT	NT	12	NT	NT
CSMRI-2	2/25/2005	0.00094 B	ND	0.11	72	ND	ND	ND	7.1	32	ND	19	ND	ND	0.53	ND	0.02
	6/14/2005	ND	ND	0.1	76	ND	ND	ND	6.3	32	ND	18	ND	ND	0.89	ND	ND
	9/7/2005	ND	ND	0.11	81	ND	ND	ND	7.1	35	ND	19	ND	ND	0.94	ND	0.011 (B)
	12/20/2005	ND	ND	0.098 (B)	76	ND	ND	0.000031 (B)	6.7	33	ND	18	ND	ND	1.06	ND	0.0043 (B)
	3/15/2006	ND	ND	0.09 (B)	74	ND	ND	0.000023 (B)	6.1	31	ND	17	ND	ND	1.36	ND	0.0059 (B)
	6/14/2006	ND	ND	0.093 (B)	70	ND	ND	ND	6.3	31	0.0048 (B)	17	ND	0.0031 (B)	0.76	ND	0.0092 (B)
	9/13/2006	ND	ND	0.11	81	ND	ND	ND	6.7	35	0.0014 (B)	19	ND	ND	0.85	ND	0.0092 (B)
	3/8/2007	ND	0.0058 (B)	0.12	88	ND	ND	ND	8.3	39	ND	21	ND	0.03	0.72	ND	0.0011 (B)
	6/28/2007	ND	ND	0.11	97	ND	ND	0.0000056 (B)	7.9	49	ND	26	ND	ND	2	0.002 (B)	0.0041 (B)
	9/11/2007	ND	ND	0.1	91	ND	ND	0.000016 (B)	7.2	43	ND	23	ND	ND	0.98	0.00086 (B)	0.0082 (B)
	11/27/2007	ND	ND	0.093 (B)	83	ND	ND	0.000023 (B)	7	38	ND	22	ND	ND	1	0.001 (B)	0.0075 (B)
	2/28/2008	ND	ND	0.094 (B)	81	ND	0.0018 (B)	ND	6.6	38	ND	21	ND	ND	0.68	0.0017 (B)	0.0073 (B)
	4/17/2008	ND	ND	0.092 (B)	78	ND	ND	ND	6.6	36	ND	20	ND	ND	0.89	0.0014 (B)	0.0055 (B)
	9/24/2008	NT	NT	NT	74	NT	NT	NT	6.4	34	NT	19	NT	NT	0.69	NT	NT
	12/5/2008	NT	NT	NT	75	NT	NT	NT	6.6	33	NT	20	NT	NT	0.83	NT	NT
	3/18/2009	NT	NT	NT	76	NT	NT	NT	6.4	34	NT	19	NT	NT	0.77	NT	NT
	6/23/2009	0.00078	0.0032	0.096	77	0.00016	0.00041	0.000024	6.6	35	20	0.0019	0.00035	NT	0.66	NT	NT
	9/25/2009	NT	NT	NT	76 (J)	NT	NT	NT	5.2	34 (J)	NT	19 (J)	NT	NT	0.6	NT	NT
	12/18/2009	NT	NT	NT	79	NT	NT	NT	5.9	35	NT	20	NT	NT	0.75	NT	NT
	3/11/2010	NT	NT	NT	80	NT	NT	NT	5.6	36	NT	19	NT	NT	0.59	NT	NT
	6/10/2010	ND	ND	0.098 (B)	93	ND	ND	0.000024 (B)	6.9	43	NT	25	ND	NT	1.6	0.00094 (B)	NT
	9/10/2010	NT	NT	NT	87	NT	NT	NT	6.7	39	NT	23	NT	NT	0.98	NT	NT
	12/8/2010	NT	NT	NT	88	NT	NT	NT	6.5	39	NT	21	NT	NT	0.97	NT	NT
	3/3/2011	NT	NT	NT	78	NT	NT	NT	5.7	35	NT	20	NT	NT	0.83	NT	NT
	6/9/2011	ND	ND	0.087 B	81	ND	ND	ND	6.1	36	NT	21 J	ND	NT	0.82	0.00059 B	NT
	9/22/2011	NT	NT	NT	81	ND	ND	ND	6.2	36	NT	20	NT	NT	0.88	NT	NT
	12/8/2011	NT	NT	NT	76	NT	NT	NT	5.8	35	NT	20	NT	NT	0.63	NT	NT
	3/15/2012	NT	NT	NT	76	NT	NT	NT	5.8	35	NT	20	NT	NT	0.69	NT	NT
CSMRI-4	2/25/2005	ND	ND	ND	72	ND	ND	ND	5.1	31	0.017	29	ND	ND	24.7	ND	0.12
	6/14/2005	ND	ND	ND	86	ND	ND	ND	6.6	34	0.038	34	ND	0.0063	31.4	ND	0.068
	9/7/2005	ND	0.0035 (B)	0.055 (B)	82	ND	ND	ND	7.6	33	0.035	31	ND	0.0049 (B)	19.3	ND	0.097
	12/20/2005	ND	ND	0.056 (B)	100	ND	ND	0.000045 (B)	6.8	43	0.024	34	ND	ND	34.3	ND	0.18
	3/15/2006	ND	ND	0.042 (B)	81	ND	ND	0.000034 (B)	5	35	0.021	29	ND	ND	27.1	0.00056 (B)	0.21
	6/15/2006	ND	0.0031 (B)	0.055 (B)	89	0.00085 (B)	ND	0.0000049 (B)	8.3	37	0.03	31	ND	ND	26.8	0.0011 (B)	0.11
	9/13/2006	ND	ND	0.043 (B)	66	ND	ND	0.000016 (B)	8.3	27	0.038	30	ND	ND	17.9	ND	0.082
	3/8/2007	ND	0.0057 (B)	0.072 (B)	120	0.00023 (B)	ND	0.000018 (B)	11	49	0.015	47	ND	0.019	48	ND	0.088
	6/27/2007	ND	ND	0.067 (B)	110	ND	ND	0.000022 (B)	11	46	0.04	47	ND	ND	66	0.00073 (B)	0.14
	9/11/2007	ND	0.0045 (B)	0.089 (B)	120	0.0011 (B)	0.0014 (B)	0.000037 (B)	12	49	0.05	41	ND	ND	49	0.0012 (B)	0.17
	11/26/2007	ND	ND	0.081 (B)	110	0.00049 (B)	ND	0.000035 (B)	10	50	0.024	43	ND	ND	48	0.0011 (B)	0.1
	2/27/2008	ND	ND	0.073 (B)	130	ND	ND	0.000016 (B)	8.2	58	0.015	45	ND	0.0034 (B)	58	ND	0.069
	4/17/2008	ND	0.0063 (B)	0.089 (B)	150	0.00047 (B)	ND	0.000016 (B)	10	66	0.014	53	ND	ND	62	0.00078 (B)	0.087
	9/25/2008	NT	NT	NT	130	NT	NT	NT	13	55	NT	50	NT	NT	43	NT	NT
	12/5/2008	NT	NT	NT	130	NT	NT	NT	11	54	NT	48	NT	NT	61	NT	NT
	3/17/2009	NT	NT	NT	100	NT	NT	NT	9.3	45	NT	63	NT	NT	80	NT	NT
	6/23/2009	0.00078	0.0032	0.084	89	0.00016	0.00041	0.00013	12	38	70	0.0019	0.00068	NT	110	NT	NT
	9/24/2009	NT	NT	NT	160 (J)	NT	NT	NT	14	65 (J)	NT	69 (J)	NT	NT	160	NT	NT
	12/16/2009	NT	NT	NT	110	NT	NT	NT	11	49	NT	62	NT	NT	79	NT	NT
	3/10/2010	NT	NT	NT	120	NT	NT	NT	11	51	NT	55	NT	NT	NT	NT	NT
	5/3/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	83	NT	NT
	6/8/2010	ND	ND	0.1	140	0.00029 (B)	ND	0.00007 (B)	16	55	NT	59	ND	NT	56	ND	NT
	9/10/2010	NT	NT	NT	150	NT	NT	NT	19	62	NT	59	NT	NT	62	NT	NT
	12/7/2010	NT	NT	NT	150	NT	NT	NT	12	62	NT	60	NT	NT	73	NT	NT
	3/1/2011	NT	NT	NT	140	NT	NT	NT	12	58	NT	54	NT	NT	68	NT	NT
	6/8/2011	ND	ND	0.086 B	130	0.00036 B	ND	0.00015 B	15	55	NT	57 J	ND	NT	44 J	ND	NT
	9/20/2011	NT	NT	NT	53	NT	NT	NT	10	21	NT	22	NT	NT	16	NT	NT
	12/6/2011	NT	NT	NT	89	NT	NT	NT	12	36	NT	37	NT	NT	35	NT	NT
	3/13/2012	NT	NT	NT	160	NT	NT	NT	16	64	NT	63	NT	NT	77	NT	NT
CSMRI-5	2/25/2005	ND	ND	ND	54	ND	ND	ND	3.4	22	ND	27	ND	ND	2.8	ND	0.067
	6/14/2005	ND	ND	ND	63	ND	ND	ND	3.3	23	ND	28	ND	ND	3.57	ND	0.047
	9/7/2005	ND	ND	0.085 (B)	85	ND	ND	ND	4.2	31	0.0042 (B)	35	ND	0.0037 (B)	4.4	0.0018 (B)	0.089
	12/20/2005	ND	ND	0.072 (B)	79	0.00071 (B)	ND	0.000048 (B)	4.1	30	0.002 (B)	31	ND	ND	3.63	0.0012 (B)	0.17
	3/15/2006	ND	ND	0.058 (B)	70	0.00037 (B)	ND	0.000029 (B)	3.5	26	0.0031 (B)	29	ND	0.0035 (B)	4.1	0.00067 (B)	0.11
	6/15/2006	ND	ND	0.052 (B)	51	ND	ND	0.000012 (B)	3.6	19	0.0028 (B)	26	ND	ND	2.8	ND	0.055
	9/13/2006	ND	ND	0.087 (B)	110	ND	0.0022 (B)	ND	4.5	41	0.0027 (B)	50	ND	ND	7	0.001 (B)	0.11
	3/8/2007	ND	0.0037 (B)	0.063 (B)	80	ND	ND	ND	4.5	31	0.0019 (B)	34	ND	0.015	5.8	ND	0.083
	6/27/2007	ND	ND	0.066 (B)	98	ND	ND	0.0000091 (B)	4.5	40	0.006 (B)	40	ND	ND	10	0.0017 (B)	0.025
	9/11/2007	ND	ND	0.13	110	ND	0.00082 (B)	0.000023 (B)	4.9	44	0.0042 (B)	47	ND	ND	11	0.0015 (B)	0.054
	11/26/2007	ND	ND	0.087 (B)	110	ND	0.00089 (B)	0.000032 (B)	4.5	42	ND	47	ND	ND	6.6	0.0012 (B)	0.12
	2/27/2008	ND	ND	0.073 (B)	100	ND	ND	ND	4.3	40	ND	42	ND	ND	6.6	ND	0.094
	4/17/2008	ND	ND	0.078 (B)	100	ND	ND	0.000018 (B)	4.6	40	0.0011 (B)	41	ND	ND	6.7	0.0011 (B)	0.093
	9/25/2008	NT	NT	NT	160	NT	NT	NT	5.5	61	NT	59	NT	NT	10	NT	NT
	12/4/2008	NT	NT	NT	110	NT	NT	NT	4.8	40	NT	47	NT	NT	10	NT	NT
	3/17/2009	NT	NT	NT	110	NT	NT	NT	4.4	40	NT	44	NT	NT	11	NT	NT
	6/23/2009	0.00078	0.0032	0.12	130	0.00016	0.00041	0.000026	5.8	50	51	0.0019	0.00049	NT	12	NT	NT
	9/24/2009	NT	NT	NT	159 (J)	NT	NT	NT	4.2	56 (J)	NT	57 (J)	NT	NT	11	NT	NT
	12/16/2009	NT	NT	NT	130	NT	NT	NT	4.4	50	NT	55	NT	NT	9.8	NT	NT
	3/10/2010	NT	NT	NT	130	NT	NT	NT	4.3	49	NT	48	NT	NT	10	NT	NT
	5/3/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/8/2010	ND	ND	0.11	150	ND	ND	0.000028 (B)	5	54	NT	53	ND	NT	8.7	ND	NT
	9/10/2010	NT	NT	NT	150	NT	NT	NT	5.1	56	NT	64	NT	NT	13	NT	NT
	12/7/2010	NT	NT	NT	150	NT	NT	NT	4.9	52	NT	62	NT	NT	14	NT	NT
	3/1/2011	NT	NT	NT	130	NT	NT	NT	4.5	47	NT	55	NT	NT	13	NT	NT
	6/8/2011	ND	ND	0.1	130	ND	ND	ND	4.3	49	NT	58 J	ND	NT	13 J	ND	NT
	9/20/2011	NT	NT	NT	160	NT	NT	NT	5.6	61	NT	75	NT	NT	18	NT	NT
	12/6/2011	NT	NT	NT	130	NT	NT	NT	4.8	50	NT	70	NT	NT	23	NT	NT
	3/13/2012	NT	NT	NT	110	NT	NT	NT	4.3	45	NT	58	NT	NT	20	NT	NT

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(Results in milligrams per liter - U in micrograms per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	U	V	Zn
CSMRI-6B	2/27/2006	NT	NT	NT	NT	NT	NT	NT	NT	NT		NT	NT	NT	NT	NT	NT
	6/26/2007	ND	ND	0.12	100	ND	ND	0.0000059 (B)	5.9	56	0.004 (B)	41	ND	ND	17	ND	ND
	9/10/2007	ND	0.0046 (B)	0.15	110	ND	0.00088 (B)	0.000013 (B)	4.8	48	0.0022 (B)	46	ND	ND	11	0.00081 (B)	0.0051 (B)
	11/27/2007	ND	0.0048 (B)	0.17	110	ND	ND	0.000025 (B)	6	49	0.0028 (B)	57	ND	0.0051	8.2	0.00066 (B)	ND
	2/28/2008	ND	ND	0.17	100	ND	ND	ND	5.8	43	0.004 (B)	49	ND	ND	4.7	ND	0.0048
	4/18/2008	ND	ND	0.17	96	ND	ND	ND	6.1	40	0.0059 (B)	45	ND	ND	5	0.0013 (B)	0.0099 (B)
CSMRI-6C	7/11/2008 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/2009	0.00078	0.0032	0.24	120	0.00016	0.00041	0.000027	18	63	46	0.0019	0.0006	NT	19	NT	NT
	9/24/2009	NT	NT	NT	120 (J)	NT	NT	NT	5.1	60 (J)	NT	49 (J)	NT	NT	17	NT	NT
	12/18/2009	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	12	NT	NT
	3/8/2010	NT	NT	NS	NT	NT	NT	NT	NS	NS	NT	NS	NT	NT	NT	NT	NT
	6/8/2010	ND	ND	0.1 (B)	120	ND	ND	0.000026 (B)	5.2	56	NT	49	ND	NT	12	ND	NT
	9/8/2010	NT	NT	NT	130	NT	NT	NT	5	63	NT	50	NT	NT	25	NT	NT
	12/8/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	21	NT	NT
	3/2/2011	NT	NT	NT	100	NT	NT	NT	7.8	39	NT	66	NT	NT	5.5	NT	NT
	6/8/2011	ND	ND	0.21	100	ND	ND	ND	6.6	38	NT	60 J	ND	NT	4.3 J	ND	NT
	9/20/2011	NT	NT	NT	120	NT	NT	NT	5.1	58	NT	44	NT	NT	28	NT	NT
	12/6/2011	NT	NT	NT	100	NT	NT	NT	5.1	47	NT	43	NT	NT	21	NT	NT
	3/13/2012	NT	NT	NT	100	NT	NT	NT	5	42	NT	49	NT	NT	12	NT	NT
CSMRI-7B	2/27/2007	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/2007	ND	ND	0.056 (B)	70	ND	ND	0.000006 (B)	5.5	37	0.024	53	ND	ND	68	0.00061 (B)	0.0041 (B)
	9/10/2007	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	11/26/07 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	2/27/2008 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	4/15/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	9/24/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/22/09 (DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	9/23/2009 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	12/15/2009	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	3/8/10 (DRY)	NT	NT	NT	NS	NT	NT	NT	NS	NS	NT	NS	NT	NT	NT	NT	NT
	6/10/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	84	NT	NT
	9/10/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	75	NT	NT
	12/8/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-7C	3/2/2011	NT	NT	NT	100	NT	NT	NT	9.7	46	NT	60	NT	NT	8.3	NT	NT
	6/8/2011	ND	ND	0.082 B	110	ND	ND	ND	7.7	49	NT	59 J	ND	NT	5.2 J	ND	NT
	9/21/2011	NT	NT	NT	130	NT	NT	NT	9.8	64	NT	54	NT	NT	21	NT	NT
	12/7/2011	NT	NT	NT	110	NT	NT	NT	8.3	52	NT	61	NT	NT	5.7	NT	NT
	3/14/2012	NT	NT	NT	110	NT	NT	NT	7.7	52	NT	63	NT	NT	4.2	NT	NT
CSMRI-8	3/8/2007	ND	0.0053 (B)	0.068 (B)	230	ND	ND	ND	23	72	0.094	74	ND	0.034	1,100	ND	0.0024 (B)
	6/27/2007	ND	ND	0.053 (B)	190	ND	ND	0.0000099 (B)	19	55	0.043	52	ND	ND	810	ND	0.069
	9/10/2007	ND	0.0069 (B)	0.076 (B)	160	ND	0.00074 (B)	0.000027 (B)	15	49	0.034	54	0.0018 (B)	ND	630	ND	0.025
	11/27/2007	ND	ND	0.091 (B)	230	ND	ND	0.000024 (B)	15	67	0.026	70	ND	0.0046 (B)	1,300	0.001 (B)	0.011 (B)
	2/27/2008	ND	0.036 (B)	0.07 (B)	270	ND	ND	ND	15	82	0.019	100	ND	ND	1,200	ND	0.038
	4/17/2008	ND	ND	0.046 (B)	210	ND	0.0011 (B)	ND	13	63	0.016	73	ND	ND	770	ND	0.032
	9/25/2008	NT	NT	NT	230	NT	NT	NT	17	68	NT	70	NT	NT	890	NT	NT
	12/5/2008	NT	NT	NT	400	NT	NT	NT	18	95	NT	84	NT	NT	1,900	NT	NT
	3/18/2009	NT	NT	NT	250	NT	NT	NT	13	74	NT	97	NT	NT	980	NT	NT
	6/23/2009	0.00078	0.0032	0.038	170	0.00095	0.00041	0.00003	14	48	60	0.0019	0.00035	NT	700	NT	NT
	9/24/2009	NT	NT	NT	250 (J)	NT	NT	NT	13	63 (J)	NT	78 (J)	NT	NT	880	NT	NT
	12/16/2009	NT	NT	NT	210	NT	NT	NT	12	59	NT	56	NT	NT	580	NT	NT
	3/10/2010	NT	NT	NT	250	NT	NT	NT	12	77	NT	79	NT	NT	960	NT	NT
	6/8/2010	ND	ND	0.052 (B)	170	ND	ND	0.000024 (B)	14	60	NT	48	ND	NT	540	ND	NT
	9/8/2010	NT	NT	NT	240	NT	NT	NT	19	75	NT	64	NT	NT	520	NT	NT
	12/8/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8B	3/1/2011	NT	NT	NT	160	NT	NT	NT	17	58	NT	60	NT	NT	310	NT	NT
	6/7/2011	ND	ND	0.14	230	ND	ND	ND	29	73	NT	110 J	ND	NT	410 J	ND	NT
	9/20/2011	NT	NT	NT	130	NT	NT	NT	18	44	NT	48	NT	NT	180	NT	NT
	12/6/2011	NT	NT	NT	150	NT	NT	NT	17	53	NT	57	NT	NT	340	NT	NT
	3/13/2012	NT	NT	NT	160	NT	NT	NT	16	60	NT	61	NT	NT	380	NT	NT
CSMRI-9	2/27/2007	ND	ND	0.08 (B)	69	ND	0.0011 (B)	0.000024 (B)	12	31	0.045	33	ND	0.011	7.9	0.001 (B)	ND
	6/26/2007	ND	ND	0.049 (B)	160	ND	ND	0.000002 (B)	8.5	77	0.0028	150	ND	0.0049 (B)	32	0.00096 (B)	0.0096 (B)
	9/10/2007	ND	0.004 (B)	0.059 (B)	100	ND	0.0009 (B)	0.000016 (B)	6	51	0.0037 (B)	49	ND	ND	35	0.00071 (B)	0.0097 (B)
	11/26/2007	ND	ND	0.078 (B)	110	0.00051 (B)	0.0011 (B)	0.000031 (B)	5.9	56	0.0023 (B)	52	ND	0.0054	28	0.0012 (B)	0.015 (B)
	2/27/2008	ND	ND	0.079 (B)	110	ND	ND	ND	5.4	56	ND	49	ND	0.0033 (B)	24	ND	0.011
	4/15/2008	ND	ND	0.077 (B)	100	ND	ND	0.000013 (B)	5	52	0.0017 (B)	46	ND	ND	22	0.00077 (B)	0.0079 (B)
	9/24/2008	NT	NT	NT	110	NT	NT	NT	5.8	54	NT	50	NT	NT	28	NT	NT
	12/5/2008	NT	NT	NT	100	NT	NT	NT	5.3	48	NT	46	NT	NT	26	NT	NT
	3/16/2009	NT	NT	NT	100	NT	NT	NT	4.7	49	NT	45	NT	NT	34	NT	NT
	6/22/2009	0.00078	0.0032	0.054	250	0.00079	0.00041	0.000026	12	100	120	0.0019	0.00035	NT	99	NT	NT
	9/24/2009	NT	NT	NT	120 (J)	NT	NT	NT	5.6	58 (J)	NT	64 (J)	NT	NT	43	NT	NT
	12/16/2009	NT	NT	NT	140	NT	NT	NT	6.2	67	NT	59	NT	NT	39	NT	NT
	3/11/2010	NT	NT	NT	140	NT	NT	NT	5.1	67	NT	49	NT	NT	41	NT	NT
	6/9/2010	ND	ND	0.07 (B)	150	ND	ND	0.000019	6.7	69	NT	69	ND	NT	48	ND	NT
	9/8/2010	NT	NT	NT	130	NT	NT	NT	6.8	62	NT	51	NT	NT	31	NT	NT
	12/7/2010	NT	NT	NT	140	NT	NT	NT	5.6	63	NT	54	NT	NT	37	NT	NT
	3/1/2011	NT	NT	NT	130	NT	NT	NT	5.7	62	NT	43	NT	NT	43	NT	NT
	6/7/2011	ND	ND	0.083 B	140	ND	ND	ND	5.3	64	NT	58 J	ND	NT	49 J	ND	NT
	9/21/2011	NT	NT	NT	150	NT	NT	NT	5.9	70	NT	58	NT	NT	54	NT	NT
	12/7/2011	NT	NT	NT	120	NT	NT	NT	5.2	56	NT	55	NT	NT	46	NT	NT
	3/14/2012	NT	NT	NT	120	NT	NT	NT	4.7	55	NT	53	NT	NT	50	NT	NT
CSMRI-10	3/1/2007	0.00051 (B)	ND	0.064 (B)	79	ND	0.0013 (B)	0.000024 (B)	7.3	33	0.01	36	ND	0.01	7.8	0.0011 (B)	ND
	6/26/2007	ND	ND	0.079 (B)	100	ND	ND	0.0000063 (B)	4.7	44	ND	37	ND	0.0044 (B)	8.8	0.00055 (B)	ND
	9/10/2007	ND	0.0039 (B)	0.071 (B)	89	ND	0.0012 (B)	0.00002 (B)	4.2	38	0.0014 (B)	36	ND	ND	9.9	0.00099 (B)	0.0042 (B)
	11/26/2007	ND	ND	0.085 (B)	110	ND	ND	0.000026 (B)	4.7	43	ND	41	ND	ND	10	ND	ND
	2/26/2008	ND	ND	0.09 (B)	110	ND	ND	ND	4.6	46	ND	41	ND	ND	9.2	ND	0.0052
	4/15/2008	ND	ND	0.088 (B)	100	ND	0.0044 (B)	ND	4.5	44	ND	40	ND	ND	8.7	0.00059 (B)	0.0018 (B)
	9/24/2008	NT	NT	NT	100	NT	NT	NT	4.6	42	NT	41	NT	NT	11	NT	NT
	12/4/2008	NT	NT	NT	100	NT	NT	NT	4.8	41	NT	43	NT	NT	19	NT	NT
	3/16/2009	NT	NT	NT	110	NT	NT	NT	4.5	43	NT	43	NT	NT	16	NT	NT
	6/22/2009	0.00078	0.0032	0.09	100	0.00016	0.00041	0.00002	4.5	41	40	0.0019	0.00035	NT	12	NT	NT
	9/25/2009	NT	NT	NT	120 (J)	NT	NT	NT	3.8	47 (J)	NT	43 (J)	NT	NT	13	NT	NT
	12/16/2009	NT	NT	NT	130	NT	NT	NT	4.9	51	NT	49	NT	NT	14	NT	NT
	3/11/2010	NT	NT	NT	130	NT	NT	NT	4.4	52	NT	45	NT	NT	13	NT	NT
	6/9/2010	ND	ND	0.098 (B)	130	ND	ND	0.000025	4.7	48	NT	49	ND	NT	9.8	ND	NT
	9/8/2010	NT	NT	NT	120	NT	NT	NT	5	46	NT	51	NT	NT	14	NT	NT
	12/7/2010	NT	NT	NT	140	NT	NT	NT	4.9	51	NT	54 (J)	NT	NT	16	NT	NT
	3/1/2011	NT	NT	NT	120	NT	NT	NT	6.2	49	NT	39	NT	NT	14	NT	NT
	6/7/2011	ND	ND	0.11	120	ND	ND	ND	4.6	47	NT	59 J	ND	NT	12. J	ND	NT
	9/21/2011	NT	NT	NT	110	NT	NT	NT	4.6	43	NT	57	NT	NT	15	NT	NT
	12/7/2011	NT	NT	NT	110	NT	NT	NT	4.4	43	NT	56	NT	NT	21	NT	NT
	3/14/2012	NT	NT	NT	110	NT	NT	NT	4.1	45	NT	52	NT	NT	19	NT	NT
CSMRI-11	2/27/2007	ND	ND	0.073 (B)	75	ND	0.00013 (B)	0.000023 (B)	9.7	29	0.033	33	ND	0.013	4.8	0.00073 (B)	0.0023 (B)
	6/26/2007	ND	ND	0.096 (B)	110	ND	0.0012 (B)	0.0000071 (B)	5.4	44	0.0014 (B)	39	ND	0.0064	8.4	0.00059 (B)	ND
	9/10/2007	ND	0.004 (B)	0.071 (B)	96	ND	0.00083 (B)	0.000016 (B)	4.5	39	0.0016 (B)	44	ND	ND	10	0.00078(B)	0.0033 (B)
	11/26/2007	ND	ND	0.11	110	ND	ND	0.000028 (B)	4.9	44	0.0012 (B)	40	ND	ND	11	0.0013 (B)	ND
	2/26/2008	ND	ND	0.11	110	ND	ND	ND	4.6	42	ND	44	ND	ND	8.7	ND	0.0048
	4/15/2008	ND	ND	0.12	100	ND	ND	ND	4.7	41	ND	44	ND	ND	7.6	ND	ND
CSMRI-11B	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/2009	0.00078	0.0032	0.22	89	0.00043	0.00041	0.000027	19	43	48	0.0019	0.00066	NT	12	NT	NT
	9/25/2009	NT	NT	NT	130 (J)	NT	NT	NT	6.2	57 (J)	NT	49 (J)	NT	NT	17	NT	NT
	12/15/2009	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	14	NT	NT
	3/8/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/8/2010	ND	ND	0.091 (B)	130	ND	0.0013 (B)	0.000026	5.6	55	NT	49	ND	NT	10	ND	NT
	9/8/2010	NT	NT	NT	140	NT	NT	NT	6.6	64	NT	76	NT	NT	18	NT	NT
	12/8/2010	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	8.1	NT	NT
	3/2/2011	NT	NT	NT	120	NT	NT	NT	5.4	45	NT	57	NT	NT	14	NT	NT
	6/7/2011	ND	ND	0.13	120	ND	ND	ND	5.1	46	NT	63 J	ND	NT	9.8 J	ND	NT
	9/20/2011	NT	NT	NT	110	NT	NT	NT	4.8	42	NT	59	NT	NT	15	NT	NT
	12/6/2011	NT	NT	NT	110	NT	NT	NT	4.5	43	NT	54	NT	NT	20	NT	NT
	3/13/2012	NT	NT	NT	110	NT	NT	NT	4.4	45	NT	51	NT	NT	18	NT	NT
CSMRI-12	3/1/2011	NT	NT	NT	140	NT	NT	NT	12	50	NT	52	NT	NT	320	NT	NT
	6/7/2011	ND	ND	0.072 B	120	ND	ND	ND	14	40	NT	48 J	ND	NT	220 J	ND	NT
	9/20/2011	NT	NT	NT	80	NT	NT	NT	11	26	NT	33	NT	NT	130	NT	NT
	12/6/2011	NT	NT	NT	130	NT	NT	NT	13	40	NT	47	NT	NT	340	NT	NT
	3/13/2012	NT	NT	NT	140	NT	NT	NT	12	45	NT	49	NT	NT	380	NT	NT

Table G-2

Historical Summary of Metals in Groundwater (Stoller)

(Results in milligrams per liter - U in micrograms per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	U	V	Zn
CSMRI-13	3/2/2011	NT	NT	NT	120	NT	NT	NT	9	52	NT	56	NT	NT	42	NT	NT
	6/7/2011	ND	ND	0.076 B	120	0.0012 B	ND	ND	7.5	54	NT	60 J	ND	NT	47 J	ND	NT
	9/20/2011	NT	NT	NT	120	NT	NT	NT	7.1	55	NT	57	NT	NT	41	NT	NT
	12/6/2011	NT	NT	NT	120	NT	NT	NT	5.3	53	NT	57	NT	NT	51	NT	NT
	3/13/2012	NT	NT	NT	130	NT	NT	NT	5.4	59	NT	57	NT	NT	58	NT	NT
CSMRI-14	3/1/2011	NT	NT	NT	26	NT	NT	NT	4.3	13	NT	39	NT	NT	1.6	NT	NT
	6/8/2011	ND	ND	0.074 B	28	ND	ND	ND	4.2	15	NT	51 J	ND	NT	2.1 J	ND	NT
	9/21/2011	NT	NT	NT	28	NT	NT	NT	4.2	15	NT	52	NT	NT	2.1	NT	NT
	12/7/2011	NT	NT	NT	26	NT	NT	NT	3.7	14	NT	50	NT	NT	1.5	NT	NT
	3/14/2012	NT	NT	NT	26	NT	NT	NT	3.4	14	NT	49	NT	NT	1.4	NT	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	0.01	1	0.003	0.005	0.01	0.01	0.02
MCL*		NE	0.01	2	NE	0.005	0.1	0.002	NE	NE	NE	NE	0.015	0.05	30	NE	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations

ND – non detect

NE – not established

NT – not tested

(B) – Detected above Instrument Detection Level but below Reported Detection Level

Table G-3
Historical Summary of Radioisotopes in Surface Water (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)
SW-1	2/25/2005	0	0.58	0.018	-0.026	-0.001	0.89	0.083	0.65
	6/14/2005	0.14	0.05	0.05	-0.025	0.016	0.246	0.021	0.251
	9/7/2005	0.18	0.42	0.041	0.25	0.102	0.35	0.031	0.35
	12/20/2005	-0.31	0.47	0.028	0.197	-0.005	0.64	0.041	0.7
	3/15/2006	-0.16	0.35	0.059	0.125	0.005	0.6	0.029	0.53
	6/14/2006	0.13	0.45	0.16	0.53	0.062	0.11	0.08	0.19
	9/13/2006	-0.03	0.25	-0.019	-0.035	0.01	0.37	-0.005	0.34
	3/1/2007	-0.1	0.25	-0.038	0.15	0.026	NT	NT	NT
	6/27/2007	0.13	0.77	0.006	0.016	0.014	NT	NT	NT
	9/11/2007	0.15	0.74	0.063	0.088	0.012	NT	NT	NT
	11/27/2007	0.2	0.24	0.026	0.049	0.025	NT	NT	NT
	2/27/2008	0.1	0.48	0.014	0.002	0.024	NT	NT	NT
	4/18/2008	0.06	-0.07	-0.023	-0.026	0.012	NT	NT	NT
	9/25/2008	0.18	-0.01	NT	NT	NT	NT	NT	NT
	12/3/2008	-0.06	0.34	NT	NT	NT	NT	NT	NT
	3/16/2009	0.14	0.73	NT	NT	NT	NT	NT	NT
	6/24/2009	0.33	1.228 J	NT	NT	NT	NT	NT	NT
	9/24/2009	-0.08	0.37	NT	NT	NT	NT	NT	NT
	12/17/2009	0.1	0.42	NT	NT	NT	NT	NT	NT
	3/9/2010	-0.04	0.2	NT	NT	NT	NT	NT	NT
	6/9/2010	0.07	0.44 (J)	NT	NT	NT	NT	NT	NT
	9/9/2010	0.04	0.21	NT	NT	NT	NT	NT	NT
	12/8/2010	0.03	0.58	NT	NT	NT	NT	NT	NT
	3/2/2011	0.07	0.31 UJ	NT	NT	NT	NT	NT	NT
	6/8/2011	0.14	0.38	NT	NT	NT	NT	NT	NT
	9/21/2011	0.2	0.71	NT	NT	NT	NT	NT	NT
	12/7/2011	0.63	0.96	NT	NT	NT	NT	NT	NT
	3/14/2012	0.13	0.32	NT	NT	NT	NT	NT	NT
SW-2	2/25/2005	0.45	0.06	0.011	-0.016	0.033	0.8	0.066	0.42
	6/14/2005	0.04	0.29	0.071	-0.028	0.007	0.259	0.032	0.23
	9/7/2005	-0.08	0.24	-0.013	0.107	0.051	0.54	0.014	0.54
	12/20/2005	0.09	0.07	-0.003	0.126	0	0.71	0.067	0.49
	3/15/2006	-0.04	-0.15	0.009	0.184	0.01	0.79	0.004	0.51
	6/14/2006	0.03	0.04	0.172	0.24	0.1	0.39	0	0.48
	9/13/2006	0.11	0.35	0.009	-0.03	0.01	0.43	-0.006	0.3
	3/8/2007	0.12	0.73	0.047	-0.055	0	NT	NT	NT
	6/28/2007	0.02	0.78	0.028	0.014	0	NT	NT	NT
	9/11/2007	0.1	0.27	0.066	0.068	0.002	NT	NT	NT
	11/26/2007	0.11	0.36	0.007	0	0.012	NT	NT	NT
	2/26/2008	0.1	0	-0.01	0.113	0.011	NT	NT	NT
	4/18/2008	0.13	0.58	0.015	0.24	0.024	NT	NT	NT
	9/24/2008	-0.16	-0.02	NT	NT	NT	NT	NT	NT
	12/3/2008	0.1	0.46	NT	NT	NT	NT	NT	NT
	3/16/2009	0.2	0.29	NT	NT	NT	NT	NT	NT
	6/24/2009	0.03	0.47 J	NT	NT	NT	NT	NT	NT
	9/24/2009	0	0.28 (J)	NT	NT	NT	NT	NT	NT
	12/17/2009	0.03	0.44	NT	NT	NT	NT	NT	NT
	3/9/2010	-0.03	0.27	NT	NT	NT	NT	NT	NT
	6/9/2010	0.07	-0.06	NT	NT	NT	NT	NT	NT
	9/9/2010	0.2	0.16	NT	NT	NT	NT	NT	NT
	12/8/2010	0.02	0.24	NT	NT	NT	NT	NT	NT
	3/2/2011	0.18	0.38 UJ	NT	NT	NT	NT	NT	NT
	6/8/2011	0.08	0.25	NT	NT	NT	NT	NT	NT
	9/21/2011	0.04	0.57	NT	NT	NT	NT	NT	NT
	12/7/2011	0.15	1.31	NT	NT	NT	NT	NT	NT
	3/14/2012	0.03	0.26	NT	NT	NT	NT	NT	NT
SW-3	6/10/2010	0.39	0.01	NT	NT	NT	NT	NT	NT
	9/9/2010	0.13	0.21	NT	NT	NT	NT	NT	NT
	12/8/2010	0.06	0.26	NT	NT	NT	NT	NT	NT
	3/2/2011	0.87	0.56 UJ	NT	NT	NT	NT	NT	NT
	6/8/2011	0.22	0.28	NT	NT	NT	NT	NT	NT
	9/21/2011	0.09	1.15	NT	NT	NT	NT	NT	NT
	12/7/2011	0.1	1.04	NT	NT	NT	NT	NT	NT
	3/14/2012	1.41	0.62	NT	NT	NT	NT	NT	NT
MCL*		Total Ra = 5		NE	Th 230 + Th 232 = 60**		NE	NE	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations

**5 CCR 1002-31 Reg 31 – Colorado Surface Water Standards

pCi/l - picoCuries per liter

µg/l – micrograms per liter

Table G-4

Historical Summary of Metals in Surface Water (Stoller)

(Results in milligrams per liter - U in micrograms per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	U	V	Zn
SW-1	2/25/2005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.97	ND	0.2
	6/14/2005	ND	ND	ND	11	ND	ND	ND	1.1	2.8	ND	5.2	ND	ND	0.75	ND	0.09
	9/7/2005	ND	0.0037 (B)	0.029 (B)	20	ND	ND	ND	2.2	4.4	0.0044 (B)	8.5	ND	0.0045 (B)	1.04	ND	0.063
	12/20/2005	ND	ND	0.042 (B)	35	0.00057 (B)	ND	0.000034 (B)	3.7	7.6	0.004 (B)	19	ND	ND	2.11	ND	0.22
	3/15/2006	ND	ND	0.04 (B)	37	0.00084 (B)	0.00047 (B)	0.000024 (B)	3.7	8.5	0.0048 (B)	23	ND	ND	1.59	0.00067 (B)	0.19
	6/14/2006	0.0012 (B)	0.0032 (B)	0.011 (B)	8.2	ND	ND	ND	1	1.9	0.0042 (B)	3.1	ND	ND	0.61	ND	0.029
	9/13/2006	ND	ND	0.03 (B)	21	ND	ND	ND	2.1	4.4	0.0049 (B)	8.6	ND	ND	1	ND	0.053
	3/1/2007	ND	ND	0.049 (B)	44	0.0011 (B)	0.00092 (B)	0.000023 (B)	4.3	11	0.0046 (B)	26	ND	ND	1.7	ND	0.22
	6/27/2007	ND	ND	0.018 (B)	10	ND	ND	0.0000068 (B)	0.93 (B)	2.5	0.0017 (B)	3.2	ND	ND	0.6	ND	0.067
	9/11/2007	ND	ND	0.032 (B)	21	ND	ND	0.000019	1.7	5	0.0029 (B)	7.4	ND	ND	0.94	ND	0.078
	11/27/2007	ND	ND	0.042 (B)	33	0.00076 (B)	ND	0.00027 (B)	2.8	8.2	0.0032 (B)	15	ND	ND	1.8	ND	0.18
	2/27/2008	ND	ND	0.042 (B)	36	ND	ND	ND	3.3	9.6	0.0022 (B)	19	ND	ND	2	ND	0.15
	4/18/2008	ND	ND	0.044 (B)	35	0.00044 (B)	ND	ND	3.4	9	0.0034 (B)	23	ND	ND	1.9	ND	0.13
	9/25/2008	NT	NT	NT	23	NT	NT	NT	1.9	5.1	NT	9	NT	NT	1.1	NT	NT
	12/3/2008	NT	NT	NT	32	NT	NT	NT	3	7.1	NT	15	NT	NT	1.6	NT	NT
	3/16/2009	NT	NT	NT	35	NT	NT	NT	3.1	8.9	NT	17	NT	NT	1.9	NT	NT
	6/24/2009	0.00078	0.0032	0.017	8.7	0.00016	0.00041	0.000024	0.92	2.1	3.3	0.0019	0.00035	NT	0.55	NT	NT
	9/24/2009	NT	NT	NT	25 (J)	NT	NT	NT	1.4	5.5 (J)	NT	9.7 (J)	NT	NT	1.1	NT	NT
	12/17/2009	NT	NT	NT	39	NT	NT	NT	2.8	8.5	NT	18	NT	NT	1.7	NT	NT
	3/9/2010	NT	NT	NT	40	NT	NT	NT	2.8	11	NT	21	NT	NT	2	NT	NT
	6/9/2010	ND	ND	0.012 (B)	8.4	ND	0.001 (B)	0.000027 (B)	0.47 (B)	1.9	NT	2.8	ND	NT	0.46	ND	NT
	9/9/2010	NT	NT	NT	23	NT	NT	NT	1.7	5.1	NT	9	NT	NT	1	NT	NT
	12/8/2010	NT	NT	NT	38	NT	NT	NT	2.5	8.3	NT	14	NT	NT	1.6	NT	NT
	3/2/2011	NT	NT	NT	38	NT	NT	NT	2.7	8.9	NT	17	NT	NT	2	NT	NT
	6/8/2011	ND	ND	0.018 (B)	11	ND	ND	ND	0.55 B	2.5	NT	4.1 J	ND	NT	0.63	ND	NT
	9/21/2011	NT	NT	NT	21	NT	NT	NT	1.2	4.1	NT	6	NT	NT	0.88	NT	NT
	12/7/2011	NT	NT	NT	46	NT	NT	NT	2.8	10	NT	18	NT	NT	2.2	NT	NT
	3/14/2012	NT	NT	NT	43	NT	NT	NT	2.8	9.6	NT	19	NT	NT	1.9	NT	NT
SW-2	2/25/2005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.29	ND	0.17
	6/14/2005	ND	ND	ND	11	`ND	ND	ND	1.1	2.8	ND	4.8	ND	ND	0.69	ND	0.085
	9/7/2005	ND	ND	0.028 (B)	20	ND	ND	ND	2.1	4.4	0.0037 (B)	8.7	ND	0.0037 (B)	1.62	ND	0.051
	12/20/2005	ND	ND	0.042 (B)	35	0.00043 (B)	ND	0.000034 (B)	3.8	8	0.0038 (B)	19	ND	ND	1.5	ND	0.21
	3/15/2006	ND	ND	0.042 (B)	39	0.00053 (B)	0.00055 (B)	0.000022 (B)	3.8	8.9	0.0046 (B)	25	ND	ND	1.52	0.00053 (B)	0.2
	6/14/2006	ND	0.0022 (B)	0.011 (B)	8.4	ND	ND	ND	1	1.9	0.0045 (B)	3	ND	ND	1.44	ND	0.031
	9/13/2006	ND	ND	0.03 (B)	21	ND	ND	ND	2.1	4.4	0.0048 (B)	8.5	ND	ND	0.89	ND	0.04
	3/8/2007	ND	0.0053 (B)	0.049 (B)	39	0.00064 (B)	ND	ND	4.2	9.8	0.0014 (B)	22	ND	ND	1.7	ND	0.17
	6/28/2007	ND	ND	0.019 (B)	10	ND	ND	0.0000056 (B)	0.93 (B)	2.6	ND	3.3	ND	ND	0.57	ND	0.075
	9/11/2007	ND	ND	0.033 (B)	21	ND	ND	0.00001	1.7	5.1	0.0035 (B)	7.5	ND	ND	0.97	ND	0.084
	11/26/2007	ND	ND	0.044 (B)	35	0.0005 (B)	ND	0.00027 (B)	2.9	8.6	0.0027 (B)	15	ND	ND	1.7	ND	0.19
	2/26/2008	ND	ND	0.051	35	0.0005 (B)	ND	ND	3.1	9.2	0.0023 (B)	21	ND	ND	2	ND	0.15
	4/18/2008	ND	ND	0.045 (B)	35	0.0005 (B)	ND	ND	3.4	9.1	0.0031 (B)	23	ND	ND	1.8	ND	0.14
	9/24/2008	NT	NT	NT	23	NT	NT	NT	1.9	5.1	NT	9	NT	NT	0.99	NT	NT
	12/3/2008	NT	NT	NT	31	NT	NT	NT	3	7.5	NT	15	NT	NT	1.5	NT	NT
	3/16/2009	NT	NT	NT	37	NT	NT	NT	3.5	9.7	NT	19	NT	NT	1.9	NT	NT
	6/24/2009	0.00078	0.0032	0.016	8.7	0.00016	0.00041	0.000027	0.9	2.2	3.3	0.0019	0.00035	NT	0.059	NT	NT
	9/24/2009	NT	NT	NT	25 (J)	NT	NT	NT	1.4	5.5 (J)	NT	9.4 (J)	NT	NT	1.1	NT	NT
	12/17/2009	NT	NT	NT	42	NT	NT	NT	3	9.8	NT	19	NT	NT	1.9	NT	NT
	3/9/2010	0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	NT	1	0.003	NT	2	0.01	NT
	6/9/2010	ND	ND	0.012 (B)	8	ND	ND	0.000024 (B)	0.49 (B)	1.9	NT	2.7	ND	NT	0.52	ND	NT
	9/9/2010	NT	NT	NT	23	NT	NT	NT	1.7	5.3	NT	9.2	NT	NT	1	NT	NT
	12/8/2010	NT	NT	NT	40	NT	NT	NT	2.5	8.8	NT	14	NT	NT	1.7	NT	NT
	3/2/2011	NT	NT	NT	40	NT	NT	NT	2.7	9.3	NT	17	NT	NT	2.1	NT	NT
	6/8/2011	ND	ND	0.018 B	11	ND	ND	ND	0.55 B	2.5	NT	4.2 J	ND	NT	0.75	ND	NT
	9/21/2011	NT	NT	NT	21	NT	NT	NT	1.2	4.2	NT	6.1	NT	NT	0.87	NT	NT
	12/7/2011	NT	NT	NT	47	NT	NT	NT	2.8	10	NT	19	NT	NT	2.1	NT	NT
	3/14/2012	NT	NT	NT	42	NT	NT	NT	3	9.7	NT	20	NT	NT	1.8	NT	NT
SW-3	6/10/2010	ND	ND	0.012 (B)	8.4	ND	ND	0.000024 (B)	0.5 (B)	1.9	NT	2.7	ND	NT	0.49	ND	NT
	9/9/2010	NT	NT	NT	23	NT	NT	NT	1.7	5.2	NT	9.3	NT	NT	0.98	NT	NT
	12/8/2010	NT	NT	NT	38	NT	NT	NT	2.5	8.3	NT	15	NT	NT	1.7	NT	NT
	3/2/2011	NT	NT	NT	40	NT	NT	NT	2.7	9.2	NT	17	NT	NT	2	NT	NT
	6/8/2011	ND	ND	0.017 B	10	ND	ND	ND	0.52 B	2.4	NT	4.1 J	ND	NT	0.64	ND	NT
	9/21/2011	NT	NT	NT	21	NT	NT	NT	1.2	4.3	NT	6.2	NT	NT	1.1	NT	NT
	12/7/2011	NT	NT	NT	48	NT	NT	NT	2.8	11	NT	19	NT	NT	2.2	NT	NT
	3/14/2012	NT	NT	NT	41	NT	NT	NT	2.9	9.4	NT	20	NT	NT	1.8	NT	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	0.01	1	0.003	0.005	0.01	0.01	0.02
MCL*		0.01	0.01	2	NE	0.005	0.1	0.002	NE	NE	NE	NE	0.015	0.05	30	NE	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations

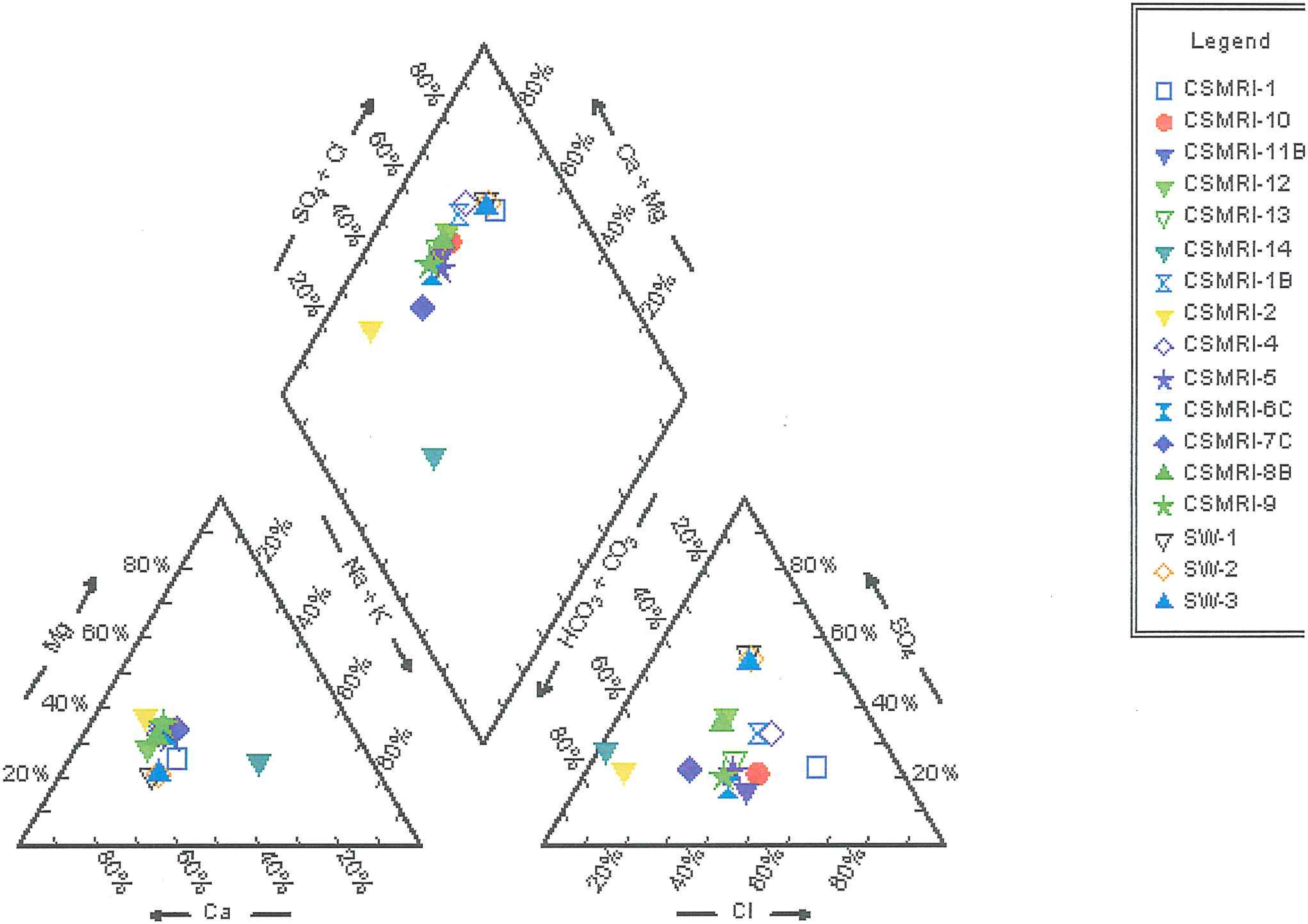
ND – Non Detect

NE – Not Established

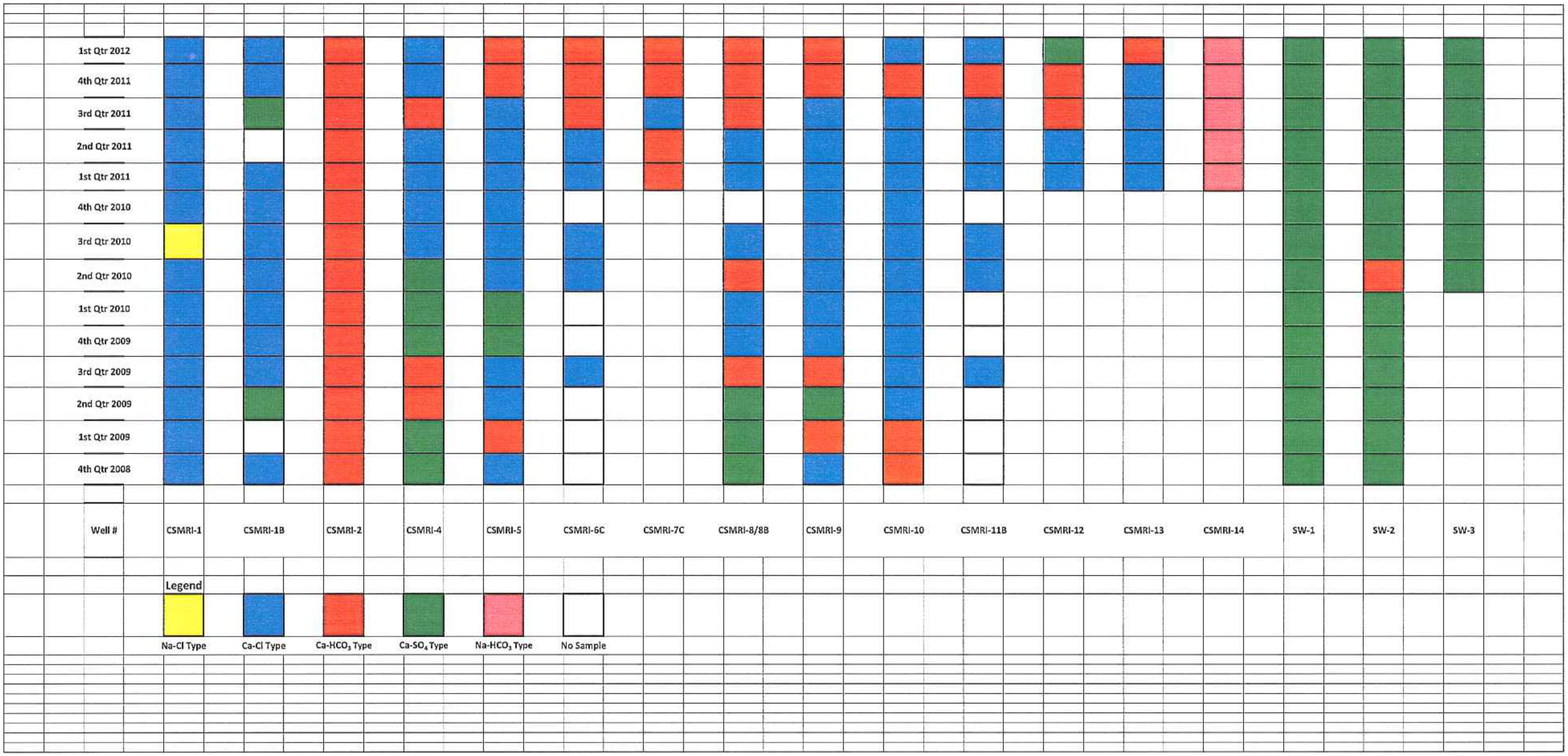
(B) – Detected above Instrument Detection Level but below Reported Detection Level

Appendix H
Anion and Cation Balances and Piper Diagram

Piper Diagram CSMRI 2012 Quarter 1



CSMRI
Water Quality Types



1st Qtr 2012	🟦	🟦	🟥	🟦	🟥	🟥	🟥	🟥	🟥	🟦	🟦	🟩	🟥	🟪	🟩	🟩	🟩
4th Qtr 2011	🟦	🟦	🟥	🟦	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟦	🟪	🟩	🟩	🟩
3rd Qtr 2011	🟦	🟩	🟥	🟥	🟦	🟥	🟦	🟥	🟦	🟦	🟦	🟥	🟦	🟪	🟩	🟩	🟩
2nd Qtr 2011	🟦	☐	🟥	🟦	🟦	🟦	🟥	🟦	🟦	🟦	🟦	🟦	🟦	🟪	🟩	🟩	🟩
1st Qtr 2011	🟦	🟦	🟥	🟦	🟦	🟦	🟥	🟦	🟦	🟦	🟦	🟦	🟦	🟪	🟩	🟩	🟩
4th Qtr 2010	🟦	🟦	🟥	🟦	🟦	☐		☐	🟦	🟦	☐				🟩	🟩	🟩
3rd Qtr 2010	🟨	🟦	🟥	🟦	🟦	🟦		🟦	🟦	🟦	🟦				🟩	🟩	🟩
2nd Qtr 2010	🟦	🟦	🟥	🟩	🟦	🟦		🟥	🟦	🟦	🟦				🟩	🟥	🟩
1st Qtr 2010	🟦	🟦	🟥	🟩	🟩	☐		🟦	🟦	🟦	☐				🟩	🟩	
4th Qtr 2009	🟦	🟦	🟥	🟩	🟩	☐		🟦	🟦	🟦	☐				🟩	🟩	
3rd Qtr 2009	🟦	🟦	🟥	🟥	🟦	🟦		🟥	🟥	🟦	🟦				🟩	🟩	
2nd Qtr 2009	🟦	🟩	🟥	🟥	🟦	☐		🟩	🟩	🟦	☐				🟩	🟩	
1st Qtr 2009	🟦	☐	🟥	🟩	🟥	☐		🟩	🟥	🟥	☐				🟩	🟩	
4th Qtr 2008	🟦	🟦	🟥	🟩	🟦	☐		🟩	🟦	🟥	☐				🟩	🟩	
Well #	CSMRI-1	CSMRI-1B	CSMRI-2	CSMRI-4	CSMRI-5	CSMRI-6C	CSMRI-7C	CSMRI-8/8B	CSMRI-9	CSMRI-10	CSMRI-11B	CSMRI-12	CSMRI-13	CSMRI-14	SW-1	SW-2	SW-3

Legend

🟨	🟦	🟥	🟩	🟪	☐
Na-Cl Type	Ca-Cl Type	Ca-HCO$_3$ Type	Ca-SO$_4$ Type	Na-HCO$_3$ Type	No Sample

CSMRI - 1

Fluid Properties

Water Type	Ca-Cl		
Dissolved Solids	441.16 mg/kg	440 mg/L	Measured
Density	0.99736 g/cm^3		Calculated
Conductivity	719 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	249.44 mg/kg	248.78 mg/L	Calculated
Carbonate	158.17	157.75	
Non-Carbonate	91.275	91.034	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	6.91	
Cations	6.83	
% Difference	0.620	OK
Measured TDS = Calculated TDS		
Measured	441.163	
Calculated	442.266	
Ratio	0.998	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	719.000	
Calculated	705.408	
Ratio	1.019	OK

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.961685	Within preferred range (0.9-1.1)
Cations	0.949840	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.615	OK
Measured TDS to EC ratio	0.614	OK

CSMRI – 1B

Fluid Properties

Water Type	Ca-Cl		
Dissolved Solids	711.73 mg/kg	710 mg/L	Measured
Density	0.99757 g/cm^3		Calculated
Conductivity	1002.5 µmho/cm		Calculated
Hardness (as $CaCO_3$)			
Total	498.52 mg/kg	497.3 mg/L	Calculated
Carbonate	477.14	475.98	
Non-Carbonate	21.38	21.328	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	9.07	
Cations	12.2	
% Difference	14.860	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	711.731	
Calculated	778.894	
Ratio	0.914	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	N/A	
Calculated	1002.498	
Ratio	N/A	

Secondary Tests

Measured EC and Ion Sums:

Measured EC not available

Calculated TDS to EC ratio

Measured EC not available

Measured TDS to EC ratio

Measured EC unavailable

CSMRI – 2

Fluid Properties

Water Type	Ca-HCO_3		
Dissolved Solids	411.09 mg/kg	410 mg/L	Measured
Density	0.99734 g/cm^3		Calculated
Conductivity	612 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	334.79 mg/kg	333.9 mg/L	Calculated
Carbonate	334.79	333.9	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests		
Anion-Cation Balance		
Anions	6.45	
Cations	7.69	
% Difference	8.742	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	411.093	
Calculated	528.204	
Ratio	0.778	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	612.000	
Calculated	636.746	
Ratio	0.961	OK
Secondary Tests		
Measured EC and Ion Sums:		
Anions	1.054646	Within preferred range (0.9-1.1)
Cations	1.256703	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.863	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio	0.672	OK

CSMRI – 4

Fluid Properties

Water Type	Ca-Cl		
Dissolved Solids	912.08 mg/kg	910 mg/L	Measured
Density	0.99772 g/cm^3		Calculated
Conductivity	1620 µmho/cm		Measured
Hardness (as CaCO$_3$)			
Total	664.59 mg/kg	663.07 mg/L	Calculated
Carbonate	460.9	459.85	
Non-Carbonate	203.69	203.22	

Internal Consistency

Primary Tests		
Anion-Cation Balance		
Anions	15	
Cations	16.4	
% Difference	4.575	OK
Measured TDS = Calculated TDS		
Measured	912.080	
Calculated	1035.361	
Ratio	0.881	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1620.000	
Calculated	1442.069	
Ratio	1.123	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	0.923798	Within preferred range (0.9-1.1)
Cations	1.012376	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.639	OK
Measured TDS to EC ratio	0.563	OK

CSMRI – 5

Fluid Properties

Water Type	Ca-HCO$_3$		
Dissolved Solids	701.71 mg/kg	700 mg/L	Measured
Density	0.99756 g/cm^3		Calculated
Conductivity	1280 µmho/cm		Measured
Hardness (as CaCO$_3$)			
Total	461.1 mg/kg	459.98 mg/L	Calculated
Carbonate	461.1	459.98	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests		
Anion-Cation Balance		
Anions	10.8	
Cations	11.8	
% Difference	4.492	OK
Measured TDS = Calculated TDS		
Measured	701.712	
Calculated	783.411	
Ratio	0.896	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1280.000	
Calculated	1038.438	
Ratio	1.233	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	0.844402	Not within preferred range (0.9-1.1)
Cations	0.923839	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.612	OK
Measured TDS to EC ratio	0.548	Not within preferred range (0.55-0.7)

CSMRI – 6C

Fluid Properties

Water Type	Ca-HCO_3		
Dissolved Solids	611.53 mg/kg	610 mg/L	Measured
Density	0.99749 g/cm^3		Calculated
Conductivity	1090 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	423.72 mg/kg	422.66 mg/L	Calculated
Carbonate	423.72	422.66	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	9.63	
Cations	10.7	
% Difference	5.285	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	611.533	
Calculated	708.276	
Ratio	0.863	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1090.000	
Calculated	936.793	
Ratio	1.164	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.883567	Not within preferred range (0.9-1.1)
Cations	0.982173	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.650	OK
Measured TDS to EC ratio	0.561	OK

CSMRI – 7C

Fluid Properties

Water Type	Ca-HCO_3		
Dissolved Solids	681.67 mg/kg	680 mg/L	Measured
Density	0.99755 g/cm^3		Calculated
Conductivity	1260 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	490.01 mg/kg	488.81 mg/L	Calculated
Carbonate	490.01	488.81	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests		
Anion-Cation Balance		
Anions	10.5	
Cations	12.7	
% Difference	9.355	Not within ± 5%
Measured TDS = Calculated TDS		
Measured	681.673	
Calculated	851.791	
Ratio	0.800	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1260.000	
Calculated	1030.652	
Ratio	1.223	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	0.835848	Not within preferred range (0.9-1.1)
Cations	1.008385	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.676	OK
Measured TDS to EC ratio	0.541	Not within preferred range (0.55-0.7)

CSMRI – 8B

Fluid Properties

Water Type	Ca-HCO_3		
Dissolved Solids	922.1 mg/kg	920 mg/L	Measured
Density	0.99773 g/cm^3		Calculated
Conductivity	1620 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	648.07 mg/kg	646.6 mg/L	Calculated
Carbonate	592.42	591.08	
Non-Carbonate	55.651	55.524	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	14.4	
Cations	16	
% Difference	5.190	Not within ± 5%
Measured TDS = Calculated TDS		
Measured	922.096	
Calculated	1041.167	
Ratio	0.886	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1620.000	
Calculated	1364.634	
Ratio	1.187	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.889329	Not within preferred range (0.9-1.1)
Cations	0.986686	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.643	OK
Measured TDS to EC ratio	0.569	OK

CSMRI – 9

Fluid Properties

Water Type	Ca-HCO$_3$		
Dissolved Solids	721.75 mg/kg	720 mg/L	Measured
Density	0.99758 g/cm^3		Calculated
Conductivity	1320 µmho/cm		Measured
Hardness (as CaCO$_3$)			
Total	527.41 mg/kg	526.13 mg/L	Calculated
Carbonate	527.41	526.13	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	10.4	
Cations	12.9	
% Difference	10.836	Not within ± 5%
Measured TDS = Calculated TDS		
Measured	721.750	
Calculated	840.337	
Ratio	0.859	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1320.000	
Calculated	1055.037	
Ratio	1.251	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.788614	Not within preferred range (0.9-1.1)
Cations	0.980295	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.637	OK
Measured TDS to EC ratio	0.547	Not within preferred range (0.55-0.7)

CSMRI – 10

Fluid Properties

Water Type	Ca-Cl		
Dissolved Solids	651.61 mg/kg	650 mg/L	Measured
Density	0.99752 g/cm^3		Calculated
Conductivity	1200 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	461.12 mg/kg	459.98 mg/L	Calculated
Carbonate	461.12	459.98	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	9.11	
Cations	11.6	
% Difference	11.853	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	651.614	
Calculated	755.371	
Ratio	0.863	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1200.000	
Calculated	965.070	
Ratio	1.243	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.759124	Not within preferred range (0.9-1.1)
Cations	0.963272	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.629	OK
Measured TDS to EC ratio	0.543	Not within preferred range (0.55-0.7)

CSMRI – 11B

Fluid Properties

Water Type	Ca-Cl		
Dissolved Solids	661.63 mg/kg	660 mg/L	Measured
Density	0.99753 g/cm^3		Calculated
Conductivity	1290 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	461.12 mg/kg	459.98 mg/L	Calculated
Carbonate	461.12	459.98	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	10.5	
Cations	11.5	
% Difference	4.622	OK
Measured TDS = Calculated TDS		
Measured	661.634	
Calculated	757.270	
Ratio	0.874	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1290.000	
Calculated	1017.738	
Ratio	1.268	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.814348	Not within preferred range (0.9-1.1)
Cations	0.893274	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.587	OK
Measured TDS to EC ratio	0.513	Not within preferred range (0.55-0.7)

CSMRI – 12

Fluid Properties

Water Type	Ca-SO_4		
Dissolved Solids	781.86 mg/kg	780 mg/L	Measured
Density	0.99762 g/cm^3		Calculated
Conductivity	1350 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	536.17 mg/kg	534.89 mg/L	Calculated
Carbonate	477.39	476.25	
Non-Carbonate	58.778	58.639	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	12.3	
Cations	13.1	
% Difference	3.317	OK
Measured TDS = Calculated TDS		
Measured	781.860	
Calculated	878.089	
Ratio	0.890	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1350.000	
Calculated	1177.072	
Ratio	1.147	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.909983	Within preferred range (0.9-1.1)
Cations	0.972420	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.650	OK
Measured TDS to EC ratio	0.579	OK

CSMRI – 13

Fluid Properties

Water Type	$Ca-HCO_3$		
Dissolved Solids	791.88 mg/kg	790 mg/L	Measured
Density	0.99763 g/cm^3		Calculated
Conductivity	1320 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	568.92 mg/kg	567.57 mg/L	Calculated
Carbonate	559.6	558.27	
Non-Carbonate	9.3254	9.3032	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	12.6	
Cations	14	
% Difference	4.945	OK
Measured TDS = Calculated TDS		
Measured	791.878	
Calculated	908.454	
Ratio	0.872	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	1320.000	
Calculated	1205.051	
Ratio	1.095	OK
Secondary Tests		
Measured EC and Ion Sums:		
Anions	0.957909	Within preferred range (0.9-1.1)
Cations	1.057565	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.688	OK
Measured TDS to EC ratio	0.600	OK

CSMRI – 14

Fluid Properties

Water Type	Na-HCO_3		
Dissolved Solids	280.77 mg/kg	280 mg/L	Measured
Density	0.99724 g/cm^3		Calculated
Conductivity	431 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	122.91 mg/kg	122.57 mg/L	Calculated
Carbonate	122.91	122.57	
Non-Carbonate	0.0	0.0	

Internal Consistency

Primary Tests		
Anion-Cation Balance		
Anions	4.89	
Cations	4.67	
% Difference	2.289	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	280.774	
Calculated	372.026	
Ratio	0.755	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	431.000	
Calculated	439.199	
Ratio	0.981	OK
Secondary Tests		
Measured EC and Ion Sums:		
Anions	1.133767	Not within preferred range (0.9-1.1)
Cations	1.083026	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.863	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio	0.651	OK

SW – 1

Fluid Properties

Water Type	Ca-SO_4		
Dissolved Solids	260.72 mg/kg	260 mg/L	Measured
Density	0.99723 g/cm^3		Calculated
Conductivity	484 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	147.31 mg/kg	146.9 mg/L	Calculated
Carbonate	85.673	85.436	
Non-Carbonate	61.639	61.468	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	4.09	
Cations	3.83	
% Difference	3.279	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	260.723	
Calculated	271.152	
Ratio	0.962	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	484.000	
Calculated	430.301	
Ratio	1.125	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.845825	Not within preferred range (0.9-1.1)
Cations	0.792119	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.560	OK
Measured TDS to EC ratio	0.539	Not within preferred range (0.55-0.7)

SW – 2

Fluid Properties

Water Type	Ca-SO_4		
Dissolved Solids	260.72 mg/kg	260 mg/L	Measured
Density	0.99723 g/cm^3		Calculated
Conductivity	451 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	145.22 mg/kg	144.82 mg/L	Calculated
Carbonate	88.963	88.716	
Non-Carbonate	56.258	56.102	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	3.87	
Cations	3.84	
% Difference	0.397	OK
Measured TDS = Calculated TDS		
Measured	260.723	
Calculated	264.433	
Ratio	0.986	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	451.000	
Calculated	417.362	
Ratio	1.081	OK

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.858423	Not within preferred range (0.9-1.1)
Cations	0.851626	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.586	OK
Measured TDS to EC ratio	0.578	OK

SW – 3

Fluid Properties

Water Type	Ca-SO_4		
Dissolved Solids	250.7 mg/kg	250 mg/L	Measured
Density	0.99722 g/cm^3		Calculated
Conductivity	498 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	141.48 mg/kg	141.09 mg/L	Calculated
Carbonate	88.964	88.716	
Non-Carbonate	52.516	52.37	

Internal Consistency

Primary Tests

Anion-Cation Balance		
Anions	3.92	
Cations	3.76	
% Difference	2.016	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	250.697	
Calculated	262.028	
Ratio	0.957	Not within range 1.0 to 1.2
Measured EC = Calculated EC		
Measured	498.000	
Calculated	415.269	
Ratio	1.199	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.786846	Not within preferred range (0.9-1.1)
Cations	0.755753	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.526	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio	0.503	Not within preferred range (0.55-0.7)