Monitoring Report for
CSMRI Site
Fourth Quarter 2009

Prepared for:

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1. Introduction

This report presents the fourth quarter (October, November, December) 2009 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).

2. Sampling and Analysis

Stoller obtained quarterly samples of groundwater and surface water on December 16, 17, and 18, 2009, from ten groundwater monitoring wells and two surface water sample locations. Groundwater quality samples were obtained on December 16 (CSMRI-4, CSMRI-5, CSMRI-8, CSMRI-9, and CSMRI-10), December 17 (CSMRI-1 and CSMRI-1B), and December 18 (CSMRI-2, CSMRI-6C, and CSMRI-11B). Several monitor wells require purging on one day and sample collection on subsequent visits over the following days to obtain sufficient sample volume. Monitor well CSMRI-7B contained sufficient groundwater to measure the water table but insufficient water to collect a sample with a bailer.

Surface water samples were collected on December 17, 2009, from SW-1 and SW-2. All aqueous samples were placed in iced coolers and couriered to ALS Laboratory Group of Fort Collins, Colorado or to TestAmerica, Inc. of Arvada, Colorado for analysis.

Figure 1 presents the monitor well and surface water sample locations. The figure also presents the groundwater potentiometric surface elevations based on depth to groundwater relative to the surveyed top-of-casing for December 16, 17, and 18, 2009. All monitor wells have depth-to-water measured to the nearest 1/100th of a foot (0.01) prior to sample purging. The elevations of the groundwater potentiometric surface at the time of sampling are posted adjacent to each monitor well location. Historically, the figure indicates a northeasterly component of flow for groundwater located on the bench terrace above the Clear Creek flood plain.

2.1 Groundwater Sampling

Water quality samples were collected following the procedure outlined in Appendix A, Groundwater Sampling Procedures. Graphs of water table elevation are presented as Figure 2 for monitor wells CSMRI-1, CSMRI-1B, CSMRI-4, CSMRI-5, CSMRI-6B (abandoned July 2008), CSMRI-6C, CSMRI-7B (intermittent presence of groundwater), CSMRI-8, CSMRI-9, CSMRI-10, CSMRI-11 (abandoned July 2008), and CSMRI-11B. Figure 2 monitor wells are located within the CSMRI site proper and illustrate historical trends in the potentiometric surface throughout the site.

The Figure 3 hydrograph of monitor well CSMRI-2, located near the southeast corner of the freshman parking lot on West Campus Drive and the former Welch Ditch, is located upgradient of the CSMRI site and historically is used to provide background groundwater quality conditions. The hydrograph initially reflected the use of and leakage from the nearby irrigation ditch during the summer months in 2005 and 2006 by a seasonal rise in the potentiometric surface. In 2007 the Welch Ditch was diverted upstream of CSMRI and piped to Washington Avenue in Golden and then to down-ditch users. Through late 2006 and 2007, the water level has remained elevated and only recently has shown a seasonal pattern of rising and falling.

Sample collection field forms showing the water quality parameters of the monitor well groundwater as it is purged and the volume removed are provided in Appendix B, Sample Collection Forms. After parameter stabilization, the water samples are 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-6C, and CSMRI-7B went dry before three casing volumes of groundwater were purged from each well. Additionally, monitor wells CSMRI-1B, CSMRI-2, CSMRI-6C, and CSMRI-11B required multiple visits to collect sufficient sample volume due to slow recharge.

2.2 Surface Water Sampling

Surface water samples from Clear Creek were collected on December 17, 2009, from two locations: one upstream of the site (SW-1) and one downstream of the site (SW-2) as shown on Figure 1. The 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 of Clear Creek, as measured by the U.S. Geological Survey, Golden, Colorado Clear Creek gauging station (#06719505 USGS Surface Water Online Database) during the fourth quarter from October 1, 2009 through December 31, 2009 are presented as Figure 4. Tabular representation of the data indicates ice affected the stream flow measurement devices and numerical values are not available.

2.3 Analyses

All samples collected were analyzed using a Comprehensive Environmental Response, Compensation and Liability Act-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 control/quality assurance (QA/QC) check, an equipment blank sample was collected in the field by pouring distilled water through a sample bailer and submitting the filtered aqueous sample 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 did not identify outstanding issues regarding analytical laboratory results. 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 iron, and milligrams per liter (mg/L) for all other metals and ions.

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

Analytical parameters submitted to TestAmerica included nitrate (NO_3), nitrite (NO_2), ferrous (Fe^2), and ferric (Fe^3) iron. TestAmerica was selected to conduct the short holding time analyses because of their proximity to the CSMRI site.

Groundwater samples were measured onsite for purged volume, temperature, pH, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity as nephlometer turbidity units (NTU) during the purging and sampling process. Onsite measurement parameters are presented on the sample collection forms in Appendix B.

Since the first quarter of monitoring in February 2005, the concentration of total uranium in ug/L had been analyzed using Paragon method 714R9. In this method, the concentration of uranium is calculated based on the activity of the uranium isotopes U-234, U-235, and U-238. Effective in the first quarter 2007 sampling event, the concentration of uranium is now analyzed using mass spectrometry method EPA 6020, which analyzes for total isotopic uranium and not for the activity of the individual isotopes.

Analytical data from Paragon and from TestAmerica as an electronic data deliverable are presented in Appendix E on a compact disk 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

A summary of 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 iron, and mg/L for all other metals and ions. Surface water samples were measured onsite for temperature, pH, specific conductance, DO, ORP, and NTU as the sampling was conducted. Onsite measurement parameters are presented on the sample collection forms in Appendix B.

2.4 Health and Safety Program

Stoller developed a program to protect the health and safety of field personnel for implementation of the environmental monitoring at the CSMRI site. This program has been developed in accordance with requirements of 29 CFR 1910.120.

3. Results

Groundwater analytical results from samples collected from the CSMRI site during the fourth quarter 2009 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 from samples collected from the CSMRI site during the fourth quarter 2009 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," yet recent (2005 through 2009) 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/g 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 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 located downgradient from the site in the Clear Creek flood plain. Well CSMRI-1 is located along Clear Creek upstream from the site, and well CSMRI-2 is located offsite on the southeast corner of the freshman parking lot on West Campus Drive.

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 essentially encircle the CSMRI site.

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

3.2 Groundwater Quality

Groundwater samples were collected from ten monitor wells and tested for the presence of metals and radioisotopes as identified in Section 2.3.1. A groundwater sample was not collected from monitor well CSMRI-7B due to insufficient volume of water in the well at the time of sampling. Partial aqueous samples were collected from monitor wells CSMRI-6C (uranium only) and from CSMRI-11B (radium 226/228 and uranium only).

Uranium was detected in monitor wells CSMRI-4 at 79 µg/L, CSMRI-8 at 580 µg/L, and CSMRI-9 at 39 µg /L at concentrations exceeding the State of Colorado groundwater standard of 30 µg/L. Uranium was also detected in the remaining six groundwater monitor wells but at concentrations below the groundwater standard. Ra-226 and Ra-228 were detected in all monitor wells at concentrations well below the established MCL of 5 pCi/L.

In the flood plain area, uranium was detected in monitor wells CSMRI-4 at 79 µg/L, CSMRI-5 at 9.8 µg/L, and CSMRI-8 at 580 µg/L. Monitor well CSMRI-4 historically has had elevated concentrations of uranium, but the values had been declining since 1991 until the last several quarterly sampling events as shown on Figure 5. Historically, the concentration of uranium in this monitor well has spiked; once in 1999 and again in 2003. The spike in the concentration of uranium in 2003 was attributed to precipitation effects at the CSMRI site and removal of the site asphalt and concrete as discussed in Section 4.2.2 of the New Horizons RI/FS (New Horizons 2004). The recent (2009) rise in the concentration of uranium in this monitor well appears to be attributed to the stormwater discharge from the new CSM artificial turf soccer field subdrains. Precipitation collected in the subdrains is discharged near the northern edge of the bench terrace and flows down a riprap-embedded concrete rundown on to the flood plain. During the process, the discharge water becomes oxygenated and is introduced into the poorly oxygenized environment of the flood plain area. Uranium present in the saturated sediments of the flood plain is then mobilized by the oxygenated discharge water and flows toward monitor well CSMRI-4.

Figure 6 presents the potentiometric surface elevation of the groundwater in CSMRI-4 (left Y axis) and the concentration of uranium (right Y axis) from 2005 through the fourth quarter 2009. The figure indicates the concentration of uranium had previously been fluctuating seasonally slightly above to slightly below the groundwater standard of 30 µg/L for 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. Since 2007, the concentration of uranium in this well has increased after the 2006 surface soil remediation activities and then spiked during the third quarter 2009 sampling event. The fourth quarter 2009 sampling event indicates the concentration of uranium at this location has been reduced by 50 percent from the previous quarterly sampling event.

The concentration of uranium detected in CSMRI-8 decreased to 580 µg/L from the previous quarterly value of 880 µg/L. Monitor well CSMRI-8 was installed in February 2007. Figure 7 presents the potentiometric surface elevation of the groundwater at this well (left Y axis) and the concentration of uranium (right Y axis) from 2007 through the fourth quarter 2009. Quarterly monitoring will be continued to document seasonal variability and trends in the concentration of uranium in groundwater at this location.

The detected concentration of uranium in CSMRI-9 at 39 µg/L is slightly lower than the September 2009 sampling event value of 43 µg/L and is more in line with historical values. 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.

3.2.1 Ionic Balance Evaluation

Groundwater and surface water samples were collected and tested for major anions and cations, DOC, and at select locations (CSMRI-1, CSMRI-4, CSMRI-5, and CSMRI-8) ferric and ferrous iron. 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 show the graphical representation of anions and cations. Ionic balance calculations for the anions and cations for most of the water samples fall within the range of 6 to 19 percent.

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-5, CSMRI-8, CSMRI-9, and CSMRI-10); Ca-HCO_3 (CSMRI-2); and Ca-SO_4 (CSMRI-4, SW-1, and SW-2).

A Piper quadrilateral diagram is included in Appendix H and presents 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 are similar as exhibited by the tight grouping of the monitor well symbols. The anion triangle in the lower right of the figure indicates the anion composition of the water samples are more diverse as exhibited by the dispersed nature of the monitor well symbols.

3.2.2 Comparison of Upgradient and Downgradient Groundwater Quality

Monitor wells CSMRI-4, CSMRI-5, and CSMRI-8 are downgradient from the site and are located on the Clear Creek flood plain. Monitor wells CSMRI-7B and CSMRI-9 are 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 monitor wells CSMRI-4 at a concentration of 79 µg /L, CSMRI-8 at a concentration of 580 µg/L, and CSMRI-9 at a concentration of 39 µg/L, which all exceed the groundwater standard of 30 µg/L. Monitor well CSMRI-8 is located at the western edge of the flood plain area and is upgradient of monitor wells CSMRI-4 and CSMRI-5.

Monitor well CSMRI-9 is located at the downgradient position on the bench terrace at the CSMRI site.

3.2.3 Comparison with Previous Groundwater Quality Analyses

Table 2-7 presents groundwater analytical results from past sampling events dating back to 1991 for radioisotopes of concern. The data indicate fluctuating concentrations of tested analytes, particularly for monitor well CSMRI-4.

Each sampling quarter as additional data are collected and 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

The groundwater standard of 30 µg/L for uranium in groundwater was exceeded in monitor wells CSMRI-4 at a concentration of 79 µg/L, CSMRI-8 at a concentration of 580 µg/L, and CSMRI-9 at a concentration of 39 µg/L. In January 2008, Colorado Department of Public Health and Environment (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.

The spikes in the concentration of uranium in CSMRI-4 shown in Figure 5 have been attributed to the increased precipitation from December 2006 through February 2007 and surface soil remediation activities in the flood plain. This monitor well exhibited the same trend in 2003 during a prolonged high-precipitation period and when the asphalt cover and buildings associated with CSMRI had been removed. The recent (2009) rise in the concentration of uranium in this monitor well appears to be attributed to the stormwater discharge from the new CSM artificial turf soccer field subdrains. Precipitation collected in the subdrains is discharged near the northern edge of the bench terrace and flows down a riprap-embedded concrete rundown on to the flood plain. During the process, the discharge water becomes oxygenated and is introduced into the reducing environment of the flood plain area. The oxygen-rich influent enhances the mobility of the uranium present in the saturated sediments of the flood plain. The flux of water in the flood plain then flows toward monitor well CSMRI-4. The Colorado School of Mines (CSM) is assessing the relocation of the discharge pipe away from the flood plain area.

Monitoring well CSMRI-8 will be temporarily abandoned in early to mid 2010 due to proposed soil characterization and source removal activities in the flood plain. After soil characterization is complete, this monitor well will be replaced and placed back into the quarterly sampling schedule. Sampling will continue on this well, along with CSMRI-9, and all other site wells and the reason(s) for the elevated level of uranium will be evaluated.

3.3 Surface Water Quality

Surface water samples are collected from two locations at the site. Location SW-1 is located upstream from the site and the second location, SW-2, is downstream from the site. The upstream and downstream surface-water concentrations of tested parameters detected at the CSMRI site from stations SW-1 and SW-2 are similar. No established water quality standards were exceeded.

4. Future Activities

A Work Plan to address the elevated concentration of uranium in groundwater in the flood plain area has been submitted to CDPHE, Radiation Program, for comment. The Work Plan calls for the characterization and source removal of contaminated subsurface soil within the flood plain area and the upstream creek bank that is contributing to the groundwater contamination. An x-ray fluorescence (XRF) field portable analyzer, calibrated to a uranium standard, will be used to identify areas of elevated uranium in soil for characterization and excavation.

A biological assessment is currently being conducted of the flood plain area. The biological assessment will be submitted to the U.S. Fish and Wildlife Service (F&WS) for a biological opinion. The biological opinion will then be submitted to the Denver Regulatory Office of the Army Corps of Engineers (ACOE). The ACOE will use the recommendations from the F&WS Biological Opinion to issue either a Nation Wide Permit 38 or a 404 permit. Either of these permits will allow for the characterization and source removal of contaminated soil that may underlie the wetlands area within the flood plain.

Restoration of any areas within the flood plain or wetlands that are disturbed due to characterization activities includes the enhancement of the existing wetlands environment. By expanding and enhancing the wetlands environment, a reducing environment would be created that would lower the mobility of the uranium by changing the uranium from a hexavalent oxidation state to a less mobile tetravalent state.

The Work Plan identifies two monitor wells that will be abandoned (CSMRI-7B and CSMRI-8) and replaced; two monitor wells that will be over-drilled to extend the well lengths through the saturated alluvial material to bedrock (CSMRI-6C and CSMRI-11B); and the installation of two new proposed alluvial monitor wells (CSMRI-12 and CSMRI-13) and one bedrock aquifer monitor well (CSMRI-14), all in the flood plain area. Implementation of the Work Plan is scheduled for the first week of March 2010 with completion of characterization by the end of May.

Due to the proposed soil characterization and source removal work, the first quarter 2010 ground water sampling will be conducted during the final week of February rather than during the month of March. Sampling of the monitor wells at this time will allow for one more quarterly sampling event before several of the wells are abandoned.

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, Final Site Characterization Work Plan, May 2006.

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)		Total U (µg/L)
		Result	Uncertainty	Result	Uncertainty	Result
CSMRI-1	12/17/09	0.39	0.3	0.96	0.52	2.4
CSMRI-1B	12/17/09	-0.03	0.29	0.98	0.53	16
CSMRI-2	12/18/09	1.02	0.54	1.6	0.6	0.75
CSMRI-4	12/16/09	0.21	0.23	0.68	0.41	79
CSMRI-5	12/16/09	1.28	0.56	0.44	0.41	9.8
CSMRI-6C	12/18/09	NT	NT	NT	NT	12
CSMRI-7B	NT	NT	NT	NT	NT	NT
CSMRI-8	12/16/09	0.26	0.25	0.37	0.36	580
CSMRI-9	12/16/09	0.45	0.28	0.61	0.37	39
CSMRI-10	12/16/09	0.17	0.23	0.85	0.43	14
CSMRI-11B	12/18/09	0.89	0.51	0.51	0.37	14
MCL*		Total Ra = 5				30

*Maximum Contaminant Level – National Primary Drinking Water Regulations
NT – Not Tested

Table 2-2
Summary of Metals in Groundwater
(All results in mg/L)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Na	Pb	V
CSMRI-1	12/17/09	NT	NT	NT	49	NT	NT	NT	3.4	16	42	NT	NT
CSMRI-1B	12/17/09	NT	NT	NT	120	NT	NT	NT	7.8	51	48	NT	NT
CSMRI-2	12/18/09	NT	NT	NT	79	NT	NT	NT	5.9	35	20	NT	NT
CSMRI-4	12/16/09	NT	NT	NT	110	NT	NT	NT	11	49	62	NT	NT
CSMRI-5	12/06/09	NT	NT	NT	130	NT	NT	NT	4.4	50	55	NT	NT
CSMRI-6C	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-7B	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	12/16/09	NT	NT	NT	210	NT	NT	NT	12	59	56	NT	NT
CSMRI-9	12/16/09	NT	NT	NT	140	NT	NT	NT	6.2	67	59	NT	NT
CSMRI-10	12/16/09	NT	NT	NT	130	NT	NT	NT	4.9	51	49	NT	NT
CSMRI-11B	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	1	0.003	0.01
MCL*		NE	0.010	2	NE	0.005	0.1	0.002	NE	NE	NE	0.015	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations
NE – Not Established
NT – Not Tested
J – Estimated

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)	Dissolved Organic Carbon (mg/L)	Ferric Iron (mg/L)	Ferrous Iron (mg/L)	Total Iron (ug/L)	Nitrate (mg/L)	Nitrite (mg/L)	Dissolved Phosphorous (mg/L)	Sulfate (mg/L)
CSMRI-1	12/17/09	83	5	83	90	1.1	ND	ND	ND	1.1	ND	NT	68
CSMRI-1B	12/17/09	230	20	230	210	3.4	NT	NT	NT	3.1	ND	NT	96
CSMRI-2	12/18/09	290	20	290	17	1	NT	NT	NT	ND	ND	NT	63
CSMRI-4	12/16/09	330	20	330	90	5.7	ND	ND	ND	ND	ND	NT	170
CSMRI-5	12/16/09	210	20	210	200	1.4	ND	ND	110	3.3	ND	NT	140
CSMRI-6C	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-7B	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	12/16/09	370	20	370	190	3.2	ND	ND	ND	ND	ND	NT	220
CSMRI-9	12/16/09	270	20	270	220	1.3	NT	NT	NT	7.2	ND	NT	130
CSMRI-10	12/16/09	230	20	230	220	1.1	NT	NT	NT	5.9	ND	NT	94
CSMRI-11B	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Reporting Limits		5 or 20	5 or 20	5 or 20	1, 2 or 4	1	0.20	0.20	100	0.50	0.50	0.05	5, 10 or 20

ND – Non Detect
NT – Not Tested

Table 2-4
Summary of Radioisotopes in Surface Water

Sample Station	Sample Date	Ra-226 (pCi/L)		Ra-228 (pCi/L)		Total U (µg/L)
		Result	Uncertainty	Result	Uncertainty	Result
SW-1	12/17/09	0.1	0.25	0.42	0.41	1.7
SW-2	12/17/09	0.03	0.22	0.44	0.39	1.9
MCL*		Total Ra = 5				30

*Maximum Contaminant Level – National Primary Drinking Water Regulations
J – Estimated

Table 2-5
Summary of Metals in Surface Water
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Na	Pb	V
SW-1	12/17/09	NT	NT	NT	39	NT	NT	NT	2.8	8.5	18	NT	NT
SW-2	12/17/09	NT	NT	NT	42	NT	NT	NT	3	9.8	19	NT	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	1	0.003	0.01
MCLs*		0.01	0.010	2	NE	0.005	0.1	0.002	NE	NE	NE	0.015	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations
NE – Not Established
NT – Not Tested - Scheduled for June only (2nd Quarter)

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/28L)	Dissolved Organic Carbon (mg/L)	Ferric Iron (mg/L)	Ferrous Iron (mg/L)	Total Iron (µg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Total Phosphorous (mg/L)	Sulfate (mg/L)
SW-1	12/17/09	52	5	47	25	1.3	NT	NT	NT	ND	ND	0.05	90
SW-2	12/17/09	47	5	52	28	1.1	NT	NT	NT	ND	ND	0.05	94
Reporting Limits		5	5	5	0.4	1	NT	NT	NT	0.50	0.50	0.05	2

ND = Not Detected at or above the Reporting Limits
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

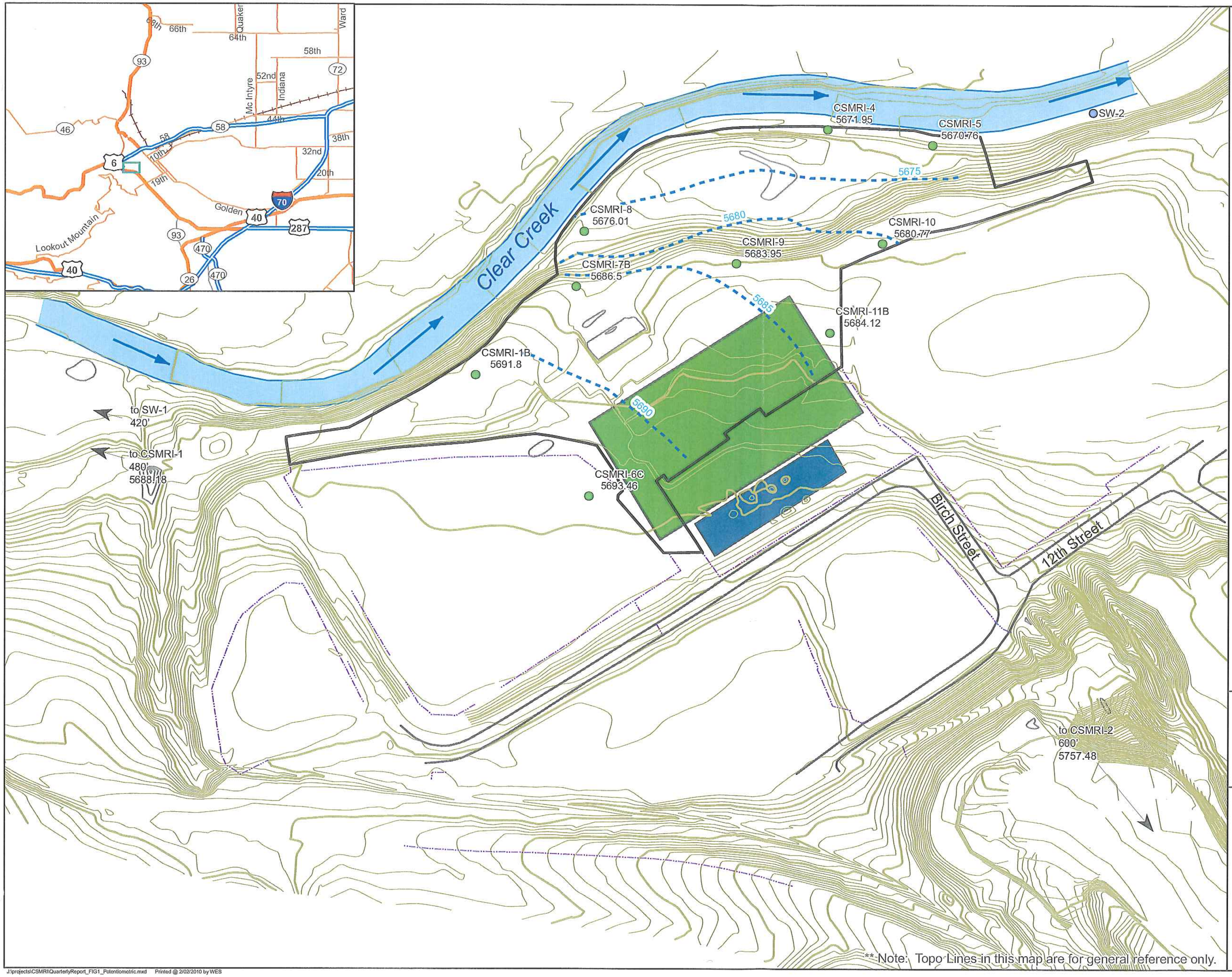


Figure 1

Groundwater Potentiometric Elevation Map - December 2009

CSMRI
Quarterly Report

Stoller

J:\projects\CSMRI\QuarterlyReport_FIG1_Potentiometric.mxd Printed @ 2/02/2010 by WES

Figure 2
CSMRI
All Monitor Wells Hydrograph

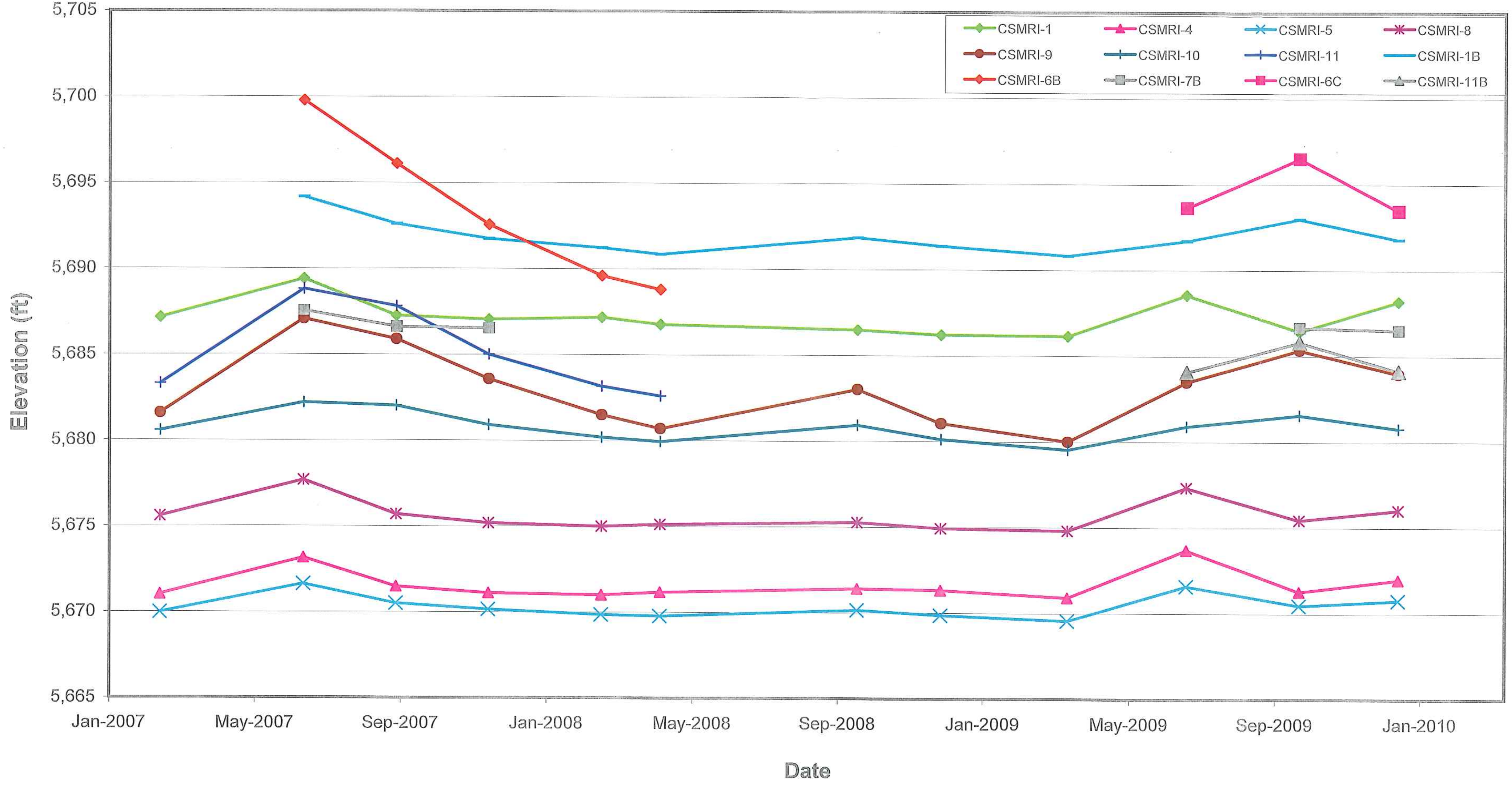


Figure 3
CSRMI-2
Hydrograph

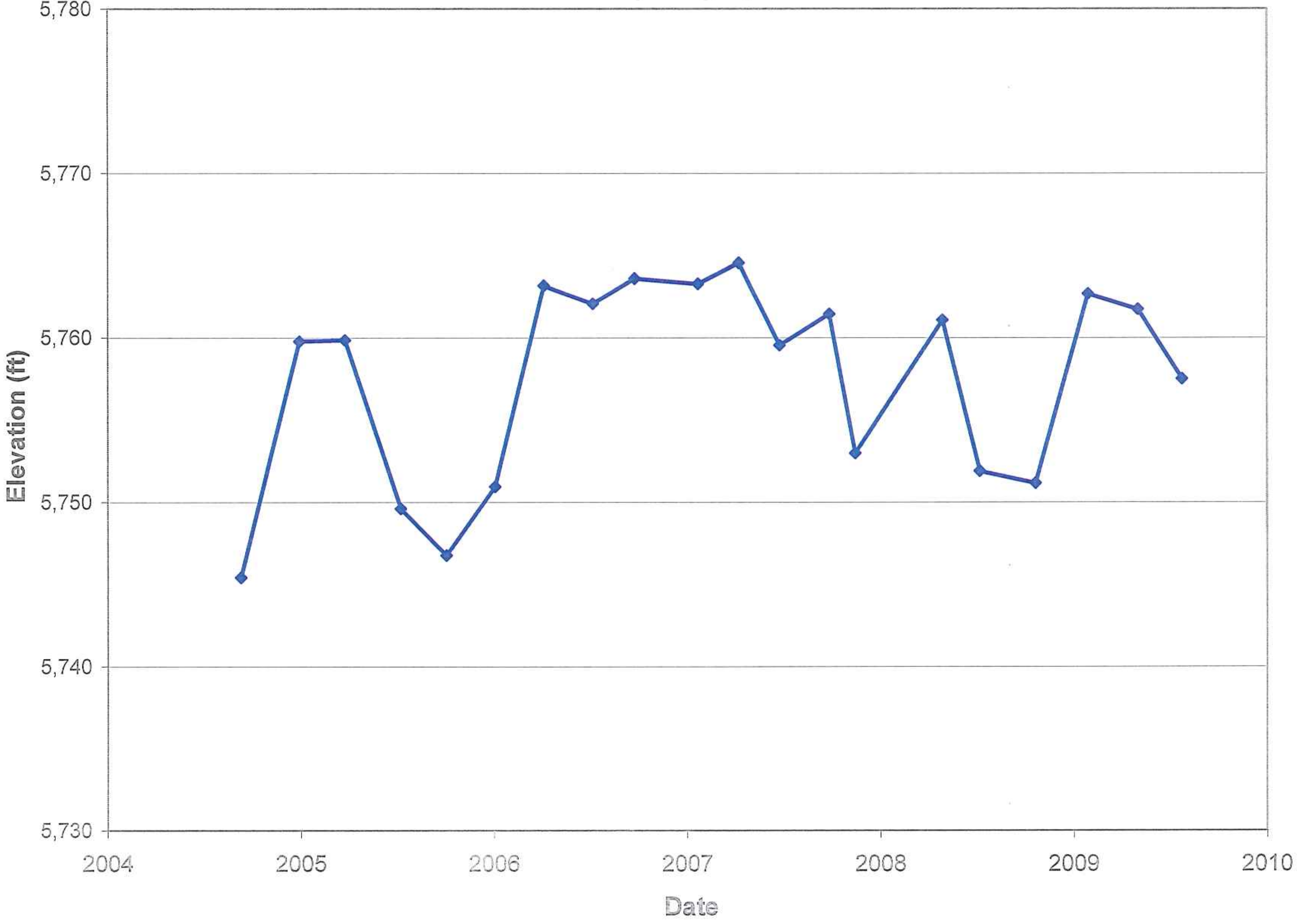
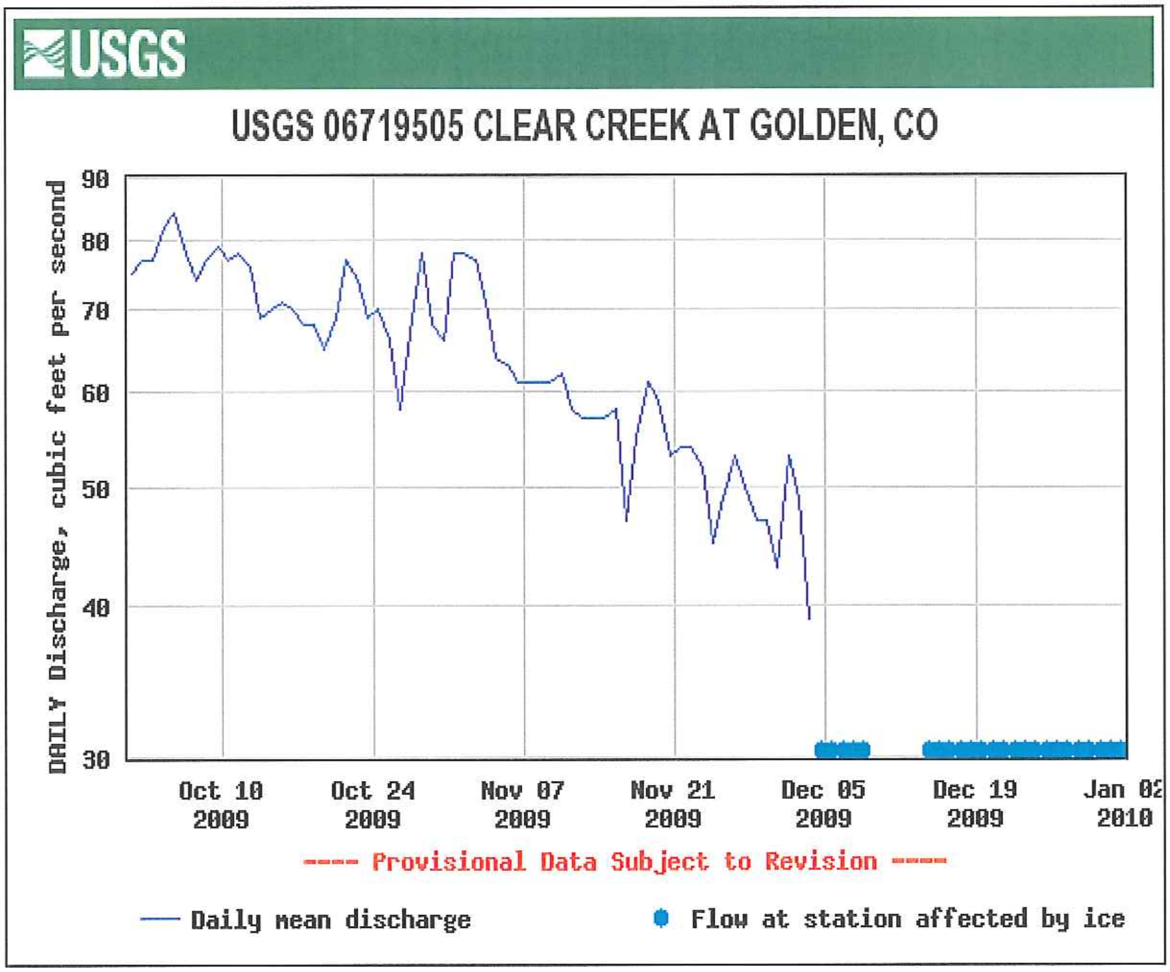


Figure 4
Clear Creek Gauging Graph
October – December 2009



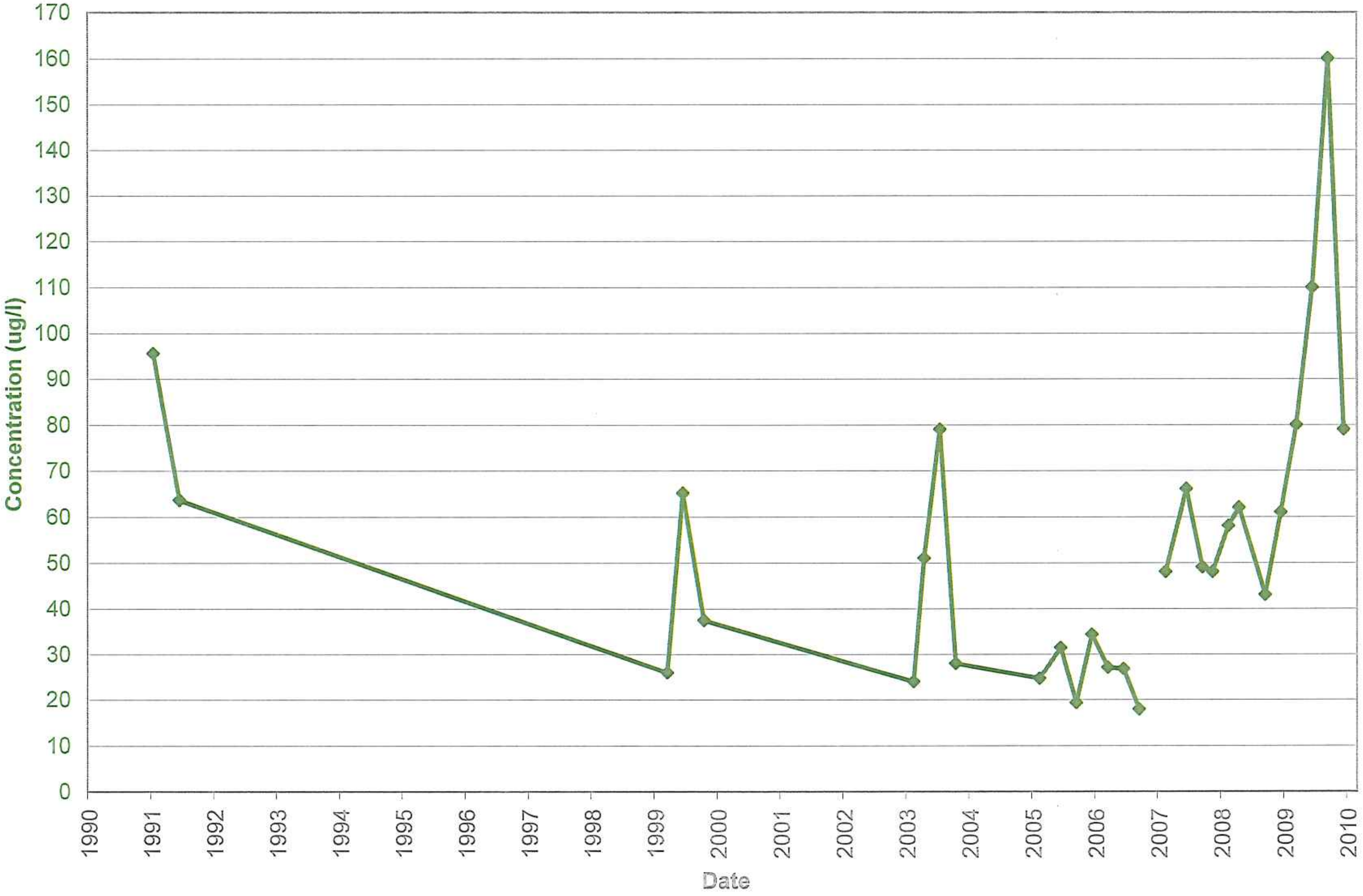
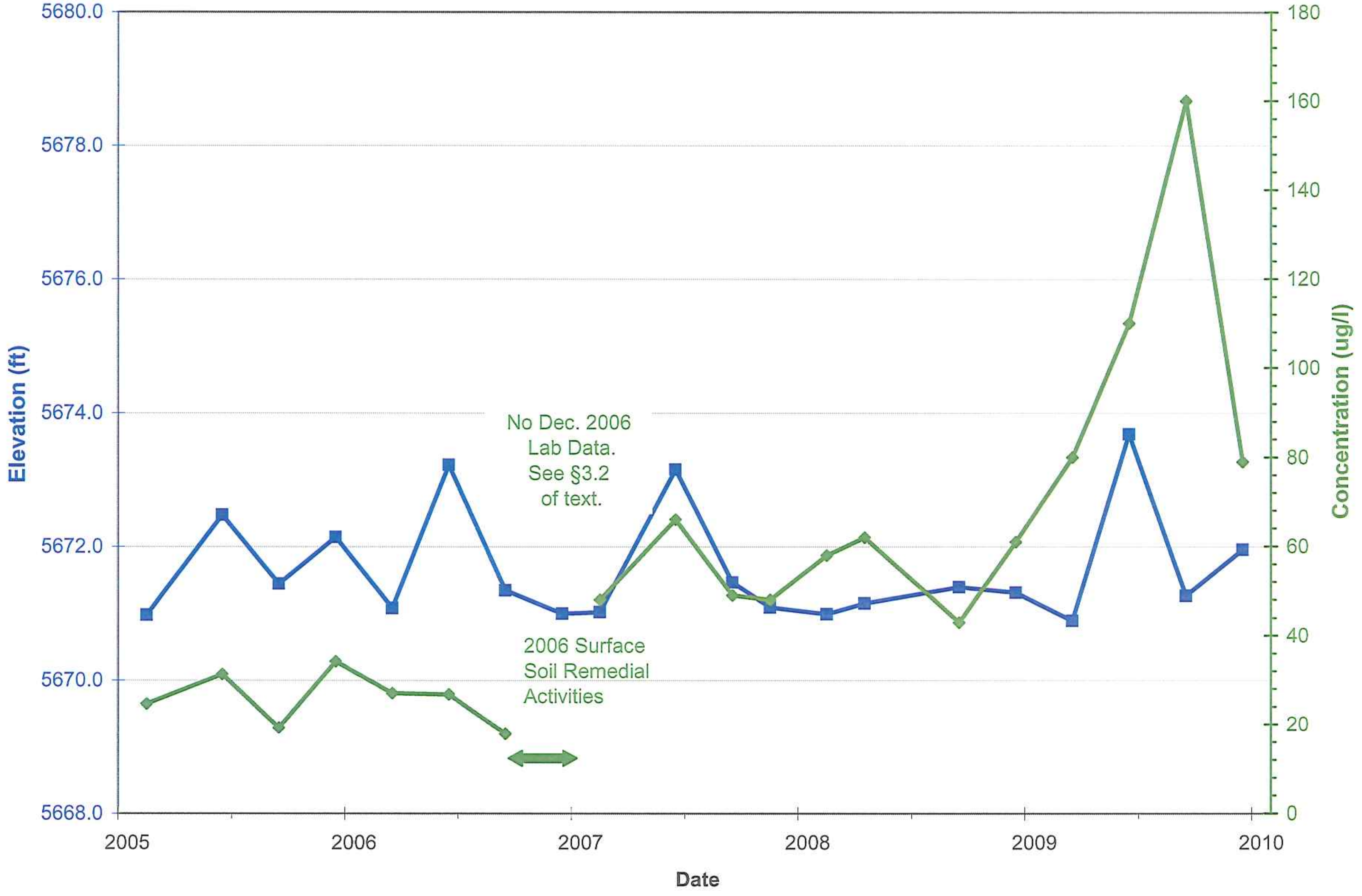


Figure 5
CSMRI-4
Historical Total Uranium Concentration (1991 - 2009)

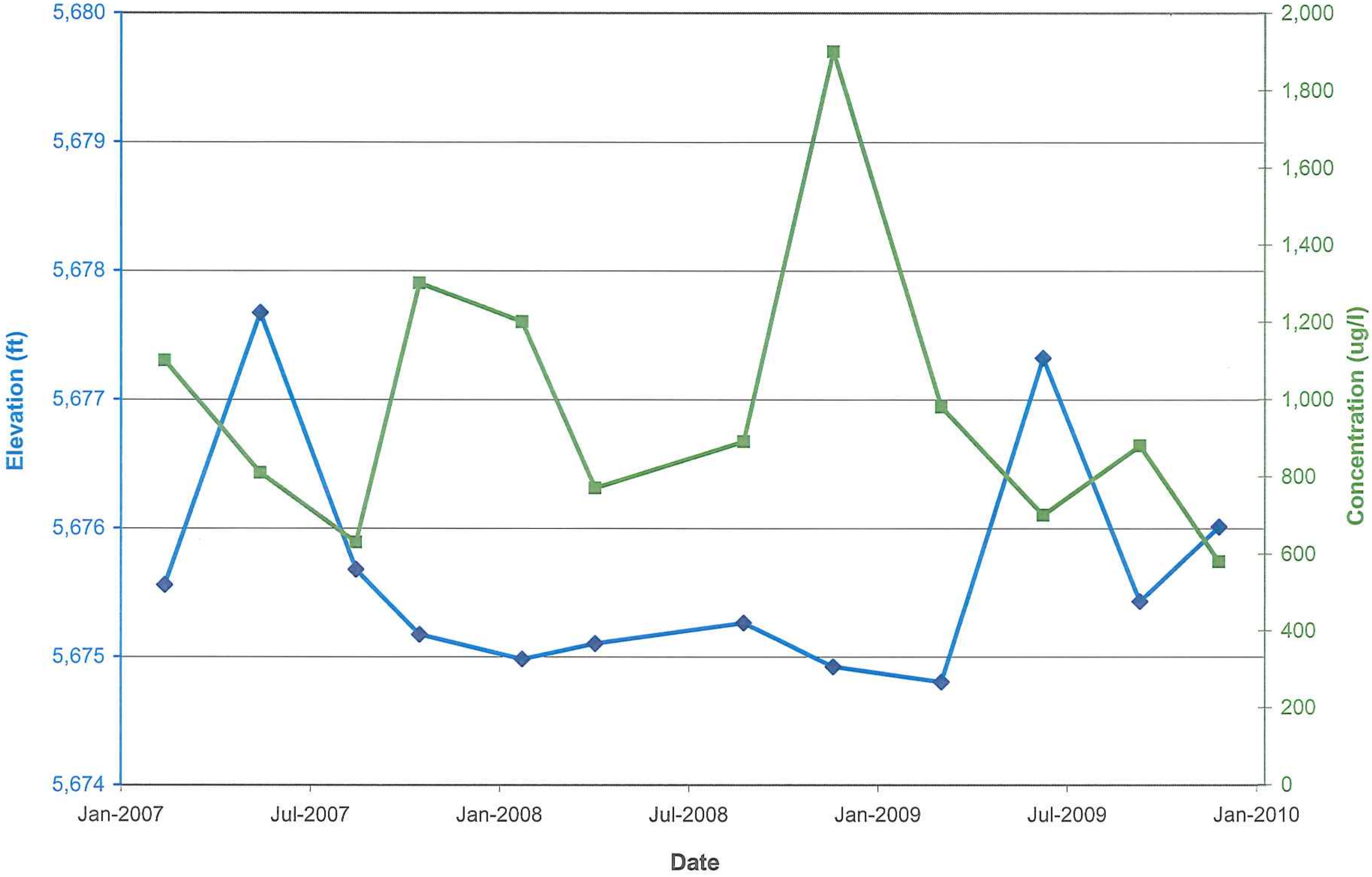
Figure 6
CSMRI-4
Total Uranium Concentration and Potentiometric Elevation



No Dec. 2006 Lab Data. See §3.2 of text.

2006 Surface Soil Remedial Activities

Figure 7
CSMRI-8
Total Uranium Concentration and Potentiometric Elevation



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 B
Sample Collection Forms

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-1
Project Number: 4107-510	Date: 12/17/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	24.99	(ft)
	(+.28)	
Total Depth =	25.27	(ft)
Depth to Water =	6.24	(ft)
Initial Water Column =	19.03	(ft)
Initial Water Volume =	3.04	(gal)
3 X Water Volume	9.12	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/17/09	1130
Anions	500 ml Plastic	—	12/17/09	1130
Cations	500 mL Plastic	HNO_3	12/17/09	1130
DOC	125 mL Amber	H_2SO_4	12/17/09	1130

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C], °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1113	1.52	9.51	6.23	538	6.59	45	1000+	brown
1116	3.04	9.58	6.34	527	7.44	46	1000+	↓
1119	4.56	9.65	6.42	533	7.40	47	1000+	
1121	6.08	9.59	6.50	532	7.60	46	1000+	
1124	7.60	9.61	6.54	534	7.49	45	1000+	
1127	9.12	9.63	6.58	534	7.57	45	1000+	

Volume purged: 9.12 gal

Comments:	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/17/09	1130
TA	Ferric Fe	500ml Plastic	HNO_3	12/17/09	1130
TA	Ferrous Fe	1L Plastic	—	12/17/09	1130

SM Stoller Corp.

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Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-1B
Project Number: 4107-510	Date: 12/15/09, 12/16/09, 12/17/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations

Measured TD =	23.41 (+.28)	(ft)
Total Depth =	23.69	(ft)
Depth to Water =	20.34	(ft)
Initial Water Column =	3.35	(ft)
Initial Water Volume =	.54	(gal)
3 X Water Volume	1.62	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/17/09	1430
Anions	500 ml Plastic	—	12/17/09	1430
Cations	500 mL Plastic	HNO_3	12/17/09	1430
DOC	125 ml Amber	H_2SO_4	12/17/09	1430

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1315	.54	11.68	6.94	1350	4.35	-75	871	black
1318	1.08	12.45	6.93	1300	4.27	-81	1000+	↓
1321	1.62	12.52	6.93	1270	10.62	-60	1000+	
								nm

Volume purged: 1.25 gal

Comments:

Analysis	Container	Preservative	Date	Time
TA NO_2/NO_3	1L Plastic	—	12/17/09	1420
~~TA Ferric Fe~~	~~500ml Plastic~~	~~HNO_3~~	~~12/ /09~~	nm
~~TA Ferrous Fe~~	~~1L Plastic~~		~~12/ /09~~	nm

well was purged dry, roots in purge water, last DO measurement suspect because probe may not have been in water

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-2
Project Number: 4107-510	Date: 12/15/09, 12/18/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	95.12 (+.28)	(ft)
Total Depth =	95.40	(ft)
Depth to Water =	62.07	(ft)
Initial Water Column =	33.33	(ft)
Initial Water Volume =	5.34	(gal)
3 X Water Volume	16.02	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/18/09	1000
Anions	500 ml Plastic	—	12/18/09	1000
Cations	500 ml Plastic	HNO_3	12/18/09	1000
DOC	125 ml Amber	H_2SO_4	12/18/09	1000

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1440	2.67	12.49	6.99	495	4.36	33	1000+	brown
1447	5.34	12.34	6.98	500	4.23	36	1000+	↓
1455	8.01	12.44	6.88	538	3.72	39	1000+	
1500	10.68	12.53	6.85	554	5.22	44	1000+	
	13.35							
	16.02							
								NEM

Volume purged: 11 gal

Comments:

Analysis	Container	Preservative	Date	Time
TA NO_2/NO_3	1L Plastic	—	12/18/09	1000
~~TA Ferric Fe~~	~~500 ml Plastic~~	~~HNO_3~~	~~12/ /09~~	NEM
~~TA Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~12/ /09~~	NEM

well was purged dry

SM Stoller Corp.

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Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-4
Project Number: 4107-510	Date: 12/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	17.34 (+.28)	(ft)
Total Depth =	17.62	(ft)
Depth to Water =	6.30	(ft)
Initial Water Column =	11.32	(ft)
Initial Water Volume =	1.82	(gal)
3 X Water Volume	5.46	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1gal cube	HNO_3	12/16/09	1215
Anions	500ml Plastic	—	12/16/09	1215
Cations	500ml Plastic	HNO_3	12/16/09	1215
DOC	125ml Amber	H_2SO_4	12/16/09	1215

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C], °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1159	.91	9.13	6.76	1300	3.92	38	276	brown
1201	1.82	8.95	6.63	1250	3.75	46	261	↓
1204	2.73	8.96	6.57	1300	3.00	51	327	
1206	3.64	8.84	6.55	1290	4.63	54	216	
1208	4.55	8.94	6.54	1290	2.54	55	568	
1211	5.46	8.88	6.53	1310	3.68	56	550	
								NCM

Volume purged: 5.46 gal

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/16/09	1215
TA	Ferric Fe	500ml Plastic	HNO_3	12/16/09	1215
TA	Ferrous Fe	1L Plastic	—	12/16/09	1215

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-5
Project Number: 4107-510	Date: 12/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	10.98 (+.28)	(ft)
Total Depth =	11.26	(ft)
Depth to Water =	5.85	(ft)
Initial Water Column =	5.41	(ft)
Initial Water Volume =	0.86	(gal)
3 X Water Volume	2.58	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/16/09	1320
Anions	500 mL Plastic	—	12/16/09	1320
Cations	500 mL Plastic	HNO_3	12/16/09	1320
DOC	125 mL Amber	H_2SO_4	12/16/09	1320

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1308	0.86	5.99	7.01	1480	7.72	36	392	brown
1310	1.72	5.66	6.76	1470	5.87	44	680	↓
1312	2.58	4.96	6.64	1520	6.41	47	260	

Volume purged: 2.58 gal

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/16/09	1320
TA	Ferric Fe	500mL Plastic	HNO_3	12/16/09	1320
TA	Ferrous Fe	1L Plastic	—	12/16/09	1320

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-6C
Project Number: 4107-510	Date: 12/15/09, 12/18/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	29.95 (+.28)	(ft)
Total Depth =	30.23	(ft)
Depth to Water =	29.57	(ft)
Initial Water Column =	0.66	(ft)
Initial Water Volume =	0.10	(gal)
3 X Water Volume	0.30	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 -228 Diss. U	1gal cube	HNO_3	12/18/09	1130	
~~Anions~~	~~500ml Plastic~~	~~—~~	~~12/ /09~~		NZM
~~Cations~~	~~500mL Plastic~~	~~HNO_3~~	~~12/ /09~~		NZM
~~DOC~~	~~125ml Amber~~	~~H_2SO_4~~	~~12/ /09~~		NZM

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1359	0.10	3.62	6.70	1680	16.34	45	1000+	brown
								NZM

Volume purged: 600mL

Comments:

Analysis	Container	Preservative	Date	Time
~~TA NO_2/NO_3~~	~~1L Plastic~~	~~—~~	~~12/ /09~~	NZM
~~TA Ferric Fe~~	~~500ml Plastic~~	~~HNO_3~~	~~12/ /09~~	NZM
~~TA Ferrous Fe~~	~~1L Plastic~~		~~12/ /09~~	NZM

well was purged dry, temperature may be artificially low because sample container was in snow and barely full

insufficient water to collect samples other than Diss. Uranium

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMEI-7B
Project Number: 4107-510	Date: 12/15/09, 12/18/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations

Measured TD =	16.81 (+.28)	(ft)
Total Depth =	17.09	(ft)
Depth to Water =	16.58	(ft)
Initial Water Column =	.51	(ft)
Initial Water Volume =	.08	(gal)
3 X Water Volume	.24	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
~~Ra-226 -228 Diss. U~~	~~1 gal cube~~	~~HNO3~~	~~12/ /09~~	nm
~~Anions~~	~~500 ml Plastic~~	~~—~~	~~12/ /09~~	nm
~~Cations~~	~~500 mL Plastic~~	~~HNO3~~	~~12/ /09~~	nm
~~DOC~~	~~125 ml Amber~~	~~H_2SO_4~~	~~12/ /09~~	nm

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature [✓ °C], °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1256	.08	10.56	6.70	1,510	10.39	67	879	brown
	.16							
	.24							
								nm

Volume purged: .1 gal

Comments:

Analysis	Container	Preservative	Date	Time
~~TA NO2/NO3~~	~~1L Plastic~~	~~—~~	~~12/ /09~~	nm
~~TA Ferric Fe~~	~~500ml Plastic~~	~~HNO3~~	~~12/ /09~~	nm
~~TA Ferrous Fe~~	~~1L Plastic~~		~~12/ /09~~	nm

Well was purged dry, barely enough water for parameters there was no recharge for sample collection

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-8
Project Number: 4107-510	Date: 12/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	17.07 (+.28)	(ft)
Total Depth =	17.35	(ft)
Depth to Water =	7.59	(ft)
Initial Water Column =	9.76	(ft)
Initial Water Volume =	1.56	(gal)
3 X Water Volume	4.68	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1gal cube	HNO_3	12/16/09	1030
Anions	500ml Plastic	—	12/16/09	1030
Cations	500mL Plastic	HNO_3	12/16/09	1030
DOC	125ml Amber	H_2SO_4	12/16/09	1030

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1011	.78	7.61	6.42	1840	4.71	89	1000+	brown
1013	1.56	7.10	6.27	1840	4.61	93	1000+	↓
1015	2.34	6.73	6.22	1850	4.57	95	1000+	
1018	3.12	6.47	6.18	1850	4.85	98	1000+	
1020	3.90	6.30	6.16	1860	5.11	99	1000+	
1023	4.68	6.21	6.12	1850	4.70	100	1000+	

Volume purged: 4.68 gal

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/16/09	1030
TA	Ferric Fe	500mL Plastic	HNO_3	12/16/09	1030
TA	Ferrous Fe	1L Plastic	—	12/16/09	1030

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-9
Project Number: 4107-510	Date: 12/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: V Malczyk

Purge Volume Calculations		
Measured TD =	33.11 (+.28)	(ft)
Total Depth =	33.39	(ft)
Depth to Water =	23.76	(ft)
Initial Water Column =	9.63	(ft)
Initial Water Volume =	1.54	(gal)
3 X Water Volume	4.62	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/16/09	0940
Anions	500 ml Plastic	—	12/16/09	0940
Cations	500 ml Plastic	HNO_3	12/16/09	0940
DOC	125 ml Amber	H_2SO_4	12/16/09	0940

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
0926	1.54	12.21	6.36	1580	6.90	118	1000+	brown
0929	3.08	12.78	6.39	1610	5.09	115	1000+	↓
0932	4.62	12.77	6.40	1620	4.81	112	1000+	

Volume purged: 4.62 gal

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/16/09	0940
~~TA~~	~~Ferric Fe~~	~~500 ml Plastic~~	~~HNO_3~~	~~12/ /09~~	vcm
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~		~~12/ /09~~	vcm

SM Stoller Corp.

105 Technology Dr., Suite 190
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(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-10
Project Number: 4107-510	Date: 12/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	27.86 (+.28)	(ft)
Total Depth =	28.14	(ft)
Depth to Water =	23.53	(ft)
Initial Water Column =	4.61	(ft)
Initial Water Volume =	.74	(gal)
3 X Water Volume	2.22	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/16/09	0915
Anions	500 ml Plastic	—	12/16/09	0915
Cations	500 mL Plastic	HNO_3	12/16/09	0915
DOC	125 ml Amber	H_2SO_4	12/16/09	0915

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
0901	.74	12.00	5.95	1490	8.90	104	1000+	brown
0904	1.48	11.95	6.13	1470	8.58	105	1000+	↓
0907	2.22	11.95	6.25	1470	8.41	107	1000+	↓
								NRM

Volume purged: 2.22 gal

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/16/09	0915
~~TA~~	~~Ferric Fe~~	~~500ml Plastic~~	~~HNO_3~~	~~12/ /09~~	NRM
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~		~~12/ /09~~	NRM

SM Stoller Corp.

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(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-11B
Project Number: 4107-510	Date: 12/15/09, 12/16/09, 12/17/09, 12/18/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations

Measured TD =	28.55 (+.28)	(ft)
Total Depth =	28.83	(ft)
Depth to Water =	27.79	(ft)
Initial Water Column =	1.64	(ft)
Initial Water Volume =	.16	(gal)
3 X Water Volume	.48	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/18/09	1045
~~Anions~~	~~500 mL Plastic~~		~~12/ /09~~	vnm
~~Cations~~	~~500 mL Plastic~~	~~HNO_3~~	~~12/ /09~~	vnm
~~DOC~~	~~125 mL Amber~~	~~H_2SO_4~~	~~12/ /09~~	vnm

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C], °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
	~~.16~~							vnm
	.32							
1242	.48	12.18	6.25	1,450	5.92	75	1000+	brown
								vnm

Volume purged: .48 gal

Comments:

Analysis	Conteiner	Preservative	Date	Time
~~TA NO2/NO3~~	~~1L Plastic~~	~~—~~	~~12/ /09~~	vnm
~~TA Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~12/ /09~~	vnm
~~TA Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~12/ /09~~	vnm

Well was purged dry
there was only enough recharge to collect one sample

SM Stoller Corp.

105 Technology Dr., Suite 190
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(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: SW-1
Project Number: 4107-510	Date: 12/17/09
Sample Type: GW [✓ SW] EB Duplicate Other:	Sampler: N Malczyk

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

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1gal cube	HNO_3	12/17/09	1200
Anions	500ml Plastic	—	12/17/09	1200
Cations	500ml Plastic	HNO_3	12/17/09	1200
DOC	125ml Amber	H_2SO_4	12/17/09	1200

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C]/°F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1150	NA	0.05	6.65	276	16.21	40	107	clear
								NM

Volume purged: N/A

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/17/09	1200
~~TA~~	~~Ferric Fe~~	~~500ml Plastic~~	~~HNO_3~~	~~12/ /09~~	NM
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~		~~12/ /09~~	NM

SM Stoller Corp.

105 Technology Dr., Suite 190
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(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: SW-2
Project Number: 4107-510	Date: 12/17/09
Sample Type: GW [✓ SW] EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations

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

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1gal cube	HNO_3	12/17/09	1020
Anions	500ml Plastic	—	12/17/09	1020
Cations	500ml Plastic	HNO_3	12/17/09	1020
DOC	125ml Amber	H_2SO_4	12/17/09	1020

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C]/°F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1015	N/A	0.12	5.37	372	16.96	149	142	clear
								nm

Volume purged: N/A

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/17/09	1020
~~TA~~	~~Ferric Fe~~	~~500ml Plastic~~	~~HNO_3~~	~~12/ /09~~	nm
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~12/ /09~~	nm

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: Equipment Blank
Project Number: 4107-510	Date: 12/17/09
Sample Type: GW SW [✓ EB] Duplicate Other:	Sampler: N Malczyk

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

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 -228 Diss. U	1 gal cube	HNO_3	12/17/09	1330
Anions	500 ml Plastic	—	12/17/09	1330
Cations	500 ml Plastic	HNO_3	12/17/09	1330
DOC	125 ml Amber	H_2SO_4	12/17/09	1330

Lab: ALS-Ft. Collins, Test America-Arvada

Purge Volumes and Field Water Quality Measurements

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

Volume purged: N/A

Comments:

	Analysis	Container	Preservative	Date	Time
TA	NO_2/NO_3	1L Plastic	—	12/17/09	1330
~~TA~~	~~Ferric Fe~~	~~500ml Plastic~~	~~HNO_3~~	~~12/ /09~~	NM
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~12/ /09~~	NM

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:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	January 29, 2010
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	0912163

This report presents the inorganic anions data validation for the data obtained for eleven CSMRI water sample collected on December 16, December 17, 2009, and December 18, 2009 and submitted to Paragon Analytics, Inc on December 18, 2009 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, and Sulfate by Method 300.0 Rev 2.1 from Paragon Analytics, Inc. (Fort Collins, CO). The water samples were analyzed for Bicarbonate, Carbonate, and Total Alkalinity, on December 28, 2009, and Chloride on December 18, 2009 and December 21, 2009, Sulfate on December 18, 2009. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-10	0912163-1	Water	December 16, 2009
CSMRI-9	0912163-2	Water	December 16, 2009
CSMRI-8	0912163-3	Water	December 16, 2009
CSMRI-4	0912163-4	Water	December 16, 2009
CSMRI-5	0912163-5	Water	December 16, 2009
SW-2	0912163-6	Water	December 17, 2009
CSMRI-1	0912163-7	Water	December 17, 2009
SW-1	0912163-8	Water	December 17, 2009
EQUIPMENT BLANK	0912163-9	Water	December 17, 2009
CSMRI-1B	0912163-10	Water	December 17, 2009
CSMRI-2	0912163-11	Water	December 18, 2009

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

Analytical holding times were evaluated and all criteria were met.

The water samples were all found to be field filtered and had a pH less than 2.

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 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

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.

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

Matrix Spike recoveries were not evaluated for Chloride. The Chloride concentration was above the analytical range and therefore quantitation of MS/MSD recoveries were not possible as the spike added was small relative to the unspiked sample concentration. The LCS, ICV, and CCV QC results indicate that the procedure was in control and no action was necessary.

Reduced aliquots were analyzed for samples CSMRI-10, CSMRI-9, CSMRI-8, CSMRI-4, CSMRI-5, CSMRI-1B and CSMRI-2 for alkalinity, bicarbonate, and carbonate. The laboratory elevated the reporting limits accordingly.

All samples except for sample EQUIPMENT BLANK were analyzed at a dilution in order to bring chloride concentrations into analytical range.

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:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	January 30, 2010
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	0912163

This report presents the inorganic metals data validation for the data obtained for thirteen CSMRI water sample collected on December 16, December 17, 2009, and December 18, 2009 and submitted to Paragon Analytics, Inc on December 18, 2009 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 Paragon Procedure PA SOP 834R7 for trace metals by Inductively Coupled Plasma (ICP) atomic emission spectrometry analysis, Method 6020A and Paragon Procedure PA SOP 827R7 for dissolved metals by Inductively Coupled Plasma mass spectrometry (ICP-MS) (Uranium only) analysis for SDG 0912163 from Paragon Analytics, Inc. (Fort Collins, CO). The water samples were analyzed for dissolved ICP trace metals on January 8, 2010 and dissolved uranium by ICP-MS on January 6, 2010. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-10	0912163-1	Water	December 16, 2009
CSMRI-9	0912163-2	Water	December 16, 2009
CSMRI-8	0912163-3	Water	December 16, 2009
CSMRI-4	0912163-4	Water	December 16, 2009
CSMRI-5	0912163-5	Water	December 16, 2009
SW-2	0912163-6	Water	December 17, 2009
CSMRI-1	0912163-7	Water	December 17, 2009
SW-1	0912163-8	Water	December 17, 2009
EQUIPMENT BLANK	0912163-9	Water	December 17, 2009
CSMRI-1B	0912163-10	Water	December 17, 2009
CSMRI-2	0912163-11	Water	December 18, 2009
CSMRI-11B	0912163-12	Water	December 18, 2009
CSMRI-6C	0912163-13	Water	December 18, 2009

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.

The water samples were field filtered and had a pH less than 2except for sample CSMRI-1B which the laboratory added nitric acid in order to bring the pH to less than 2. The samples were received between 2°C and 14.4°C.

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 trace. 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 and CRI %Rs for mercury were within 80-120% limits. No action was necessary.

Preparation and Initial/ Continuing Calibration Blanks

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.

Interference Check Sample (ICSA) Results

Interference Check Samples were prepared and analyzed at the required frequencies.

No aqueous concentrations of aluminum, calcium, iron, or magnesium exceeded the ICSA values in any of the samples. No action was necessary.

Matrix Spike/Matrix Spike Duplicate Results

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

Duplicate Sample Analysis

All ICP and Mercury 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 metals. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

All %Ds were less than 10% for Uranium by ICP-MS and trace metals by ICP and ICP/MS.

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.

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: Steve Brinkman/Robert Hill
From: John Garrett
Date: January 29, 2010
Project/Site: Colorado School of Mines
Project No.: 4060
SDG No.: 0912163

This report presents the Total Organic Carbon data validation for the data obtained for eleven CSMRI water sample collected on December 16, December 17, 2009, and December 18, 2009 and submitted to Paragon Analytics, Inc on December 18, 2009 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, Total Organic Carbon by Method 415.1 from Paragon Analytics, Inc. (Fort Collins, CO). The water samples were analyzed January 4, 2010. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-10	0912163-1	Water	December 16, 2009
CSMRI-9	0912163-2	Water	December 16, 2009
CSMRI-8	0912163-3	Water	December 16, 2009
CSMRI-4	0912163-4	Water	December 16, 2009
CSMRI-5	0912163-5	Water	December 16, 2009
SW-2	0912163-6	Water	December 17, 2009
CSMRI-1	0912163-7	Water	December 17, 2009
SW-1	0912163-8	Water	December 17, 2009
EQUIPMENT BLANK	0912163-9	Water	December 17, 2009
CSMRI-1B	0912163-10	Water	December 17, 2009
CSMRI-2	0912163-11	Water	December 18, 2009

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

The organics 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 all field filtered and had a pH less than 2.

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 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

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.

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

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.

DATA VALIDATION REPORT

To:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	January 28, 2010
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	0912163 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 Paragon Procedure PA SOP 783R8 for Radium-226 by Radon Emanation Counting for SDG 0912163 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of twelve water samples for the Colorado School of Mines/4060 project collected on December 16, December 17, 2009, and December 18, 2009 and submitted to Paragon Analytics, Inc on December 18, 2009. The samples were analyzed for Radium-226 by Radon Emanation Counting on January 1, 2010. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-10	0912163-1	Water	December 16, 2009
CSMRI-9	0912163-2	Water	December 16, 2009
CSMRI-8	0912163-3	Water	December 16, 2009
CSMRI-4	0912163-4	Water	December 16, 2009
CSMRI-5	0912163-5	Water	December 16, 2009
SW-2	0912163-6	Water	December 17, 2009
CSMRI-1	0912163-7	Water	December 17, 2009
SW-1	0912163-8	Water	December 17, 2009
EQUIPMENT BLANK	0912163-9	Water	December 17, 2009
CSMRI-1B	0912163-10	Water	December 17, 2009
CSMRI-2	0912163-11	Water	December 18, 2009
CSMRI-11B	0912163-12	Water	December 18, 2009

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 2.3 (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 Paragon Procedure PA SOP 783R8 for Radium-226 by Radon Emanation counting.

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.

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

All isotopes that were analyzed had activities that were below their respective MDCs in their QC batch preparation blanks.

Duplicate Sample Analysis

All isotopic activities for Radium-226 duplicate and original analysis 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

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

Radium-226 was detected above the RDL in samples CSMRI-5 at 1.28 pCi/L and CSMRI-2 at 1.02 and are considered detected.

The laboratory reported that the ICP-AES measurement of the added barium carrier prior to chemical separation had a concentration of -0.0005ug in the quality control samples LCS, LCSD, and MB. 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 reanalyses.

DATA VALIDATION REPORT

To:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	January 29, 2010
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	0912163 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 Paragon PA SOP 724R10 for Radium-228 by gas proportional counting for SDG 0912163 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of twelve water samples for the Colorado School of Mines/4060 project collected on December 16, December 17, 2009, and December 18, 2009 and submitted to Paragon Analytics, Inc on December 18, 2009. The samples were analyzed for Radium-228 by Radon gas proportional counting on January 5, 2010, January 8, 2010 and January 18, 2010. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
CSMRI-10	0912163-1	Water	December 16, 2009
CSMRI-9	0912163-2	Water	December 16, 2009
CSMRI-8	0912163-3	Water	December 16, 2009
CSMRI-4	0912163-4	Water	December 16, 2009
CSMRI-5	0912163-5	Water	December 16, 2009
SW-2	0912163-6	Water	December 17, 2009
CSMRI-1	0912163-7	Water	December 17, 2009
SW-1	0912163-8	Water	December 17, 2009
EQUIPMENT BLANK	0912163-9	Water	December 17, 2009
CSMRI-1B	0912163-10	Water	December 17, 2009
CSMRI-2	0912163-11	Water	December 18, 2009
CSMRI-11B	0912163-12	Water	December 18, 2009

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 2.3 (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 Paragon Procedure PA SOP 724R10 for Radium-228 by gas proportional counting for SDG 0912163.

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.

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

All isotopes that were analyzed had activities that were below their respective MDC's in their QC batch preparation blanks.

Duplicate Sample Analysis

Due to insufficient sample volume the laboratory prepared and analyzed a Laboratory Control Sample Duplicate (LCSD) in lieu of a client sample duplicate.

All isotopic activities for Radium-228 duplicate (LCS) and original (LCSD) analysis 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

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

Radium-228 was detected above the RDL in sample CSMRI-2 at 1.60 pCi/L and is considered detected.

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 QC criteria were within control limits and no action was necessary.

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

Laboratory Group

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

Chain-of-Custody

Date 12/15/09 Page 1 of 1

Lab ID

Project Name/No.	CO School of Mines
REPORT TO:	Robert Hill
PHONE:	(303) 546-4446
FAX:	(303) 443-1168
E-MAIL:	rhill@stoller.com
COMPANY:	SM Stoller
ADDRESS:	105 Technology Dr #190 Broomfield, CO 80021

Sampler(s) N Ablock

Turnaround [✓ Standard] or Due ________

Disposal [✓ By Lab] or Return to Client

Provide additional information as needed in Comments below.

Sample ID	Date	Time*	Lab ID	Matrix	Preservative (Type HCl, etc.)	No. of Containers
CSMRT-10	12/15/09	0815		W	HNO3	1
↓	↓	↓		↓	—	↓
↓	↓	↓		↓	HNO3	↓
↓	↓	↓		↓	H2SO4	↓
CSMRT-9	↓	0910		↓	HNO3	↓
↓	↓	↓		↓	—	↓
↓	↓	↓		↓	HNO3	↓

Circle Analytical Method Above

	TPH	VOCs	BTEX + MtBE	SVOCs	OC Pesticides	PCBs	Herbicides	Explosives	TCLP Organics SW1311	TCLP Metals SW1311	Total Metals (ICP) or Hg	Dissolved Metals (ICP) or Hg	Total Metals (ICP-MS)	Dissolved Metals (ICP-MS)	Hexavalent Chromium	Inorganic Anions	Solids	pH	Perchlorate	Alk
Sample ID	SW8015B GRO DRO Other	SW8260C	SW8260C	SW8270D	SW8081A	SW8082	SW8151A	SW8330 SW8330B SW8321 by LC/MS/MS	SW8260C SW8270D SW8081A SW8151A	SW6010B SW7470A	SW6010B 7470A/7471A E200.7 E245.1	SW6010B 7470A/7471A E200.7 E245.1	SW6020A E200.8	SW6020A E200.8	SW7196A Alkaline Digestion? Y / N	SW9056 E300.0	TDS: E160.1 TSS: E160.2 Total: E160.3	SW9040B SW9045C E150.1	SW6850 by LC/MS/MS E314.0	
CSMRT-10																				
↓																X				
↓																				
↓																				X
CSMRT-9																				
↓																X				
↓																				

Circle Analytical Method Above

	Actinides	Gamma Isotopes	Gross Alpha / Beta	Total Alpha-Emitting Radium	Radium 226	Radium 228	Strontium 90 (Total RadioSr)	Tritium	Radon 222	[illegible]	Cations
Sample ID	Circle: Am / Cm / Pu / Th / U	E901.1	SW9310 E900.0	SW9315 E903.0	E903.1	SW9320 E904.0	D5811	E906.0	SM7500Rn		
CSMRT-10					X	X				X	
↓											
↓											X
↓											
CSMRT-9					X	X				X	
↓											
↓											X

* 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 analyte list below.

Comments: All samples were filtered
Anions - HCO3, CO3, Alkalinity, Cl, SO4
Cations - Ca, Mg, K, Na

Relinquished By: (1)
Signature
Printed Name N.K. Ablock
Date 12/15/09 Time 1315
Company Stoller

Relinquished By: (2)
Signature ________
Printed Name ________
Date ________ Time ________
Company ________

Received By: (1)
Signature
Printed Name Lauren Schmitt
Date 12/15/09 Time 1315
Company ALS

Received By: (2)
Signature ________
Printed Name ________
Date ________ Time ________
Company ________

Originator: Retain pink page or a photocopy!

Form 202r7 (5/19/09)

ALS . . .s Laboratory Group
225 Commerce Drive, Fort Collins, CO 80524
TF: 800-443-1511 PH: 970-490-1511 FX: 970-490-1522

Chain-o.-Custody

Date 12/14/09	**Page** 2 **of** 7	**Lab ID**	
Project Name/No. CO School of Mines	**Sampler(s)** N Malcik	**Turnaround** [✓ Standard] or Due ____	**Disposal** [✓ By Lab] or Return to Client

REPORT TO:	
PHONE:	
FAX:	
E-MAIL:	
COMPANY:	
ADDRESS:	see page 1

Provide additional information as needed in Comments below.

Sample ID	Date	Time*	Lab ID	Matrix	Preservative (Type HCl, etc.)	No. of Containers	TPH	VOCs	BTEX + MtBE	SVOCs	OC Pesticides	PCBs	Herbicides	Explosives	TCLP Organics SW1311	TCLP Metals SW1311	Total Metals (ICP) or Hg	Dissolved Metals (ICP) or Hg	Total Metals (ICP-MS)	Dissolved Metals (ICP-MS)	Hexavalent Chromium	Inorganic Anions	Solids	pH	Perchlorate	DOC
							SW8015B GRO DRO Other	SW8260C	SW8260C	SW8270D	SW8081A	SW8082	SW8151A	SW8330 SW8330B SW8321 by LC/MS/MS	SW8260C SW8270D SW8081A SW8151A	SW6010B SW7470A	SW6010B 7470A/7471A E200.7 E245.1	SW6010B 7470A/7471A E200.7 E245.1	SW6020A E200.8	SW6020A E200.8	SW7196A Alkaline Digestion? Y / N	SW9056 E300.0	TDS: E160.1 TSS: E160.2 Total: E160.3	SW9040B SW9045C E150.1	SW6850 by LC/MS/MS E314.0	
CSMIRT-9	12/14/09	0940		W	H2SO4	1																				X
CSMIRT-8	↓	1030		↓	HNO3	2																				
↓	↓	↓		↓	–	↓																X				
↓	↓	↓		↓	HCl	3																				
↓	↓	↓		↓	H2SO4	↓																				X
CSMIRT-11	↓	1215		↓	HNO3	2																				
↓	↓	↓		↓	–	↓																X				

Circle Analytical Method Above

Sample ID	Actinides	Gamma Isotopes	Gross Alpha / Beta	Total Alpha-Emitting Radium	Radium 226	Radium 228	Strontium 90 (Total RadioSr)	Tritium	Radon 222	[illegible]	Cations
	Circle: Am / Cm / Pu / Th / U	E901.1	SW9310 E900.0	SW9315 E903.0	E903.1	SW9320 E904.0	D5811	E906.0	SM7500Rn		
CSMIRT-9											
CSMIRT-8					X	X				X	
↓											
↓											X
↓											
CSMIRT-11					X	X				X	
↓											

Circle Analytical Method Above

* 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 analyte list below.

Comments:

see page 1

Relinquished By: (1)
Signature
Printed Name Nick Malcik
Date 12/15/09 Time 1315
Company Chilco

Relinquished By: (2)
Signature ____
Printed Name ____
Date ____ Time ____
Company ____

Received By: (1)
Signature
Printed Name Lauren Ullrich
Date 12/15/09 Time 1315
Company ALS

Received By: (2)
Signature ____
Printed Name ____
Date ____ Time ____
Company ____

Originator: Retain pink page or a photocopy!

Form 202r7 (5/19/09)

ALS Laboratory Group
225 Commerce Drive, Fort Collins, CO 80524
TF: 800-443-1511 PH: 970-490-1511 FX: 970-490-1522

Chain-of-Custody

Date 12/15/09	**Page** 3 **of** 7	**Lab ID**			
Project Name/No. CO School of Mines	**Sampler(s)** N. Mehalik	**Turnaround** [✓ Standard] or Due ______	**Disposal** [✓ By Lab] or Return to Client		

REPORT TO:
PHONE:
FAX:
E-MAIL:
COMPANY:
ADDRESS: see page 1

Provide additional information as needed in Comments below.

Sample ID	Date	Time*	Lab ID	Matrix	Preservative (Type HCl, etc.)	No. of Containers	TPH	VOCs	BTEX + MtBE	SVOCs	OC Pesticides	PCBs	Herbicides	Explosives	TCLP Organics SW1311	TCLP Metals SW1311	Total Metals (ICP) or Hg	Dissolved Metals (ICP) or Hg	Total Metals (ICP-MS)	Dissolved Metals (ICP-MS)	Hexavalent Chromium	Inorganic Anions	Solids	pH	Perchlorate	DOC	Actinides	Gamma Isotopes	Gross Alpha / Beta	Total Alpha-Emitting Radium	Radium 226	Radium 228	Strontium 90 (Total RadioSr)	Tritium	Radon 222	[illegible]	[illegible]
							SW8015B GRO DRO Other	SW8260C	SW8260C	SW8270D	SW8081A	SW8082	SW8151A	SW8330 SW8330B SW8321 by LC/MS/MS	SW8260C SW8270D SW8081A SW8151A	SW6010B SW7470A	SW6010B 7470A/7471A E200.7 E245.1	SW6010B 7470A/7471A E200.7 E245.1	SW6020A E200.8	SW6020A E200.8	SW7196A Alkaline Digestion? Y / N	SW9056 E300.0	TDS: E160.1 TSS: E160.2 Total: E160.3	SW9040B SW9045C E150.1	SW6850 by LC/MS/MS E314.0		Circle: Am / Cm / Pu / Th / U	E901.1	SW9310 E900.0	SW9315 E903.0	E903.1	SW9320 E904.0	D5811	E906.0	SM7500Rn		
							Circle Analytical Method Above																				Circle Analytical Method Above										
CS-11R-T 11	12/14/09	1215		W	HNO3	1																															X
↓	↓	↓		↓	H2SO4	↓																				X											X
CS-MIR-7-5	↓	1320		↓	HNO3	↓																									X	X				X	
↓	↓	↓		↓	—	↓															X																
↓	↓	↓		↓	HNO3	↓																															X
↓	↓	↓		↓	H2SO4	↓																				X											
SI-2	12/14/09	1020		↓	HNO3	↓																									X	X				X	

*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 analyte list below.

Comments:
see page 1

Relinquished By: (1)
Signature
Printed Name Nick Mehalik
Date 12/16/09 Time 1315
Company [illegible]

Relinquished By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Received By: (1)
Signature
Printed Name Jan Kirschmann
Date 12/16/09 Time 1315
Company ALS

Received By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Originator: Retain pink page or a photocopy!

Form 202r7 (5/19/09)

ALS

S Laboratory Group
225 Commerce Drive, Fort Collins, CO 80524
TF: 800-443-1511 PH: 970-490-1511 FX: 970-490-1522

Chain-of-Custody

Date 12/15/09 **Page** 4 **of** 7

Lab ID

Project Name/No.: CO School of Mines
Sampler(s) N Malezuk
Turnaround [✓ Standard] or Due ____
Disposal [✓ By Lab] or Return to Client

REPORT TO:
PHONE:
FAX:
E-MAIL:
COMPANY:
ADDRESS: see page 1

Provide additional information as needed in Comments below.

Sample ID	Date	Time*	Lab ID	Matrix	Preservative (Type HCl, etc.)	No. of Containers	TPH	VOCs	BTEX + MtBE	SVOCs	OC Pesticides	PCBs	Herbicides	Explosives	TCLP Organics SW1311	TCLP Metals SW1311	Total Metals (ICP) or Hg	Dissolved Metals (ICP) or Hg	Total Metals (ICP-MS)	Dissolved Metals (ICP-MS)	Hexavalent Chromium	Inorganic Anions	Solids	pH	Perchlorate	[illegible]
							SW8015B GRO DRO Other	SW8260C	SW8260C	SW8270D	SW8081A	SW8082	SW8151A	SW8330 SW8330B SW8321 by LC/MS/MS	SW8260C SW8270D SW8081A SW8151A	SW6010B SW7470A	SW6010B 7470A/7471A E200.7 E245.1	SW6010B 7470A/7471A E200.7 E245.1	SW6020A E200.8	SW6020A E200.8	SW7196A Alkaline Digestion? Y / N	SW9056 E300.0	TDS: E160.1 TSS: E160.2 Total: E160.3	SW9040B SW9045C E150.1	SW6850 by LC/MS/MS E314.0	
SW-2	12/10/09	1020		W	-	1																X				
↓	↓	↓		↓	HNO3	↓																				
↓	↓	↓		↓	H2SO4	↓																				X
CSMRI-1	↓	1130		↓	HNO3	↓																				
↓	↓	↓		↓	-	↓																X				
↓	↓	↓		↓	HNO3	↓																				
↓	↓	↓		↓	H2SO4	↓																				X

Circle Analytical Method Above

Sample ID	Actinides	Gamma Isotopes	Gross Alpha / Beta	Total Alpha-Emitting Radium	Radium 226	Radium 228	Strontium 90 (Total RadioSr)	Tritium	Radon 222	[illegible]	[illegible]
	Circle: Am / Cm / Pu / Th / U	E901.1	SW9310 E900.0	SW9315 E903.0	E903.1	SW9320 E904.0	D5811	E906.0	SM7500Rn		
SW-2											
↓											X
↓											
CSMRI-1					X	X				X	
↓											
↓											X
↓											

Circle Analytical Method Above

* 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 analyte list below.

Comments:

see page 1

Relinquished By: (1)	*Relinquished By:* (2)
Signature	Signature
Printed Name Nick Malezuk	Printed Name
Date 12/15/09 Time 1315	Date Time
Company Stoller	Company
Received By: (1)	*Received By:* (2)
Signature	Signature
Printed Name Lauren Schmitt	Printed Name
Date 12/15/09 Time 1215	Date Time
Company ALS	Company

Originator: Retain pink page or a photocopy!

Form 202r7 (5/19/09)

ALS Laboratory Group

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

Chain-of-Custody

Date 12/16/09 Page 5 of 7

Lab ID

Project Name/No. CO School of Mines

Sampler(s) N. Walbreck

Turnaround [✓ Standard] or Due ______

Disposal [✓ By Lab] or Return to Client

REPORT TO:

PHONE:

FAX:

E-MAIL:

COMPANY:

ADDRESS: see page 1

Provide additional information as needed in Comments below.

Circle Analytical Method Above

Sample ID	Date	Time*	Lab ID	Matrix	Preservative (Type HCl, etc.)	No. of Containers	TPH	VOCs	BTEX + MtBE	SVOCs	OC Pesticides	PCBs	Herbicides	Explosives	TCLP Organics SW1311	TCLP Metals SW1311	Total Metals (ICP) or Hg	Dissolved Metals (ICP) or Hg	Total Metals (ICP-MS)	Dissolved Metals (ICP-MS)	Hexavalent Chromium	Inorganic Anions	Solids	pH	Perchlorate	DOC	Actinides	Gamma Isotopes	Gross Alpha / Beta	Total Alpha-Emitting Radium	Radium 226	Radium 228	Strontium 90 (Total RadioSr)	Tritium	Radon 222	[illegible]	Cations
							SW8015B GRO DRO Other	SW8260C	SW8260C	SW8270D	SW8081A	SW8082	SW8151A	SW8330 SW8330B SW8321 by LC/MS/MS	SW8260C SW8270D SW8081A SW8151A	SW6010B SW7470A	SW6010B 7470A/7471A E200.7 E245.1	SW6010B 7470A/7471A E200.7 E245.1	SW6020A E200.8	SW6020A E200.8	SW7196A Alkaline Digestion? Y / N	SW9056 E300.0	TDS: E160.1 TSS: E160.2 Total: E160.3	SW9040B SW9045C E150.1	SW6850 by LC/MS/MS E314.0		Circle: Am / Cm / Pu / Th / U	E901.1	SW9310 E900.0	SW9315 E903.0	E903.1	SW9320 E904.0	D5811	E906.0	SM7500Rn		
SW-1	12/16/09	1220		W	HNO3	1																									X	X				X	
↓	↓	↓		↓	–	↓																X															
↓	↓	↓		↓	None	↓																															X
↓	↓	↓		↓	H2SO4	↓																			X												
Equipment blank	↓	1250		↓	None	↓																									X	X				X	
↓	↓	↓		↓	–	↓																X															
↓	↓	↓		↓	None	↓																															X

*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 analyte list below.

Comments:

see page 1

Relinquished By: (1)
Signature
Printed Name N. Walbreck
Date 12/16/09 Time 1315
Company Stoller

Relinquished By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Received By: (1)
Signature Lauren Schurtz
Printed Name Lauren Schurtz
Date 12/15/09 Time 1315
Company AL

Received By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Originator: Retain pink page or a photocopy!

Form 202r7 (5/19/09)

Pa Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 80524
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) ____________

Chain-of-Custody

Date 12/16/09 Page 6 of 7

Originator: Retain pink copy!

Project Name/No.: CO [illegible] Sampler(s): [illegible] Turnaround (circle one) [✓ Standard] or Rush (Due ____________) Dispose: Date ____________ or Return to Client

Report To:
Phone: see page 1
Fax:
E-mail:
Company:
Address:

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type... HCl, etc.)	No. of Containers	VOCs SW8260B	BTEX (only) SW8021B	SVOCs SW8270C	OC Pesticides SW8081A	PCBs SW8082	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 Hg SW6010B 7470	Total Metals by ICP Hg SW6010B 7470 7471 E200.7	Dissolved Metals by ICP Hg SW6010B 7470 E200.7	Total Metals by ICP/MS SW6020A E200.8	Dissolved Metals by ICP/MS SW6020A E200.8	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions SW9056 E300.0 (specify in comments)	Solids: Total E160.3 TDS E160.1 TSS E160.2	pH SW9040B SW9045C	TPH SW8015B GRO DRO (circle one or both)	Gross Alpha / Beta SW9310 E900.0	Actinides by Paragon SOP Pu / U / Am / Th / Cm / ___	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 E903.1	Radium 228 SW9320 E904.0	Strontium 90 (Total RadioSr) D5811-00	Gamma Isotopes E901.1	Radon 222 SM7510Rn	DIC	Dissolved Uranium	Cations
Equipment Blank	12/17/09	1330		W	H_2SO_4	1																												X		
CSAMT 1-17R	↓	1430		↓	HNO_3	↓																							X	X					X	
↓	↓	↓		↓	-	↓															X															
↓	↓	↓		↓	HNO_3	↓																														X
↓	↓	↓		↓	H_2SO_4	↓																												X		
CSAMT-2 [illegible]	12/16/09	1100		↓	HNO_3	↓																							X	X					X	
↓	↓	↓		↓	-	↓															X															
↓	↓	↓		↓	HNO_3	↓																														X
↓	↓	↓		↓	H_2SO_4	↓																												X		
CSAMT 11B	↓	1445		↓	HNO_3	↓																							X	X					X	

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

Comments:

see page 1

Relinquished By: (1)
Signature
Printed Name Nick [illegible]
Date 12/16/09 Time 1315
Company [illegible]

Relinquished By: (2)
Signature ____________
Printed Name ____________
Date ____________ Time ____________
Company ____________

Received By: (1)
Signature
Printed Name [illegible]
Date 12/18/09 Time [illegible]
Company [illegible]

Received By: (2)
Signature ____________
Printed Name ____________
Date ____________ Time ____________
Company ____________

Form 202r6.xls (6/16/06)

Pa[illegible]on Analytics
A Division of DataChem Laboratories, Inc.
225 Commerce Drive Fort Collins, CO 8052
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) ______

Chain-of-Custody Date ______ Page 7 of 7

Originato. Retain pink copy!

roject Name/No.: CO School of Mines **Sampler(s):** Nick Malcolek Turnaround (circle one) [✓ Standard] or **Rush (Due** ______) Dispose: **Date** ______ or **Return to Client**

Report To:
hone:
ax:
-mail:
Company: See page 1
ddress:

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type... HCl, etc.)	No. of Containers	VOCs SW8260B	BTEX (only) SW8021B	SVOCs SW8270C	OC Pesticides SW8081A	PCBs SW8082	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 Hg SW6010B 7470	Total Metals by ICP Hg SW6010B 7470 7471 E200.7	Dissolved Metals by ICP Hg SW6010B 7470 E200.7	Total Metals by ICP/MS SW6020A E200.8	Dissolved Metals by ICP/MS SW6020A E200.8	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions SW9056 E300.0 (specify in comments)	Solids: Total E160.3 TDS E160.1 TSS E160.2	pH SW9040B SW9045C	TPH SW8015B GRO DRO (circle one or both)	Gross Alpha / Beta SW9310 E900.0	Actinides by Paragon SOP Pu / U / Am / Th / Cm / ___	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 E903.1	Radium 228 SW9320 E904.0	Strontium 90 (Total RadioSr) D5811-00	Gamma Isotopes E901.1	Radon 222 SM7510Rn	DCC	Dissolved Uranium	Cations
CSMRT-GC	12/14/09	1130		W	None	1																							X	X					X	

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

Comments:

See page 1

CSMRT-GC only has about 250ml of water for Diss. Uranium test and Ra-226, 228 if there is enough water

Form 202r6.xls (6/16/06)

Relinquished By: (1)
Signature
Printed Name Nick Malcolek
Date 12/14/09 Time 1315
Company Stoller

Received By: (1)
Signature
Printed Name Lauren Schmitt
Date 12/15/09 Time 1315
Company [illegible]

Relinquished By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Received By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

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 Robert Hill	Date 12/16/09	Chain of Custody Number 123522
Address 105 Technology Dr #190	Telephone Number (Area Code)/Fax Number (303) 546-4440	Lab Number	Page 1 of ___
City Broomfield	State CO	Zip Code 80021	
Site Contact	Lab Contact Lee Antercak		
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	Ferrous Fe	Ferric Fe	Special Instructions/Conditions of Receipt
CSMRT-10	12/16/09	0915		X				X							X			
CSMRT-9		0940		X				X							X			
CSMRT-8		1030		X				X							X			
				X				X								X		
↓		↓		X						X							X	
CSMRT-4		1215		X				X							X			
				X				X								X		
↓		↓		X						X							X	
CSMRT-5		1320		X				X							X			
				X				X								X		
↓	↓	↓		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 <10 days

QC Requirements (Specify)

1. Relinquished By	Date 12/16/09	Time 1647	1. Received By	Date 12/16/09	Time 1647
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 Robert Hill	Date 12/17/09	Chain of Custody Number 123521
Address 105 Technology Dr # 190	Telephone Number (Area Code)/Fax Number (303) ~~[illegible]~~ 541-4410	Lab Number	Page 1 of ___

City	State	Zip Code	Site Contact	Lab Contact
Broomfield	CO	80021		Lisa Antonczek

Project Name and Location (State)
CO School of Mines

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	Ferrous Fe	Ferric Fe								Special Instructions/ Conditions of Receipt
SW-2	12/17/09	1020		X				X							X										
CSMRT-1		1130		X				X								~~X~~ mm									
		↓		X						X							X								
↓				X				X								X									
SW-1		1200		X				X							X										
Equipment Blank		1330		X				X							X										
CSMRT-1R	↓	1430		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 2 weeks

QC Requirements (Specify)

1. Relinquished By	Date 12/17/09	Time 1640	1. Received By	Date 12/17/09	Time 1640
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

SEVERN TRENT STL

Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client Steller	Project Manager Robert Hall	Date 12/15/09	Chain of Custody Number 355454
Address 105 Technology Dr #190	Telephone Number (Area Code)/Fax Number (303) 546-4410	Lab Number	Page 1 of 1

City	State	Zip Code	Site Contact	Lab Contact
Broomfield	CO	80021		Lisa Dabrowski

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

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): Mets (Low)												Special Instructions/ Conditions of Receipt
CSMP T-2	12/15/09	1600		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 10 days

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By	12/16/09	1205	1. Received By	12/18/09	1205
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

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)	Total U (µg/l)
CSMRI-1	2/25/05	-0.11	0.81	0.007	0.07	0.01	0.77	0.043	0.53	1.61
	6/14/05	0.16	0.44	0.018	-0.021	0.012	0.43	0.011	0.217	0.64
	9/7/05	0.1	0.63	0.068	0.167	0.114	0.85	0.053	0.43	1.3
	12/20/05	-0.19	0.59	-0.045	0.32	0.014	0.94	0.073	0.46	1.41
	3/15/06	-0.15	0.58	0.025	0.032	-0.004	1.76	0.11	0.92	2.8
	6/14/06	0.42	0.05	0.15	-0.06	0.062	0.18	0.18	0.08	0.31
	9/13/06	0.25	0.34	0.11	-0.079	0.027	0.45	0.051	0.25	0.77
	3/1/07	0.32	0.78	0.052	-0.031	0.012	NT	NT	NT	1.2
	6/27/07	0.51	0.91	0.17	0.064	-0.005	NT	NT	NT	0.88
	9/11/07	-0.3	0.53	-0.031	0.019	0.001	NT	NT	NT	0.72
	11/27/07	-0.2	0.72	0.71	0.101	0.02	NT	NT	NT	1.2
	2/27/08	0.2	0.85	0.035	0.032	0.011	NT	NT	NT	1.5
	4/18/08	-0.02	0.66	-0.03	-0.004	0.01	NT	NT	NT	1.9
	9/25/08	0.26	0.88	NT	NT	NT	NT	NT	NT	0.96
	12/3/08	0.32	1.39	NT	NT	NT	NT	NT	NT	1.5
	3/17/09	0.09	0.96	NT	NT	NT	NT	NT	NT	2
	6/24/09	0.19	0.16 J	NT	NT	NT	NT	NT	NT	1.6
	9/24/09	2.64	1.01	NT	NT	NT	NT	NT	NT	2.4
CSMRI-1B	3/8/07	0.13	1.19	-0.03	-0.09	0.02	NT	NT	NT	2.7
	6/26/07	0.09	0.3	0.001	0.002	0.012	NT	NT	NT	5
	9/11/07	-0.13	0.65	0.019	0.012	0.001	NT	NT	NT	6.3
	11/27/07	0.11	1.16	0.004	0.06	0.016	NT	NT	NT	6.9
	2/28/08	0.32	0.61	0.01	0.058	0.033	NT	NT	NT	6.5
	4/18/08	0.03	0.72	-0.004	-0.046	0	NT	NT	NT	6
	9/24/08	0.05	0.3	NT	NT	NT	NT	NT	NT	4
	12/5/08	0.02	0.88	NT	NT	NT	NT	NT	NT	4.6
	3/18/09	0.2	1.15	NT	NT	NT	NT	NT	NT	8.1
	6/24/09	0.05	0.69 J	NT	NT	NT	NT	NT	NT	15
	9/25/09	0.08	0.89	NT	NT	NT	NT	NT	NT	34
CSMRI-2	2/25/05	0.8	1.85	0.07	-0.02	0.01	0.6	0.05	0.16	0.53
	6/14/05	1.47	3.0	0.14	0.003	0.026	0.68	0.025	0.299	0.89
	9/7/05	1.78	2.71	0.162	0.108	0.049	0.65	0.050	0.31	0.94
	12/20/05	1.35	1.62	0.108	0.285	0.024	0.83	0.002	0.35	1.06
	3/15/06	1.25	2.53	0.03	0.204	0.012	0.83	0.066	0.45	1.36
	6/14/06	0.99	1.79	0.25	0.22	0.049	0.69	0.04	0.25	0.76
	9/13/06	1.01	2.35	0.088	-0.039	-0.008	0.46	0.014	0.28	0.85
	3/8/07	0.76	2.15	0.022	-0.01	0.011	NT	NT	NT	0.72
	6/28/07	1.4	3.2	-0.075	-0.01	-0.007	NT	NT	NT	2
	9/11/07	0.78	3.2	0.016	0.101	0.014	NT	NT	NT	0.98
	11/27/07	0.45	2.05	0.037	0.035	0.006	NT	NT	NT	1
	2/28/08	1.37	2.26	0.043	0.085	0.044	NT	NT	NT	0.68

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)	Total U (µg/l)
	4/17/08	1.08	1.89	0.041	-0.021	0.008	NT	NT	NT	0.89
	9/24/08	0.97	1.41	NT	NT	NT	NT	NT	NT	0.69
	12/5/08	1.1	1.88	NT	NT	NT	NT	NT	NT	0.83
	3/18/09	2.37	2.68	NT	NT	NT	NT	NT	NT	0.77
	6/24/09	0.78	2.64 J	NT	NT	NT	NT	NT	NT	0.66
	9/25/09	0.63	2.12	NT	NT	NT	NT	NT	NT	0.6
CSMRI-4	2/25/05	-0.03	0.16	0.019	-0.009	0.013	9.7	0.53	8.2	24.7
	6/14/05	0.26	0.34	0.013	0.014	0.005	11.4	0.49	10.6	31.4
	9/7/05	0.17	0.78	-0.013	0.164	0.086	6.4	0.33	6.4	19.3
	12/20/05	0.13	0.1	0.033	0.311	0.012	11.5	0.61	11.4	34.3
	3/15/06	0	0.38	0.004	0.174	0.007	9	0.43	9	27.1
	6/15/06	0.41	0.39	0.11	0.17	0.061	9.2	0.4	8.9	26.8
	9/13/06	-0.05	0.79	0.056	-0.015	0.007	6.5	0.35	6	17.9
	3/8/07	0.09	0.37	-0.034	-0.037	0.013	NT	NT	NT	48
	6/27/07	0.07	0.87	0.011	0.035	0.004	NT	NT	NT	66
	9/11/07	0.99	1.12	0.024	0.112	0.021	NT	NT	NT	49
	11/26/07	0.33	0.73	0.029	0.149	0.016	NT	NT	NT	48
	2/27/08	0.24	0.78	0.011	0.038	0.014	NT	NT	NT	58
	4/17/08	0.11	0.71	0.017	-0.019	0.002	NT	NT	NT	62
	9/25/08	0.32	0.8	NT	NT	NT	NT	NT	NT	43
	12/5/08	0.09	0.97	NT	NT	NT	NT	NT	NT	61
	3/17/09	0.54	0.56	NT	NT	NT	NT	NT	NT	80
	6/23/09	0.21	0.89 J	NT	NT	NT	NT	NT	NT	110
	9/24/09	0.11	0.73	NT	NT	NT	NT	NT	NT	160
CSMRI-5	2/25/05	1.06	0.53	0.009	0.007	0.034	1.22	0.056	0.93	2.8
	6/14/05	2.51	0.44	-0.018	0.039	0.011	1.51	0.086	1.2	3.57
	9/7/05	2.50	0.76	0.06	1.25	0.051	1.85	0.051	1.47	4.4
	12/20/05	1.97	0.52	0.032	0.126	0.01	1.45	0.066	1.21	3.63
	3/15/06	0.57	0.45	0.038	0.144	0.019	1.81	0.058	1.38	4.1
	6/15/06	2.13	0.87	0.145	0.08	0.043	1.03	0.13	0.92	2.8
	9/13/06	2.29	0.56	0.053	-0.053	0.005	3.18	0.17	2.32	7
	3/8/07	1.78	0.39	-0.012	-0.061	0	NT	NT	NT	5.8
	6/27/07	2.22	0.86	0.008	-0.023	0.013	NT	NT	NT	10
	9/11/07	1.91	1.2	0.091	0.003	0.006	NT	NT	NT	11
	11/26/07	1.52	0.49	0.004	-0.008	0.01	NT	NT	NT	6.6
	2/27/08	1.05	0.17	-0.011	0.02	0.051	NT	NT	NT	6.6
	4/17/08	1.37	0.64	0.068	0.029	0.017	NT	NT	NT	6.7
	9/25/08	2.87	0.47	NT	NT	NT	NT	NT	NT	10
	12/4/08	0.78	0.68	NT	NT	NT	NT	NT	NT	10
	3/17/09	0.29	1.24	NT	NT	NT	NT	NT	NT	11
	6/23/09	1.96	1.15 J	NT	NT	NT	NT	NT	NT	12

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)	Total U (µg/l)
	9/24/09	-0.15	0.85	NT	NT	NT	NT	NT	NT	11
CSMRI-6B	2/27/07	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	0.46	0.63	-0.009	-0.006	0.024	NT	NT	NT	17
	9/10/07	0.15	0.91	0.046	0.025	0.023	NT	NT	NT	11
	11/27/07	-0.02	0.77	-0.002	0.069	0.004	NT	NT	NT	8.2
	2/28/08	0.26	1	-0.009	0.022	0.022	NT	NT	NT	4.7
	4/18/08	0.36	0.88	-0.005	-0.022	0.021	NT	NT	NT	5
CSMRI-6C	7/11/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/09	-0.11	1.81 J	NT	NT	NT	NT	NT	NT	19
	9/24/09	0.09	1.39	NT	NT	NT	NT	NT	NT	17
CSMRI-7B	2/27/07	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	0.65	0.22	0.036	0.054	0.027	NT	NT	NT	68
	9/10/07	NT	NT	NT	NT	NT	NT	NT	NT	NT
	11/26/07	NT	NT	NT	NT	NT	NT	NT	NT	NT
	2/26/08	NT	NT	NT	NT	NT	NT	NT	NT	NT
	4/15/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	9/24/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	9/25/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	3/8/07	0.7	1.06	0.072	-0.031	0.016	NT	NT	NT	1,100
	6/27/07	0.8	0.4	0.039	0.046	0.008	NT	NT	NT	810
	9/10/07	1.31	0.9	0.031	0.05	0.009	NT	NT	NT	630
	11/27/07	1.27	1.2	-0.02	0.074	-0.003	NT	NT	NT	1,300
	2/27/08	1.19	1.38	0.089	0.1	0.043	NT	NT	NT	1,200
	4/17/08	0.39	0.71	-0.015	-0.053	0.009	NT	NT	NT	770
	9/25/08	1.5	1.02	NT	NT	NT	NT	NT	NT	890
	12/5/08	1.55	1.44	NT	NT	NT	NT	NT	NT	1,900
	3/18/09	0.31	0.69	NT	NT	NT	NT	NT	NT	980
	6/23/09	-0.28	0.73 J	NT	NT	NT	NT	NT	NT	700
	9/24/09	0.39	1.25	NT	NT	NT	NT	NT	NT	880
CSMRI-9	2/27/07	0.12	0.53	-0.017	0.04	0.027	NT	NT	NT	7.9
	6/26/07	0.22	0.37	0.018	0.004	-0.015	NT	NT	NT	32
	9/10/07	0.5	1.01	0.04	-0.043	0.012	NT	NT	NT	35
	11/26/07	0.25	0.27	0.023	0.003	0.003	NT	NT	NT	28
	2/27/08	0.11	0.24	0.047	0.037	0.041	NT	NT	NT	24
	4/15/08	0.27	0.65	-0.004	0.015	0.022	NT	NT	NT	22
	9/24/08	0.11	0.48	NT	NT	NT	NT	NT	NT	28

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)	Total U (µg/l)
	12/5/08	0.13	0.65	NT	NT	NT	NT	NT	NT	26
	3/16/09	0.17	0.45	NT	NT	NT	NT	NT	NT	34
	6/22/09	0	0.88 J	NT	NT	NT	NT	NT	NT	99
	9/24/09	0.24	0.59	NT	NT	NT	NT	NT	NT	43
CSMRI-10	3/1/07	0.19	0.63	0.014	-0.004	0.018	NT	NT	NT	7.8
	6/26/07	0.26	0.43	-0.008	0.03	-0.005	NT	NT	NT	8.8
	9/10/07	-0.04	0.48	0.103	0.05	0.005	NT	NT	NT	9.9
	11/26/07	-0.05	0.57	0.068	0.141	0.031	NT	NT	NT	10
	2/26/08	0.12	0.44	0.094	0.011	0.019	NT	NT	NT	9.2
	4/15/08	0.03	0.56	-0.006	-0.05	0.005	NT	NT	NT	8.7
	9/24/08	0.21	0.48	NT	NT	NT	NT	NT	NT	11
	12/4/08	0.11	0.92	NT	NT	NT	NT	NT	NT	19
	3/16/09	0.15	1.01	NT	NT	NT	NT	NT	NT	16
	6/22/09	0.35	0.48 J	NT	NT	NT	NT	NT	NT	12
	9/25/09	0.25	0.62	NT	NT	NT	NT	NT	NT	13
CSMRI-11	3/1/07	0.16	0.46	0.051	0.085	0.007	NT	NT	NT	4.8
	6/26/07	0.37	0.43	0.084	0	0.008	NT	NT	NT	8.4
	9/10/07	-0.26	0.52	0.012	0.006	0.016	NT	NT	NT	10
	11/26/07	0.16	0.87	0.089	0.099	-0.012	NT	NT	NT	11
	2/26/08	0.28	-0.03	0.044	0.044	0.074	NT	NT	NT	8.7
	4/15/08	0.35	0.75	-0.032	0.004	0.016	NT	NT	NT	7.6
CSMRI-11B	12/3/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/09	0.52	NT	NT	NT	NT	NT	NT	NT	12
	9/25/09	3.5	0.88	NT	NT	NT	NT	NT	NT	17
MCL*		Total Ra = 5		NE	Th 230 + Th 232 = 60**		NE	NE	NE	30

*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)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
CSMRI-1	2/25/05	ND	ND	ND	28	ND	ND	ND	2.8	9.4	ND	29	ND	ND	ND	0.032
	6/14/05	ND	ND	ND	17	ND	ND	ND	2.3	5.1	ND	16	ND	ND	ND	0.032
	9/7/05	ND	ND	0.055 (B)	21	ND	ND	ND	2.9	6.3	0.0021 (B)	25	ND	0.0041 (B)	ND	.034
	12/20/05	ND	ND	0.067 (B)	32	ND	ND	0.000034 (B)	2.9	10	ND	26	ND	ND	ND	0.052
	3/15/06	ND	ND	0.064 (B)	33	ND	ND	0.00002 (B)	2.6	10	0.0013 (B)	24	ND	ND	ND	0.049
	6/14/06	ND	ND	0.031 (B)	10	ND	ND	ND	1.9	3	0.0051 (B)	9.2	ND	0.0035 (B)	ND	0.015 (B)
	9/13/06	ND	ND	0.061 (B)	20	ND	0.041 (B)	ND	2.7	6	0.0038 (B)	14	ND	ND	ND	0.03
	3/1/07	ND	ND	0.081 (B)	39	0.00045 (B)	0.00063 (B)	0.000017 (B)	3	12	0.0059 (B)	26	ND	0.0066	ND	0.048
	6/27/07	ND	ND	0.063 (B)	23	ND	ND	0.0000073 (B)	2.4	9	ND	21	ND	ND	ND	0.017 (B)
	9/11/07	ND	ND	0.065 (B)	23	ND	0.00061 (B)	0.000011 (B)	2.5	7.2	0.002 (B)	14	ND	ND	ND	0.038
	11/27/07	ND	ND	0.075 (B)	31	ND	ND	0.000029 (B)	2.5	9.7	0.0014 (B)	18	ND	ND	ND	0.049
	2/27/08	ND	ND	0.08 (B)	36	ND	ND	ND	2.5	12	0.0013 (B)	22	ND	ND	ND	0.048
	4/18/08	ND	ND	0.081 (B)	36	ND	ND	ND	2.7	11	0.0015 (B)	22	ND	ND	ND	0.057
	9/25/08	NT	NT	NT	30	NT	NT	NT	3	9	NT	18	NT	NT	NT	NT
	12/3/08	NT	NT	NT	39	NT	NT	NT	3.5	12	NT	25	NT	NT	NT	NT
	3/17/09	NT	NT	NT	46	NT	NT	NT	3	14	NT	27	NT	NT	NT	NT
	6/24/09	0.00078	0.0032	0.097	36	0.00016	0.00041	0.00002	3.3	13	32	0.0019	0.00035	NT	NT	NT
	9/24/09	NT	NT	NT	48 (J)	NT	NT	NT	3.2	18 (J)	NT	45 (J)	NT	NT	NT	NT
CSMRI-1B	3/1/07	ND	ND	0.098 (B)	130	ND	0.00014 (B)	0.000017 (B)	52	47	0.17	91	ND	0.0058	0.0009 (B)	ND
	6/26/07	ND	ND	0.071 (B)	83	ND	ND	0.0000072 (B)	10	38	0.029	35	ND	ND	ND	ND
	9/11/07	ND	ND	0.1	93	ND	ND	0.0000094 (B)	8.4	43	0.031	36	ND	ND	ND	0.0012 (B)
	11/27/07	ND	ND	0.11	100	ND	ND	0.000029 (B)	9.4	46	0.024	42	ND	ND	0.00073 (B)	0.0039 (B)
	2/28/08	ND	ND	0.11	97	ND	0.0015 (B)	ND	9.3	45	0.029	41	ND	0.0039 (B)	ND	0.0033 (B)
	4/18/08	ND	ND	0.11	93	ND	ND	ND	9.1	43	0.027	39	ND	ND	0.00065 (B)	ND
	9/24/08	NT	NT	NT	92	NT	NT	NT	7.3	39	NT	38	NT	NT	NT	NT
	12/5/08	NT	NT	NT	95	NT	NT	NT	7.6	39	NT	40	NT	NT	NT	NT
	3/18/09	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/24/09	0.00078	0.0032	0.14	140	0.00016	0.00041	0.000022	7.2	61	59	0.0019	0.00035	NT	NT	NT
	9/25/09	NT	NT	NT	120 (J)	NT	NT	NT	7	55 (J)	NT	42 (J)	NT	NT	NT	NT
CSMRI-2	2/25/05	ND	ND	0.11	72	ND	ND	ND	7.1	32	ND	19	ND	ND	ND	0.02
	6/14/05	ND	ND	0.1	76	ND	ND	ND	6.3	32	ND	18	ND	ND	ND	ND
	9/7/05	ND	ND	0.11	81	ND	ND	ND	7.1	35	ND	19	ND	ND	ND	0.011 (B)
	12/20/05	ND	ND	0.098 (B)	76	ND	ND	0.000031 (B)	6.7	33	ND	18	ND	ND	ND	0.0043 (B)
	3/15/06	ND	ND	0.09 (B)	74	ND	ND	0.000023 (B)	6.1	31	ND	17	ND	ND	ND	0.0059 (B)
	6/14/06	ND	ND	0.093 (B)	70	ND	ND	ND	6.3	31	0.0048 (B)	17	ND	0.0031 (B)	ND	0.0092 (B)
	9/13/06	ND	ND	0.11	81	ND	ND	ND	6.7	35	0.0014 (B)	19	ND	ND	ND	0.0092 (B)
	3/8/07	ND	0.0058 (B)	0.12	88	ND	ND	ND	8.3	39	ND	21	ND	0.03	ND	0.0011 (B)
	6/28/07	ND	ND	0.11	97	ND	ND	0.0000056 (B)	7.9	49	ND	26	ND	ND	0.002 (B)	0.0041 (B)
	9/11/07	ND	ND	0.1	91	ND	ND	0.000016 (B)	7.2	43	ND	23	ND	ND	0.00086 (B)	0.0082 (B)
	11/27/07	ND	ND	0.093 (B)	83	ND	ND	0.000023 (B)	7	38	ND	22	ND	ND	0.001 (B)	0.0075 (B)
	2/28/08	ND	ND	0.094 (B)	81	ND	0.0018 (B)	ND	6.6	38	ND	21	ND	ND	0.0017 (B)	0.0073 (B)

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
	4/17/08	ND	ND	0.092 (B)	78	ND	ND	ND	6.6	36	ND	20	ND	ND	0.0014 (B)	0.0055 (B)
	9/24/08	NT	NT	NT	74	NT	NT	NT	6.4	34	NT	19	NT	NT	NT	NT
	12/5/08	NT	NT	NT	75	NT	NT	NT	6.6	33	NT	20	NT	NT	NT	NT
	3/18/09	NT	NT	NT	76	NT	NT	NT	6.4	34	NT	19	NT	NT	NT	NT
	6/23/09	0.00078	0.0032	0.096	77	0.00016	0.00041	0.000024	6.6	35	20	0.0019	0.00035	NT	NT	NT
	9/25/09	NT	NT	NT	76 (J)	NT	NT	NT	5.2	34 (J)	NT	19 (J)	NT	NT	NT	NT
CSMRI-4	2/25/05	ND	ND	ND	72	ND	ND	ND	5.1	31	0.017	29	ND	ND	ND	0.12
	6/14/05	ND	ND	ND	86	ND	ND	ND	6.6	34	0.038	34	ND	0.0063	ND	0.068
	9/7/05	ND	0.0035 (B)	0.055 (B)	82	ND	ND	ND	7.6	33	0.035	31	ND	0.0049 (B)	ND	0.097
	12/20/05	ND	ND	0.056 (B)	100	ND	ND	0.000045 (B)	6.8	43	0.024	34	ND	ND	ND	0.18
	3/15/06	ND	ND	0.042 (B)	81	ND	ND	0.000034 (B)	5	35	0.021	29	ND	ND	0.00056 (B)	0.21
	6/15/06	ND	0.0031 (B)	0.055 (B)	89	0.00085 (B)	ND	0.0000049 (B)	8.3	37	0.03	31	ND	ND	0.0011 (B)	0.11
	9/13/06	ND	ND	0.043 (B)	66	ND	ND	0.000016 (B)	8.3	27	0.038	30	ND	ND	ND	0.082
	3/8/07	ND	0.0057 (B)	0.072 (B)	120	0.00023 (B)	ND	0.000018 (B)	11	49	0.015	47	ND	0.019	ND	0.088
	6/27/07	ND	ND	0.067 (B)	110	ND	ND	0.000022 (B)	11	46	0.04	47	ND	ND	0.00073 (B)	0.14
	9/11/07	ND	0.0045 (B)	0.089 (B)	120	0.0011 (B)	0.0014 (B)	0.000037 (B)	12	49	0.05	41	ND	ND	0.0012 (B)	0.17
	11/26/07	ND	ND	0.081 (B)	110	0.00049 (B)	ND	0.000035 (B)	10	50	0.024	43	ND	ND	0.0011 (B)	0.1
	2/27/08	ND	ND	0.073 (B)	130	ND	ND	0.000016 (B)	8.2	58	0.015	45	ND	0.0034 (B)	ND	0.069
	4/17/08	ND	0.0063 (B)	0.089 (B)	150	0.00047 (B)	ND	0.000016 (B)	10	66	0.014	53	ND	ND	0.00078 (B)	0.087
	9/25/08	NT	NT	NT	130	NT	NT	NT	13	55	NT	50	NT	NT	NT	NT
	12/5/08	NT	NT	NT	130	NT	NT	NT	11	54	NT	48	NT	NT	NT	NT
	3/17/09	NT	NT	NT	100	NT	NT	NT	9.3	45	NT	63	NT	NT	NT	NT
	6/23/09	0.00078	0.0032	0.084	89	0.00016	0.00041	0.00013	12	38	70	0.0019	0.00068	NT	NT	NT
	9/24/09	NT	NT	NT	160 (J)	NT	NT	NT	14	65 (J)	NT	69 (J)	NT	NT	NT	NT
CSMRI-5	2/25/05	ND	ND	ND	54	ND	ND	ND	3.4	22	ND	27	ND	ND	ND	0.067
	6/14/05	ND	ND	ND	63	ND	ND	ND	3.3	23	ND	28	ND	ND	ND	0.047
	9/7/05	ND	ND	0.085 (B)	85	ND	ND	ND	4.2	31	0.0042 (B)	35	ND	0.0037 (B)	0.0018 (B)	0.089
	12/20/05	ND	ND	0.072 (B)	79	0.00071 (B)	ND	0.000048 (B)	4.1	30	0.002 (B)	31	ND	ND	0.0012 (B)	0.17
	3/15/06	ND	ND	0.058 (B)	70	0.00037 (B)	ND	0.000029 (B)	3.5	26	0.0031 (B)	29	ND	0.0035 (B)	0.00067 (B)	0.11
	6/15/06	ND	ND	0.052 (B)	51	ND	ND	0.000012 (B)	3.6	19	0.0028 (B)	26	ND	ND	ND	0.055
	9/13/06	ND	ND	0.087 (B)	110	ND	0.0022 (B)	ND	4.5	41	0.0027 (B)	50	ND	ND	0.001 (B)	0.11
	3/8/07	ND	0.0037 (B)	0.063 (B)	80	ND	ND	ND	4.5	31	0.0019 (B)	34	ND	0.015	ND	0.083
	6/27/07	ND	ND	0.066 (B)	98	ND	ND	0.0000091 (B)	4.5	40	0.006 (B)	40	ND	ND	0.0017 (B)	0.025
	9/11/07	ND	ND	0.13	110	ND	0.00082 (B)	0.000023 (B)	4.9	44	0.0042 (B)	47	ND	ND	0.0015 (B)	0.054
	11/26/07	ND	ND	0.087 (B)	110	ND	0.00089 (B)	0.000032 (B)	4.5	42	ND	47	ND	ND	0.0012 (B)	0.12
	2/27/08	ND	ND	0.073 (B)	100	ND	ND	ND	4.3	40	ND	42	ND	ND	ND	0.094
	4/17/08	ND	ND	0.078 (B)	100	ND	ND	0.000018 (B)	4.6	40	0.0011 (B)	41	ND	ND	0.0011 (B)	0.093
	9/25/08	NT	NT	NT	160	NT	NT	NT	5.5	61	NT	59	NT	NT	NT	NT
	12/4/08	NT	NT	NT	110	NT	NT	NT	4.8	40	NT	47	NT	NT	NT	NT
	3/17/09	NT	NT	NT	110	NT	NT	NT	4.4	40	NT	44	NT	NT	NT	NT
	6/23/09	0.00078	0.0032	0.12	130	0.00016	0.00041	0.000026	5.8	50	51	0.0019	0.00049	NT	NT	NT

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
	9/24/09	NT	NT	NT	159 (J)	NT	NT	NT	4.2	56 (J)	NT	57 (J)	NT	NT	NT	NT
CSMRI-6B	2/27/08	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	ND	ND	0.12	100	ND	ND	0.0000059 (B)	5.9	56	0.004 (B)	41	ND	ND	ND	ND
	9/10/07	ND	0.0046 (B)	0.15	110	ND	0.00088 (B)	0.000013 (B)	4.8	48	0.0022 (B)	46	ND	ND	0.00081 (B)	0.0051 (B)
	11/27/07	ND	0.0048 (B)	0.17	110	ND	ND	0.000025 (B)	6	49	0.0028 (B)	57	ND	0.0051	0.00066 (B)	ND
	2/28/08	ND	ND	0.17	100	ND	ND	ND	5.8	43	0.004 (B)	49	ND	ND	ND	0.0048
	4/18/08	ND	ND	0.17	96	ND	ND	ND	6.1	40	0.0059 (B)	45	ND	ND	0.0013 (B)	0.0099 (B)
CSMRI-6C	12/3/08 (DRY)	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
	6/24/09	0.00078	0.0032	0.24	120	0.00016	0.00041	0.000027	18	63	46	0.0019	0.0006	NT	NT	NT
	9/24/09	NT	NT	NT	120 (J)	NT	NT	NT	5.1	60 (J)	NT	49 (J)	NT	NT	NT	NT
CSMRI-7B	2/27/07	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	ND	ND	0.056 (B)	70	ND	ND	0.000006 (B)	5.5	37	0.024	53	ND	ND	0.00061 (B)	0.0041 (B)
	9/10/07	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	11/26/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	2/27/08	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
	9/24/08 (DRY)	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
	3/16/09 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	Dry	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
		NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	3/807	ND	0.0053 (B)	0.068 (B)	230	ND	ND	ND	23	72	0.094	74	ND	0.034	ND	0.0024 (B)
	6/27/07	ND	ND	0.053 (B)	190	ND	ND	0.0000099 (B)	19	55	0.043	52	ND	ND	ND	0.069
	9/10/07	ND	0.0069 (B)	0.076 (B)	160	ND	0.00074 (B)	0.000027 (B)	15	49	0.034	54	0.0018 (B)	ND	ND	0.025
	11/27/07	ND	ND	0.091 (B)	230	ND	ND	0.000024 (B)	15	67	0.026	70	ND	0.0046 (B)	0.001 (B)	0.011 (B)
	2/27/08	ND	0.036 (B)	0.07 (B)	270	ND	ND	ND	15	82	0.019	100	ND	ND	ND	0.038
	4/17/08	ND	ND	0.046 (B)	210	ND	0.0011 (B)	ND	13	63	0.016	73	ND	ND	ND	0.032
	9/25/08	NT	NT	NT	230	NT	NT	NT	17	68	NT	70	NT	NT	NT	NT
	12/5/08	NT	NT	NT	400	NT	NT	NT	18	95	NT	84	NT	NT	NT	NT
	3/18/09	NT	NT	NT	250	NT	NT	NT	13	74	NT	97	NT	NT	NT	NT
	6/23/09	0.00078	0.0032	0.038	170	0.00095	0.00041	0.00003	14	48	60	0.0019	0.00035	NT	NT	NT
	9/24/09	NT	NT	NT	250 (J)	NT	NT	NT	13	63 (J)	NT	78 (J)	NT	NT	NT	NT
CSMRI-9	2/27/07	ND	ND	0.08 (B)	69	ND	0.0011 (B)	0.000024 (B)	12	31	0.045	33	ND	0.011	0.001 (B)	ND
	6/26/07	ND	ND	0.049 (B)	160	ND	ND	0.000002 (B)	8.5	77	0.0028	150	ND	0.0049 (B)	0.00096 (B)	0.0096 (B)
	9/10/07	ND	0.004 (B)	0.059 (B)	100	ND	0.0009 (B)	0.000016 (B)	6	51	0.0037 (B)	49	ND	ND	0.00071 (B)	0.0097 (B)
	11/26/07	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	0.0012 (B)	0.015 (B)
	2/27/08	ND	ND	0.079 (B)	110	ND	ND	ND	5.4	56	ND	49	ND	0.0033 (B)	ND	0.011
	4/15/08	ND	ND	0.077 (B)	100	ND	ND	0.000013 (B)	5	52	0.0017 (B)	46	ND	ND	0.00077 (B)	0.0079 (B)
	9/24/08	NT	NT	NT	110	NT	NT	NT	5.8	54	NT	50	NT	NT	NT	NT

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
	12/5/08	NT	NT	NT	100	NT	NT	NT	5.3	48	NT	46	NT	NT	NT	NT
	3/16/09	NT	NT	NT	100	NT	NT	NT	4.7	49	NT	45	NT	NT	NT	NT
	6/22/09	0.00078	0.0032	0.054	250	0.00079	0.00041	0.000026	12	100	120	0.0019	0.00035	NT	NT	NT
	9/24/09	NT	NT	NT	120 (J)	NT	NT	NT	5.6	58 (J)	NT	64 (J)	NT	NT	NT	NT
CSMRI-10	3/1/07	0.00051 (B)	ND	0.064 (B)	79	ND	0.0013 (B)	0.000024 (B)	7.3	33	0.01	36	ND	0.01	0.0011 (B)	ND
	6/26/07	ND	ND	0.079 (B)	100	ND	ND	0.0000063 (B)	4.7	44	ND	37	ND	0.0044 (B)	0.00055 (B)	ND
	9/10/07	ND	0.0039 (B)	0.071 (B)	89	ND	0.0012 (B)	0.00002 (B)	4.2	38	0.0014 (B)	36	ND	ND	0.00099 (B)	0.0042 (B)
	11/26/07	ND	ND	0.085 (B)	110	ND	ND	0.000026 (B)	4.7	43	ND	41	ND	ND	ND	ND
	2/26/08	ND	ND	0.09 (B)	110	ND	ND	ND	4.6	46	ND	41	ND	ND	ND	0.0052
	4/15/08	ND	ND	0.088 (B)	100	ND	0.0044 (B)	ND	4.5	44	ND	40	ND	ND	0.00059 (B)	0.0018 (B)
	9/24/08	NT	NT	NT	100	NT	NT	NT	4.6	42	NT	41	NT	NT	NT	NT
	12/4/08	NT	NT	NT	100	NT	NT	NT	4.8	41	NT	43	NT	NT	NT	NT
	3/16/09	NT	NT	NT	110	NT	NT	NT	4.5	43	NT	43	NT	NT	NT	NT
	6/22/09	0.00078	0.0032	0.09	100	0.00016	0.00041	0.00002	4.5	41	40	0.0019	0.00035	NT	NT	NT
	9/25/09	NT	NT	NT	120 (J)	NT	NT	NT	3.8	47 (J)	NT	43 (J)	NT	NT	NT	NT
CSMRI-11	2/27/07	ND	ND	0.073 (B)	75	ND	0.00013 (B)	0.000023 (B)	9.7	29	0.033	33	ND	0.013	0.00073 (B)	0.0023 (B)
	6/26/07	ND	ND	0.096 (B)	110	ND	0.0012 (B)	0.0000071 (B)	5.4	44	0.0014 (B)	39	ND	0.0064	0.00059 (B)	ND
	9/10/07	ND	0.004 (B)	0.071 (B)	96	ND	0.00083 (B)	0.000016 (B)	4.5	39	0.0016 (B)	44	ND	ND	0.00078(B)	0.0033 (B)
	11/26/07	ND	ND	0.11	110	ND	ND	0.000028 (B)	4.9	44	0.0012 (B)	40	ND	ND	0.0013 (B)	ND
	2/26/08	ND	ND	0.11	110	ND	ND	ND	4.6	42	ND	44	ND	ND	ND	0.0048
	4/15/08	ND	ND	0.12	100	ND	ND	ND	4.7	41	ND	44	ND	ND	ND	ND
CSMRI-11B	12/3/08 (DRY)	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
	6/24/09	0.00078	0.0032	0.22	89	0.00043	0.00041	0.000027	19	43	48	0.0019	0.00066	NT	NT	NT
	9/25/09	NT	NT	NT	130 (J)	NT	NT	NT	6.2	57 (J)	NT	49 (J)	NT	NT	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	0.02
MCL*		NE	0.01	2	NE	0.005	0.1	0.002	NE	NE	NE	NE	0.015	0.05	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)	Total U (µg/l)
SW-1	2/25/05	0	0.58	0.018	-0.026	-0.001	0.89	0.083	0.65	1.97
	6/14/05	0.14	0.05	0.05	-0.025	0.016	0.246	0.021	0.251	0.75
	9/7/05	0.18	0.42	0.041	0.25	0.102	0.35	0.031	0.35	1.04
	12/20/05	-0.31	0.47	0.028	0.197	-0.005	0.64	0.041	0.7	2.11
	3/15/06	-0.16	0.35	0.059	0.125	0.005	0.6	0.029	0.53	1.59
	6/14/06	0.13	0.45	0.16	0.53	0.062	0.11	0.08	0.19	0.61
	9/13/06	-0.03	0.25	-0.019	-0.035	0.01	0.37	-0.005	0.34	1
	3/1/07	-0.1	0.25	-0.038	0.15	0.026	NT	NT	NT	1.7
	6/27/07	0.13	0.77	0.006	0.016	0.014	NT	NT	NT	0.6
	9/11/07	0.15	0.74	0.063	0.088	0.012	NT	NT	NT	0.94
	11/27/07	0.2	0.24	0.026	0.049	0.025	NT	NT	NT	1.8
	2/27/08	0.1	0.48	0.014	0.002	0.024	NT	NT	NT	2
	4/18/08	0.06	-0.07	-0.023	-0.026	0.012	NT	NT	NT	1.9
	9/25/08	0.18	-0.01	NT	NT	NT	NT	NT	NT	1.1
	12/3/08	-0.06	0.34	NT	NT	NT	NT	NT	NT	1.6
	3/16/09	0.14	0.73	NT	NT	NT	NT	NT	NT	1.9
	6/24/09	0.33	1.228 J	NT	NT	NT	NT	NT	NT	0.55
	9/24/09	-0.08	0.37	NT	NT	NT	NT	NT	NT	1.1
SW-2	2/25/05	0.45	0.06	0.011	-0.016	0.033	0.8	0.066	0.42	1.29
	6/14/05	0.04	0.29	0.071	-0.028	0.007	0.259	0.032	0.23	0.69
	9/7/05	-0.08	0.24	-0.013	0.107	0.051	0.54	0.014	0.54	1.62
	12/20/05	0.09	0.07	-0.003	0.126	0	0.71	0.067	0.49	1.5
	3/15/06	-0.04	-0.15	0.009	0.184	0.01	0.79	0.004	0.51	1.52
	6/14/06	0.03	0.04	0.172	0.24	0.1	0.39	0	0.48	1.44
	9/13/06	0.11	0.35	0.009	-0.03	0.01	0.43	-0.006	0.3	0.89
	3/8/07	0.12	0.73	0.047	-0.055	0	NT	NT	NT	1.7
	6/28/07	0.02	0.78	0.028	0.014	0	NT	NT	NT	0.57
	9/11/07	0.1	0.27	0.066	0.068	0.002	NT	NT	NT	0.97
	11/26/07	0.11	0.36	0.007	0	0.012	NT	NT	NT	1.7
	2/26/08	0.1	0	-0.01	0.113	0.011	NT	NT	NT	2
	4/18/08	0.13	0.58	0.015	0.24	0.024	NT	NT	NT	1.8
	9/24/08	-0.16	-0.02	NT	NT	NT	NT	NT	NT	0.99
	12/3/08	0.1	0.46	NT	NT	NT	NT	NT	NT	1.5
	3/16/09	0.2	0.29	NT	NT	NT	NT	NT	NT	1.9
	6/24/09	0.03	0.47 J	NT	NT	NT	NT	NT	NT	.059
	9/24/09	0	0.28 (J)	NT	NT	NT	NT	NT	NT	1.1
MCL*		Total Ra = 5		NE	Th 230 + Th 232 = 60**		NE	NE	NE	30

*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

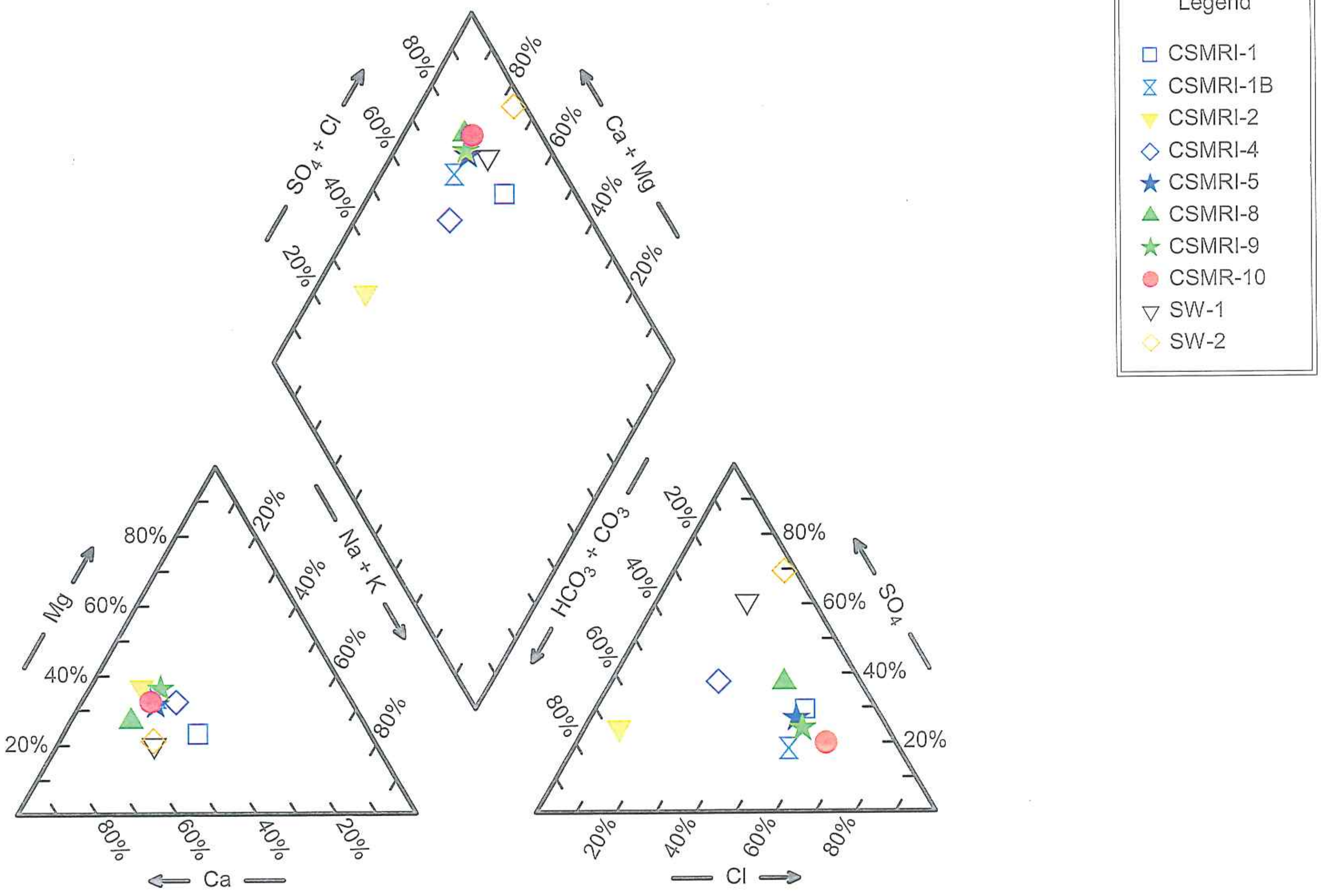
Table G-4
Historical Summary of Metals in Surface Water (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
SW-1	2/25/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2
	6/14/05	ND	ND	ND	11	ND	ND	ND	1.1	2.8	ND	5.2	ND	ND	ND	0.09
	9/7/05	ND	0.0037 (B)	0.029 (B)	20	ND	ND	ND	2.2	4.4	0.0044 (B)	8.5	ND	0.0045 (B)	ND	0.063
	12/20/05	ND	ND	0.042 (B)	35	0.00057 (B)	ND	0.000034 (B)	3.7	7.6	0.004 (B)	19	ND	ND	ND	0.22
	3/15/06	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	0.00067 (B)	0.19
	6/14/06	0.0012 (B)	0.0032 (B)	0.011 (B)	8.2	ND	ND	ND	1	1.9	0.0042 (B)	3.1	ND	ND	ND	0.029
	9/13/06	ND	ND	0.03 (B)	21	ND	ND	ND	2.1	4.4	0.0049 (B)	8.6	ND	ND	ND	0.053
	3/1/07	ND	ND	0.049 (B)	44	0.0011 (B)	0.00092 (B)	0.000023 (B)	4.3	11	0.0046 (B)	26	ND	ND	ND	0.22
	6/27/07	ND	ND	0.018 (B)	10	ND	ND	0.0000068 (B)	0.93 (B)	2.5	0.0017 (B)	3.2	ND	ND	ND	0.067
	9/11/07	ND	ND	0.032 (B)	21	ND	ND	0.000019	1.7	5	0.0029 (B)	7.4	ND	ND	ND	0.078
	11/27/07	ND	ND	0.042 (B)	33	0.00076 (B)	ND	0.00027 (B)	2.8	8.2	0.0032 (B)	15	ND	ND	ND	0.18
	2/27/08	ND	ND	0.042 (B)	36	ND	ND	ND	3.3	9.6	0.0022 (B)	19	ND	ND	ND	0.15
	4/18/08	ND	ND	0.044 (B)	35	0.00044 (B)	ND	ND	3.4	9	0.0034 (B)	23	ND	ND	ND	0.13
	9/25/08	NT	NT	NT	23	NT	NT	NT	1.9	5.1	NT	9	NT	NT	NT	NT
	12/3/08	NT	NT	NT	32	NT	NT	NT	3	7.1	NT	15	NT	NT	NT	NT
	3/16/09	NT	NT	NT	35	NT	NT	NT	3.1	8.9	NT	17	NT	NT	NT	NT
	6/24/09	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	NT	NT
	9/24/09	NT	NT	NT	25 (J)	NT	NT	NT	1.4	5.5 (J)	NT	9.7 (J)	NT	NT	NT	NT
SW-2	2/25/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17
	6/14/05	ND	ND	ND	11	`ND	ND	ND	1.1	2.8	ND	4.8	ND	ND	ND	0.085
	9/7/05	ND	ND	0.028 (B)	20	ND	ND	ND	2.1	4.4	0.0037 (B)	8.7	ND	0.0037 (B)	ND	0.051
	12/20/05	ND	ND	0.042 (B)	35	0.00043 (B)	ND	0.000034 (B)	3.8	8	0.0038 (B)	19	ND	ND	ND	0.21
	3/15/06	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	0.00053 (B)	0.2
	6/14/06	ND	0.0022 (B)	0.011 (B)	8.4	ND	ND	ND	1	1.9	0.0045 (B)	3	ND	ND	ND	0.031
	9/13/06	ND	ND	0.03 (B)	21	ND	ND	ND	2.1	4.4	0.0048 (B)	8.5	ND	ND	ND	0.04
	3/8/07	ND	0.0053 (B)	0.049 (B)	39	0.00064 (B)	ND	ND	4.2	9.8	0.0014 (B)	22	ND	ND	ND	0.17
	6/28/07	ND	ND	0.019 (B)	10	ND	ND	0.0000056 (B)	0.93 (B)	2.6	ND	3.3	ND	ND	ND	0.075
	9/11/07	ND	ND	0.033 (B)	21	ND	ND	0.00001	1.7	5.1	0.0035 (B)	7.5	ND	ND	ND	0.084
	11/26/07	ND	ND	0.044 (B)	35	0.0005 (B)	ND	0.00027 (B)	2.9	8.6	0.0027 (B)	15	ND	ND	ND	0.19
	2/26/08	ND	ND	0.051	35	0.0005 (B)	ND	ND	3.1	9.2	0.0023 (B)	21	ND	ND	ND	0.15
	4/18/08	ND	ND	0.045 (B)	35	0.0005 (B)	ND	ND	3.4	9.1	0.0031 (B)	23	ND	ND	ND	0.14
	9/24/08	NT	NT	NT	23	NT	NT	NT	1.9	5.1	NT	9	NT	NT	NT	NT
	12/3/08	NT	NT	NT	31	NT	NT	NT	3	7.5	NT	15	NT	NT	NT	NT
	3/16/09	NT	NT	NT	37	NT	NT	NT	3.5	9.7	NT	19	NT	NT	NT	NT
	6/24/09	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	NT	NT
	9/24/09	NT	NT	NT	25 (J)	NT	NT	NT	1.4	5.5 (J)	NT	9.4 (J)	NT	NT	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	0.02
MCL*		0.01	0.01	2	NE	0.005	0.1	0.002	NE	NE	NE	NE	0.015	0.05	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 2009 Quarter 4



CSMRI-1

Water Type	Ca-Cl		
Dissolved Solids	353.46 mg/kg	352.5 mg/L	Calculated
Density	0.9973 g/cm^3		Calculated
Conductivity	534 µmho/cm		Measured
Hardness (as CaCO$_3$)			
Total	188.75 mg/kg	188.24 mg/L	Calculated
Carbonate	136.52	136.15	
Non-Carbonate	52.233	52.092	

Primary Tests

Anion-Cation Balance		
Anions	4.83	
Cations	5.68	
% Difference	8.021	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	353.455	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	534.000	
Calculated	548.333	
Ratio	0.974	OK

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.905062	Within preferred range (0.9-1.1)
Cations	1.062917	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.662	OK
Measured TDS to EC ratio		
Measured TDS unavailable		

Organic Mass Balance

DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.100 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-1B

Water Type	Ca-Cl		
Dissolved Solids	767.73 mg/kg	765.9 mg/L	Calculated
Density	0.99761 g/cm^3		Calculated
Conductivity	1270 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	510.88 mg/kg	509.66 mg/L	Calculated
Carbonate	378.18	377.28	
Non-Carbonate	132.7	132.38	

Primary Tests		
Anion-Cation Balance		
Anions	11	
Cations	12.5	
% Difference	6.314	Not within ± 5%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	767.735	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	1270.000	
Calculated	1110.645	
Ratio	1.143	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	0.865442	Not within preferred range (0.9-1.1)
Cations	0.982087	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.605	OK
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	3.400 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-2

Water Type	Ca-HCO_3		
Dissolved Solids	511.22 mg/kg	509.9 mg/L	Calculated
Density	0.99742 g/cm^3		Calculated
Conductivity	554 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	342.28 mg/kg	341.39 mg/L	Calculated
Carbonate	342.28	341.39	
Non-Carbonate	0.0	0.0	

Primary Tests

Anion-Cation Balance		
Anions	5.43	
Cations	7.84	
% Difference	18.201	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	511.221	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	554.000	
Calculated	602.543	
Ratio	0.919	OK

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.979759	Within preferred range (0.9-1.1)
Cations	1.415774	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.923	Not within preferred range (0.55-0.7)

Measured TDS to EC ratio

Measured TDS unavailable

Organic Mass Balance

DOC ≥ Sum of Organics

DOC unavailable

CSMRI-4

Water Type	Ca-SO_4		
Dissolved Solids	823.93 mg/kg	822 mg/L	Calculated
Density	0.99765 g/cm^3		Calculated
Conductivity	1310 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	477.57 mg/kg	476.45 mg/L	Calculated
Carbonate	477.57	476.45	
Non-Carbonate	0.0	0.0	

Primary Tests

Anion-Cation Balance		
Anions	9.4	
Cations	12.5	
% Difference	14.141	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	823.934	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	1310.000	
Calculated	1015.356	
Ratio	1.290	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.717768	Not within preferred range (0.9-1.1)
Cations	0.954191	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.629	OK
Measured TDS to EC ratio		
Measured TDS unavailable		

Organic Mass Balance

DOC ≥ Sum of Organics		
Dissolved Organic Carbon	5.700 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-5

Water Type	Ca-Cl		
Dissolved Solids	794.58 mg/kg	792.7 mg/L	Calculated
Density	0.99763 g/cm^3		Calculated
Conductivity	1520 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	531.77 mg/kg	530.51 mg/L	Calculated
Carbonate	345.29	344.47	
Non-Carbonate	186.48	186.04	

Primary Tests

Anion-Cation Balance		
Anions	10.9	
Cations	13.1	
% Difference	9.066	Not within ± 5%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	794.583	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	1520.000	
Calculated	1145.958	
Ratio	1.326	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions (0.9-1.1)	0.718943	Not within preferred range
Cations (0.9-1.1)	0.862295	Not within preferred range
Calculated TDS to EC ratio (0.55-0.7)	0.523	Not within preferred range
Measured TDS to EC ratio		
Measured TDS unavailable		

Organic Mass Balance

DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.400 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-8

Water Type	Ca-Cl		
Dissolved Solids	1119.4 mg/kg	1117 mg/L	Calculated
Density	0.99788 g/cm^3		Calculated
Conductivity	1850 µmho/cm		Measured
Hardness (as CaCO$_3$)			
Total	768.97 mg/kg	767.33 mg/L	Calculated
Carbonate	608.22	606.93	
Non-Carbonate	160.75	160.4	

<u>Primary Tests</u>

Anion-Cation Balance		
Anions	12.3	
Cations	18.1	
% Difference	19.054	Not within ± 5%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	1119.378	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	1850.000	
Calculated	1402.473	
Ratio	1.319	Not within range 0.9 to 1.1

<u>Secondary Tests</u>

Measured EC and Ion Sums:		
Anions	0.664402	Not within preferred range
(0.9-1.1)		
Cations	0.977199	Within preferred range (0.9-
1.1)		
Calculated TDS to EC ratio	0.605	OK
Measured TDS to EC ratio		
Measured TDS unavailable		

<u>Organic Mass Balance</u>

DOC ≥ Sum of Organics		
Dissolved Organic Carbon	3.200 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-9

Water Type	Ca-Cl		
Dissolved Solids	901.46 mg/kg	899.4 mg/L	Calculated
Density	0.99771 g/cm^3		Calculated
Conductivity	1620 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	626.92 mg/kg	625.49 mg/L	Calculated
Carbonate	443.91	442.89	
Non-Carbonate	183.01	182.59	

Primary Tests

Anion-Cation Balance		
Anions	11.4	
Cations	15.2	
% Difference	14.208	Not within ± 5%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	901.463	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	1620.000	
Calculated	1245.068	
Ratio	1.301	Not within range 0.9 to 1.1

Secondary Tests

Measured EC and Ion Sums:		
Anions	0.705977	Not within preferred range (0.9-1.1)
Cations	0.939816	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.556	OK
Measured TDS to EC ratio		
Measured TDS unavailable		

Organic Mass Balance

DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.300 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMR-10

Water Type	Ca-Cl		
Dissolved Solids	786.67 mg/kg	784.8 mg/L	Calculated
Density	0.99762 g/cm^3		Calculated
Conductivity	1470 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	535.9 mg/kg	534.63 mg/L	Calculated
Carbonate	378.18	377.28	
Non-Carbonate	157.72	157.35	

<u>Primary Tests</u>		
Anion-Cation Balance		
Anions	9.98	
Cations	12.9	
% Difference	12.939	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	786.669	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	1470.000	
Calculated	1103.352	
Ratio	1.332	Not within range 0.9 to 1.1
<u>Secondary Tests</u>		
Measured EC and Ion Sums:		
Anions (0.9-1.1)	0.678646	Not within preferred range
Cations (0.9-1.1)	0.880364	Not within preferred range
Calculated TDS to EC ratio (0.55-0.7)	0.535	Not within preferred range
Measured TDS to EC ratio		
Measured TDS unavailable		
<u>Organic Mass Balance</u>		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.100 mg/L	
Sum of Organics	0.000 mg/L	OK

SW-1

Water Type	Ca-SO_4		
Dissolved Solids	230.95 mg/kg	230.3 mg/L	Calculated
Density	0.9972 g/cm^3		Calculated
Conductivity	276 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	132.76 mg/kg	132.39 mg/L	Calculated
Carbonate	77.312	77.096	
Non-Carbonate	55.445	55.29	

Primary Tests		
Anion-Cation Balance		
Anions	3.09	
Cations	3.5	
% Difference	6.188	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	230.946	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	276.000	
Calculated	361.833	
Ratio	0.763	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions (0.9-1.1)	1.120456	Not within preferred range
Cations (0.9-1.1)	1.268282	Not within preferred range
Calculated TDS to EC ratio (0.55-0.7)	0.837	Not within preferred range
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.300 mg/L	
Sum of Organics	0.000 mg/L	OK

SW-2

Water Type	Ca-SO_4		
Dissolved Solids	248.49 mg/kg	247.8 mg/L	Calculated
Density	0.99722 g/cm^3		Calculated
Conductivity	372 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	145.64 mg/kg	145.23 mg/L	Calculated
Carbonate	85.536	85.298	
Non-Carbonate	60.1	59.932	

Primary Tests		
Anion-Cation Balance		
Anions	2.83	
Cations	3.81	
% Difference	14.799	Not within ± 0.2meq/L.
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	248.491	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	372.000	
Calculated	371.593	
Ratio	1.001	OK
Secondary Tests		
Measured EC and Ion Sums:		
Anions	0.760155	Not within preferred range (0.9-1.1)
Cations	1.024217	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.668	OK
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.100 mg/L	
Sum of Organics	0.000 mg/L	OK