Colorado School of Mines Research Institute Site

February 2008

Monitoring Report for CSMRI Creekside Facility Fourth Quarter 2007

Prepared for:
Colorado School of Mines Research Institute
Golden, CO

Prepared by:
The S.M. Stoller Corporation
105 Technology Drive, Suite 190
Broomfield, CO 80021

Stoller

Monitoring Report for
CSMRI Site
Fourth Quarter 2007

Prepared for:

Colorado School of Mines
Golden, Colorado

Prepared by:

The S.M. Stoller Corporation
Broomfield, Colorado

February 2008

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. Introduction

This report presents the fourth quarter (October, November, and December) 2007 results for air monitoring, groundwater monitoring, 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 for groundwater and surface water on November 26 and November 27, 2007 from 10 groundwater monitoring wells and two surface water sample locations. Groundwater quality samples were obtained on November 26 (CSMRI-4, CSMRI-5, CSMRI-9, CSMRI-10, and CSMRI-11) and on November 27 (CSMRI-1, CSMRI-1B, CSMRI-2, CSMRI-6B, and CSMRI-8). Monitor well CSMRI-7B did not provide sufficient volume of water for sampling.

Surface water samples were collected from surface water location SW-1 on November 27 and from SW-2 on November 26. Aqueous samples were placed in iced coolers and couriered to Paragon Analytics Laboratory, Inc. of Fort Collins, Colorado for analysis.

Air particulate samples were collected from filters of two onsite air monitoring stations, AS-East on October 9, November 27, and December 14, 2007 and AS-West on October 9, 2007. Air monitor sampler AS-West was not operational at the time of the November and December filter sample collection due to electrical issues.

Figure 1 presents the monitor well, surface water sample, and air sampling station locations. The figure also presents a groundwater potentiometric surface elevation map based on depth to groundwater relative to the surveyed top-of-casing for the time periods of November 26 and November 27, 2007. The elevation of the groundwater potentiometric surface at the time of sampling is posted adjacent to each monitor well location. The figure indicates a north to northeastward component of flow.

2.1 Atmospheric Monitoring

Particulate monitoring has been conducted at two locations within the CSMRI site at the locations shown on Figure 1. The monitoring was conducted using low-volume air sampling pumps with 47-millimeter-diameter filters. The pumps generally have run continuously beginning February 15, 2005, although the locations have changed depending on site activities. The pump filters are collected once per month and sent to Paragon Analytics Laboratory for analysis. Samples were collected following the procedures outlined in Appendix A, Long-Lived Airborne Radioparticulate Survey. The filters were analyzed for gross alpha, gross beta, radium (Ra-226), thorium (Th-228, Th-230, Th-232), uranium (U-234, U-235, U-238), and total uranium.

The pumps are placed about 4 feet above the ground. The pumps are located in protective housings, which prevent precipitation from contacting the samplers but still allows for air circulation around the samplers.

2.2 Groundwater Sampling

Groundwater samples were obtained from all monitoring wells except from CSMRI-7B. Monitor wells CSMRI-1B, CSMRI-6B, CSMRI-7B, CSMRI-8, CSMRI-9, CSMRI-10, and CSMRI-11 were installed in February 2007. Monitor well as-built construction diagrams and borehole lithology were provided in Appendix I of the March 2007 quarterly report.

Water quality samples were collected following the procedures outlined in Appendix B, Groundwater Sampling Procedures. All monitor wells have depth to water measured relative to top-of-casing to the nearest 1/100th of a foot (0.01) prior to sample purging. Graphs of water table elevation are presented as Figure 2 for monitor wells CSMRI-1, CSMRI-4, and CSMRI-5, and as Figure 3 for monitor well CSMRI-2. The hydrograph figures (Figures 2 and 3) present data for the four monitor wells that have been measured quarterly since March 2005. As potentiometric surface data are developed for the seven monitor wells that were installed in February 2007, the data will be incorporated into hydrographs.

The Figure 2 hydrograph reflects the seasonal trends of flow in Clear Creek due to the proximity of select monitor wells to the creek. Monitor well CSMRI-1 is located upstream of CSMRI-4 and CSMRI-5, which accounts for the difference in elevation of the water table between the wells as shown on Figure 2.

The Figure 3 hydrograph for monitor well CSMRI-2, located near the southeast corner of the freshman parking lot on West Campus Drive and the Welch Ditch, until recently reflected the use of and leakage from an adjacent irrigation ditch during the summer months.

Sample collection field forms that record the water quality parameters of the monitor well water as it is purged and the volume removed are provided in Appendix C, Sample Collection Forms. After parameter stabilization, the 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.

2.3 Surface Water Sampling

Surface water samples from Clear Creek were collected from two locations: one upstream of the site and one downstream of the site as shown on Figure 1. Samples were collected on November 26, 2007 for SW-2 and November 27, 2007 for SW-1. The surface water samples were collected following the procedures outlined in Appendix D, Surface Water Sampling Procedures. 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.

A graph of the stream flow in Clear Creek during the fourth quarter from October 2007 through December 2007 is attached as Figure 4. The graph indicates that measurement of stream flow at the time of sample collection was affected by ice. The last valid stream flow measurement of 55 cubic feet per second (cfs) was taken on November 21 at the USGS Golden, Colorado Clear Creek gauging station (USGS Surface Water Online Database).

2.4 Analyses

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

- Data completeness
- Holding times and preservation
- Instrument initial calibrations
- Instrument performance checks
- Preparation blanks
- Duplicate sample results
- Laboratory control samples results
- Compound quantization and reporting limits (full validation only)

Data validation reports are attached in Appendix E. No laboratory anomalies with the groundwater and surface water samples were identified during the data validation review. No laboratory anomalies with the air filter samples were identified during the data validation review.

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 any interferences or anomalies in the laboratory data.

2.4.1 Atmospheric Analyses

Paragon Analytics Laboratory, Inc. of Fort Collins, Colorado, performed laboratory analyses of the monthly air monitoring filters. The filters from the sampling locations were analyzed for gross alpha, gross beta, Ra-226, Th-228, Th-230, Th-232, U-234, U-235, U-238, and total uranium. Data were reviewed for completeness, accuracy, and calibration; results of the QA/QC review are presented in Appendix E, Data Validation Reports. The results of these analyses are presented in Appendix F on a compact disk as a series of Excel spreadsheets. A summary of the air monitoring results is presented in Table 2-1. Where negative values exist in the data, the values are within uncertainty boundaries.

2.4.2 Groundwater Quality Analyses

Paragon Analytics Laboratory, Inc. conducted laboratory analyses of the aqueous samples. The groundwater and surface water samples were analyzed for the metals: Ag (silver), As (arsenic), Ba (barium), Ca (calcium), Cd (cadmium), Cr (chromium), Hg (mercury), K (potassium), Mg (magnesium), Mo (molybdenum), Na (sodium), Pb (lead), Se (selenium), V(vanadium), and Zn (zinc) as well as the radioisotopes: radium (Ra-226 and Ra-228), thorium (Th-228, Th-230, and Th-232), and U (uranium). Since the first quarter of monitoring in February 2005, the concentration of total uranium in micrograms per liter (µg/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 with the first quarter 2007 sampling event, the concentration of uranium is now analyzed using mass spectrometry method EPA 6020, which analyzes for total uranium and not for the activity of the individual isotopes.

The results of these analyses are presented in Appendix F on a compact disk as a series of Excel spreadsheets.

An equipment blank was also analyzed for quality control purposes, as described in the Data Validation Report. Results of the data validation analyses are included as Appendix E, Data Validation Reports, and the chain-of-custody documentation are included as Appendix G, Chain of Custody. The data validation analyses of the analytical data and the laboratory QA/QC checks did not indicate any anomalies.

A summary of groundwater results for radioisotopes and metals is presented in Table 2-2 and Table 2-3, respectively. Groundwater parameters are reported as dissolved concentration in milligrams per liter (mg/l) for metals; picoCuries per liter (pCi/l) for radioisotopes; and micrograms per liter (µg/l) for uranium. Groundwater samples were measured onsite for temperature, pH, and specific conductance during the purging and sampling process. Onsite measurement parameters are presented on the sample collection forms in Appendix C.

2.4.3 Surface Water Analyses

A summary of Clear Creek surface water results for radioisotopes and metals is presented in Table 2-4 and Table 2-5, respectively. Surface water parameters are reported as dissolved concentration in mg/l for metals; pCi/l for radioisotopes; and µg/l for uranium. Surface water samples were measured onsite for temperature, pH, and specific conductance as the sampling was conducted. Onsite measurement parameters are presented on the sample collection forms in Appendix C.

2.5 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

Results from samples collected from the CSMRI site during the fourth quarter 2007 are summarized on Tables 2-1 through 2-5. Table 2-6 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 2-6 are presented in pCi/l as “activity” yet recent (2005 through 2007) 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 MCL, based on data from the National Inorganics and Radionuclides Survey.

Table 2-7 presents the monthly historical air filter radioisotopic sample results collected by Stoller since March 2005. Tables 2-8 and 2-9 present the quarterly historical groundwater radioisotopic and metals sample results, respectively, collected by Stoller since February 2005. Tables 2-10 and 2-11 present the quarterly historical Clear Creek surface water radioisotopic and metals sample results, respectively, collected by Stoller since February 2005.

3.1 Atmospheric Results

Results from air sampling stations AS-East and AS-West are summarized in Table 2-1. Station AS-West is located adjacent to and west (upwind) of the former stockpiled soil site, and station AS-East is located adjacent to and east (downwind) of the former stockpiled soil site. The analytical results indicate no significant difference between the two sample locations for the month of October 2007. This indicates limited airborne emissions from the site during this sampling period. Air sampler AS-West was not operational at the time of filter collection on November and December; thus filter samples was not collected from this station during these months. All analytical results are well below Colorado air standards as shown on Table 2-1.

3.2 Groundwater Conditions

Groundwater monitor wells are located in areas likely to detect impacts, if any, to groundwater emanating from the site as well as locations that represent background water quality. 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 excavation and stockpile creation that were conducted during the summer of 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 upland areas and essentially encircle the CSMRI site.

3.3 Groundwater Quality

Groundwater samples were collected from ten monitor wells and tested for the presence of metals and radioisotopes as identified in Section 2.4.2. No groundwater sample was collected from monitor well CSMRI-7B due to insufficient recharge.

The measured activities of Ra-226, Ra-228, Th-228, Th-230, and Th-232 for all groundwater monitor wells were below their respective National Primary Drinking Water Standards MCL as shown in Table 2-2. Uranium was detected in monitor wells CSMRI-4 at 48 µg/l and CSMRI-8 at 1,300 µg/l at concentrations exceeding the MCL of 30 µg/l. Uranium was also detected in the remaining seven groundwater monitor wells but at concentrations below the MCL.

The concentration of uranium in CSMRI-9 at 28 µg/l will be monitored since initial sampling at this location in March 2007 indicated a concentration of 7.9 µg/l, well below the MCL of 30 µg/l. This monitor well is located at the top of the slope that rises above the Clear Creek flood plain.

In the flood plain area, uranium was detected in monitor wells CSMRI-4 (48 µg/l), CSMRI-5 (6.6 µg/l); and CSMRI-8 (1,300 µg/l). Uranium in monitor well CSMRI-4 has historically had elevated concentrations of uranium, but the values had been declining since 1991 until the last several quarterly sampling events. Figure 5 illustrates the decreasing concentration of uranium in CSMRI-4 since 1991. Historically, the concentration of uranium in this monitor well has spiked; once in 1999 and then 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). Soil remediation activities in the flood plain area in December 2006 may have affected the recent rise in the concentration of uranium in this monitor well. This is commonly observed after soil remediation activities.

Figure 6 presents the uranium concentration and the elevation of the water table for 2005 through the third quarter (September) 2007 for monitor well CSMRI-4. The figure indicates the concentration of uranium had previously been fluctuating seasonally slightly above to below the MCL of 30 µg/l for seven quarterly sampling events in 2005 and 2006. The second quarter 2006 concentration of uranium at 26.8 µg/l for CSMRI-4 in Figure 6 may not be valid due to analytical laboratory tracer recoveries of less than 20 percent. A discussion regarding the validity of this data point was presented in the second quarter 2006 report. An ice chest from the fourth quarter 2007 (December) sampling event was lost by the courier service resulting in a gap in the analytical data for CSMRI-4.

The concentration of uranium in monitor well CSMRI-5 has decreased to 6.6 µg/l. Historical data from Tables 2-6 and 2-8 indicate concentrations of uranium between 2 µg/l and 4 µg/l. Beginning in September 2006, the concentration increased to a high of 11 µg/l. The slight increase can be attributed to the soil remediation efforts within the flood plain in the vicinity of CSMRI-5. The current value of 6.6 µg/l is still well below the MCL of 30 µg/l.

The concentration of uranium detected in CSMRI-8 increased to 1,300 µg/l from a previous low of 630 µg/l. Monitor well CSMRI-8 was installed in February 2007 and quarterly monitoring will be continued to document seasonal variability and trends in the concentration of uranium at this location.

The groundwater at the CSMRI site will be monitored on a quarterly basis, and the exceedances of uranium in monitoring wells CSMRI-4 and CSMRI-8 will continue to be evaluated as more data are made available. The relationship between the seasonal stream flow of Clear Creek and the exceedances of uranium for the monitor wells located on the flood plain will be assessed.

3.3.1 Comparison of Upgradient and Downgradient Groundwater Quality

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 a topographical slope above the flood plain; and CSMRI-6B, CSMIR-10, and CSMRI-11 are upgradient from the site.

Metals concentrations that are above detection limits vary widely regarding upgradient versus downgradient wells. The analytical data indicates the influence of Clear Creek to CSMRI-1 where Ca was detected in SW-1, SW-2 and CSMRI-1 at concentrations of 33 mg/l, 35 mg/l, and 31 mg/l, respectively. Seven monitor wells within the immediate CSMRI site detected Ca at concentrations narrowly ranging from 100 to 110 mg/l. However, the analytical results indicate the presence of Ca at a concentration of 230 mg/l in monitor well CSMRI-8, twice the concentration of most of the other monitor wells. The concentration of all other tested metals appears inconclusive for discerning trends in upgradient and downgradient metals.

Uranium was detected in monitor well CSMRI-4 at a concentration of 48 µg/l and in CSMRI-8 at a concentration of 1,300 µg/l, which exceed the MCL of 30 µg/l. As shown on Figure 6, there appears to be a seasonal correlation between fluctuations of the water table elevation and the concentration of uranium in monitor well CSMRI-4. However, as presented in Figure 6, the concentration of uranium in this monitor well has decreased compared to the June 2007 analytical results. This is likely due to the soil remediation activities that were initiated in the flood plain area in December 2006 and completed in August 2007.

3.3.2 Comparison with Previous Groundwater Quality Analyses

Table 2-6 presents groundwater analytical results from past sampling events dating back to 1991 for radioisotopes of concern. The data indicate a slight decreasing trend in contaminant concentrations over time, indicating improving groundwater quality.

As additional data are collected and trends become more defined, graphs of concentration versus time will be produced and presented. This analytical data will be incorporated to show longer-term trends and correlation between the detected concentration of uranium in groundwater, the fluctuating water table and seasonal variability if present.

3.3.3 Comparison with Colorado Groundwater Standards

The statewide dissolved concentration standard of 5 pCi/l for the sum of Ra-226 and Ra-228 in drinking water set by the State of Colorado Water Quality Control (WQC) Commission is not exceeded in any of the sampled monitoring wells. The statewide dissolved concentration standard for drinking water for the sum of Th-230 and Th-232 at 60 pCi/l was not exceeded in any of the monitoring wells sampled. No exceedances of the MCL for tested metals were identified in any of the groundwater and surface water samples.

The EPA MCL for uranium in drinking water was exceeded in monitor wells CSMRI-4 (48 µg/l) and CSMRI-8 (1,300 µg/l). In January 2008, CDPHE WQC Commission adopted the surface water quality standard of 30 µg/l as the groundwater quality standard in an effort to keep both standards consistent. There was previously no groundwater quality standard; the 30 µg/l standard will be effective on May 31, 2008.

The spike in the concentration of uranium in CSMRI-4 shown in Figure 5 may be attributed to the increased precipitation during the months of December 2006 through February 2007. This monitor well exhibited the same trend in 2003 during a prolonged high precipitation time period and when the asphalt cover and buildings associated with CSMRI had been removed. The third and fourth quarter 2007 analytical results indicate a decrease in the concentration of total U compared to the second quarter (June 2007) sample results.

The detected concentration of 1,300 µg/l at monitoring well CSMRI-8 may be due to several reasons:

- The well contains residual uranium from the former pond area on the flood plain.
- Uranium was disturbed and introduced into the monitor well during installation.
- The well contains residual uranium from the former Building 101 area at the top of the slope above the flood plain.

- Uranium is naturally occurring in the Fox Hills bedrock formation.
- The well is located in a zone where strong mixing between Clear Creek water and groundwater occurs, and the oxidizing conditions associated with creek water causes uranium to dissolve more readily.

Monitoring well CSMRI-8 will continue to be sampled on a quarterly basis with the other site wells, and the reason for the elevated level of uranium will be evaluated.

3.4 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 metals detected above their respective detection limits include: Ca, K, Mg, Na, and Zn. The upstream and downstream surface-water concentrations of all metals and radionuclides detected at the CSMRI site from stations SW-1 and SW-2 are similar. No established MCLs were exceeded.

4. Activities for Fourth Quarter 2007

Fourth quarter 2007 activities at the site included removal of the air particulate samplers after the December 2007 filter samplers were collected. The removal of the samplers was conducted with the concurrence of CDPHE.

Clean fill soil was brought to the vicinity of CSMRI-5 to fill-in the area that was excavated in 2006 and 2007. The fill soil was graded to the surrounding topography and the area was reseeded.

The site will be visited on a regular basis for inspection and maintenance of the storm water best management practices (BMPs) and scheduled quarterly monitor well groundwater and surface water sampling.

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 Air
(All results in microcuries per milliliter)

Sample Station	Sample Date	Gross Alpha		Gross Beta		Ra-226		Th-228		Th-230		Th-232		U-234		U-235		U-238		Total U	
		Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
AS-East	10/9/2007	1.06E-15	2.4E-16	1.23E-14	2.0E-15	-1.30E-16	1.5E-16	-3.67E-17	1.3E-16	-5.67E-17	1.1E-16	3.33E-18	5.0E-17	1.33E-17	3.7E-17	-3.33E-18	4.3E-17	1.67E-17	3.7E-17	3.00E-17	7.0E-17
AS-East	11/27/2007	1.50E-15	2.8E-16	1.12E-14	1.8E-15	1.07E-16	9.6E-17	1.96E-17	6.7E-17	1.96E-17	7.8E-17	6.75E-17	5.0E-17	3.48E-17	3.9E-17	2.40E-17	3.5E-17	4.57E-17	4.4E-17	1.02E-16	6.7E-17
AS-East	12/14/2007	1.02E-15	2.8E-16	1.26E-14	2.1E-15	2.57E-16	1.7E-16	6.28E-17	1.9E-16	3.45E-16	2.8E-16	1.26E-17	8.2E-17	8.79E-17	8.8E-17	4.39E-17	8.2E-17	3.14E-17	6.9E-17	1.63E-16	1.4E-16
AS-West	10/9/2007	7.80E-16	1.9E-16	8.54E-15	1.4E-15	-3.00E-17	7.7E-17	3.67E-17	8.3E-17	-3.33E-17	9.3E-17	1.00E-17	3.7E-17	8.34E-17	6.7E-17	-3.33E-18	4.3E-17	3.33E-17	4.3E-17	1.13E-16	9.0E-17
AS-West	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
AS-West	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Unrestricted use limit*		NE		NE		9E-13		3E-14		2E-14		4E-15		1E-12		1E-12		1E-12		9E-13	

*6 CCR 1007-1 Part 4, Appendix 4B, Table 4B-2, assuming Class W
NE – Not Established

Table 2-2
Summary of Radioisotopes in Groundwater

Sample Station	Sample Date	Ra-226 (pCi/l)		Ra-228 (pCi/l)		Th-228 (pCi/l)		Th-230 (pCi/l)		Th-232 (pCi/l)		Total U (µg/l)	
		Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
CSMRI-1	11/27/07	-0.2	0.35	0.72	0.45	0.071	0.083	0.101	0.08	0.02	0.031	1.2	
CSMRI-1B	11/27/07	0.11	0.2	1.16	0.65	0.004	0.056	0.06	0.071	0.016	0.023	6.9	
CSMRI-2	11/27/07	0.45	0.37	2.05	0.72	0.037	0.069	0.035	0.065	0.006	0.023	1	
CSMRI-4	11/26/07	0.33	0.32	0.73	0.39	0.029	0.073	0.149	0.087	0.016	0.026	48	
CSMRI-5	11/26/07	1.52	0.57	0.49	0.38	0.004	0.056	-0.008	0.056	0.01	0.023	6.6	
CSMRI-6B	11/27/07	-0.02	0.3	0.77	0.44	-0.002	0.072	0.069	0.074	0.004	0.024	8.2	
CSMRI-7B	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	
CSMRI-8	11/27/07	1.27	0.53	1.2	0.49	-0.02	0.071	0.074	0.072	-0.003	0.022	1300	
CSMRI-9	11/26/07	0.25	0.23	0.27	0.31	0.023	0.076	0.003	0.058	0.003	0.022	28	
CSMRI-10	11/26/07	-0.05	0.31	0.57	0.39	0.068	0.077	0.141	0.089	0.031	0.036	10	
CSMRI-11	11/26/07	0.16	0.36	0.87	0.42	0.089	0.082	0.099	0.08	-0.012	0.024	11	
MCL*		Total Ra = 5				NE		Th 230 + Th 232 = 60**				30	

*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-41 Reg 41 – Colorado Groundwater Standards
NE - Not Established
NT – Not Tested

Table 2-3
Summary of Metals in Groundwater

(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	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
CSMRI-1B	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)
CSMRI-2	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)
CSMRI-4	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
CSMRI-5	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
CSMRI-6B	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
CSMRI-7B	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	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)
CSMRI-9	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)
CSMRI-10	11/26/07	ND	ND	0.085 (B)	110	ND	ND	0.000026 (B)	4.7	43	ND	41	ND	ND	ND	ND
CSMRI-11	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
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002 (B)	1	1	0.01	1	0.003	0.005	0.01	0.02
MCL*		NE	0.010	2	NE	0.005	0.1	0.002 (B)	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 2-4
Summary of Radioisotopes in Surface Water

Sample Station	Sample Date	Ra-226 (pCi/l)		Ra-228 (pCi/l)		Th-228 (pCi/l)		Th-230 (pCi/l)		Th-232 (pCi/l)		Total U (µg/l)	
		Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty	Result	Uncertainty
SW-1	11/27/07	0.2	0.28	0.24	0.34	0.026	0.068	0.049	0.071	0.025	0.034	1.8	
SW-2	11/26/07	0.11	0.24	0.36	0.34	0.007	0.07	0	0.061	0.012	0.023	1.7	
MCL*		Total Ra = 5				NE		Th 230 + Th 232 = 60**				30	

*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-31 Reg 31 – Colorado Surface Water Standards
NE – Not Established

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	Mo	Na	Pb	Se	V	Zn
SW-1	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
SW-2	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
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
MCLs*		0.01	0.010	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

Table 2-6
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)	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	0.3	0.2	<0.55	<0.45	ND (<0.38)	ND (<0.31)
	U Total			2.09	2.59	2.59	1.44	2.4	2.9	0.87	1.4
	Th-230			0.4	0.2	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	1.4	2.8	2.1	1.7
	U Total	11	5.7	0.55	1.46	1.46	0.71	1.5	1.3	1.9	1.3
	Th-230		0	0.1	0.1	0.1	0.9	<0.17	0.43	0.20	0.31
CSMRI–3	Ra-226		0.6	1.5	1.2	1.2	1.6	<0.75	<0.81	ND (<0.49)	<0.98
	U Total	17	10.4	8.41	12.4	12.4	10	12	12	9	10
	Th-230		0	0.3	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	0.6	0.4	<0.85	<0.42	<0.32	ND (<0.64)
	U Total	86	57.3	23.4	58.6	58.6	33.7	16	34.2	53	19
	Th-230		0	0.7	0.3	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	3.3	2.7	ND (<0.49)	1.1	2.6	1.59
	U Total	14	16.8	3.6	3.6	3.6	4	2.8	2.3	2.7	3.3
	Th-230		0	0.2	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

Table 2-7
Historical Summary of Radioisotopes in Air (Stoller)

(All results in microCuries per milliliter)

Sample Station	Sample Date	Gross Alpha	Gross Beta	Ra-226	Th-228	Th-230	Th-232	U-234	U-235	U-238	Total U
AS-East	3/17/05	1.3E-15	1.3E-14	1.4E-16	6.8E-17	7.1E-17	4.1E-17	2.5E-16	1.3E-17	8.2E-17	3.5E-16
	4/18/05	1.2E-15	1.2E-14	5.3E-17	1.7E-17	8.7E-17	3.0E-18	9.8E-17	1.0E-17	3.2E-17	1.4E-16
	5/11/05	6.1E-16	8.0E-15	9.3E-18	5.1E-17	1.4E-17	-3.3E-18	7.5E-17	-3.3E-17	4.8E-17	1.2E-16
	6/14/05	7.2E-16	1.1E-14	6.3 E-17	-4.4E-17	2.5E-17	1.7E-17	6.1E-17	6.0E-18	3.1E-17	9.7E-17
	7/12/05	5.11E-16	1.3E-14	0	9.5E-17	9.5 E-17	2.1E-17	9.1E-17	1.6E-17	4.5E-17	1.5E-16
	8/16/05	9.1E-16	1.6E-14	1.1E-16	1.1E-17	0	7.9E-18	1.5E-16	1.2E-18	2.8E-17	1.8E-16
	9/14/05	1.3E-15	1.5E-14	-6.3E-17	4.8E-17	4.8 E-17	3.6E-17	6.7E-17	0	3.7E-18	7.0E-17
	10/11/05	1.78E-15	1.43E-14	7.31E-16	6.32E-17	1.98E-17	-3.16E-18	8.30E-17	9.88E-18	2.77E-17	1.22E-16
	11/10/05	1.14E-15	1.31E-14	1.64E-16	3.56E-17	7.47E-17	1.60E-16	8.18E-17	1.42E-17	8.89E-17	1.85E-16
	12/20/05	9.60E-16	5.44E-15	2.03E-16	2.40E-17	-6.67E-17	2.93E-17	2.93E-17	8.00E-18	5.60E-17	9.60E-17
	1/19/06	8.71E-16	6.05E-15	1.17E-16	3.20E-17	9.96E-17	4.98E-17	2.13E-16	7.11E-18	6.76E-17	2.88E-16
	2/16/06	8.38E-16	9.79E-15	9.91E-17	-3.81E-17	-7.62E-17	2.29E-17	1.52E-16	6.48E-17	1.64E-16	3.81E-16
	3/15/06	8.30E-16	1.39E-14	-5.93E-17	2.77E-17	-4.74E-17	7.90E-18	6.32E-17	-3.95E-18	3.16E-17	9.09E-17
	4/14/06	7.93E-16	1.18E-14	-4.27E-17	0	3.56E-17	6.40E-17	4.27E-17	1.42E-17	1.78E-17	7.11E-17
	5/15/06	7.95E-16	1.17E-14	3.44E-17	3.44E-18	-1.93E-16	6.88E-18	9.29E-17	1.72E-17	6.88E-17	1.79E-16
	6/15/06	8.02E-16	1.51E-14	4.13E-17	4.47E-17	1.93E-16	5.85E-17	1.69E-16	-3.44E-18	5.16E-17	2.20E-16
	7/17/06	3.00E-15	1.20E-14	1.00E-16	3.33E-18	-1.00E-17	4.33E-17	1.47E-16	0	5.00E-17	1.97E-16
	8/7/06	2.95E-15	1.41E-14	3.00E-16	1.93E-16	-1.02E-16	-9.14E-18	1.98E-16	3.05E-17	1.12E-16	3.40E-16
	9/13/06	1.64E-15	1.28E-14	8.65-17	8.65E-18	-2.31E-17	1.12E-17	5.48E-17	-1.15E-17	7.21E-17	1.15E-16
	10/23/2006	7.60E-16	1.10E-14	1.33E-16	-2.67E-17	8.00E-18	-5.33E-18	4.27E-17	1.33E-17	3.47E-17	9.07E-17
	11/15/2006	1.33E-15	1.50E-14	-2.78E-17	5.57E-17	3.25E-17	1.39E-17	6.03E-17	1.86E-17	2.32E-17	1.02E-16
	12/13/2006	1.57E-15	8.19E-15	1.64E-16	1.91E-17	6.86E-17	-3.81E-18	4.57E-17	1.91E-17	6.48E-17	1.26E-16
	1/18/2007	1.72E-15	8.95E-15	8.89E-18	*2.96E-17*	*1.96E-16*	*2.67E-17*	*6.52E-17*	*0*	*2.96E-18*	*6.82E-17*
	2/17/2007	1.10E-15	1.21E-14	1.42E-16	*3.20E-17*	*1.14E-16*	*5.69E-17*	*1.60E-16*	*-3.56E-18*	*9.60E-17*	*2.52E-16*
	3/16/2007	8.93E-16	6.99E-15	-1.98E-17	-3.16E-17	-7.51E-17	2.37E-17	2.37E-17	-3.95E-18	3.56E-17	5.53E-17
	4/23/2007	7.75 E-15	3.71 E-15	7.86E-17	5.62E-18	-1.40E-17	1.68E-17	2.53E-17	5.62E-18	*2.08E-17*	*5.05E-17*
	5/30/2007	2.97E-16	1.19E-15	5.48E-17	3.75E-17	8.36E-17	-2.88E-18	1.79E-17	1.73E-17	3.46E-17	6.92E-17
	6/28/07	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
AS-West	3/17/05	1.4E-15	1.5E-14	2.5E-16	2.5E-17	0	3.3E-17	4.2E-16	7.1E-18	7.3E-17	5.0E-16
	4/18/05	1.2E-15	1.2E-14	-1.0E-17	1.7E-17	-2.3 E-17	2.5E-17	2.5E-16	1.2E-17	5.5E-17	3.1E-16
	5/11/05	5.8E-16	8.0E-15	-1.3E-16	-4.7E-18	3.3E-17	1.5E-17	1.7E-16	1.4E-17	4.6E-17	6.5E-17
	6/14/05	8.8E-16	9.8E-15	1.0E-16	8.5E-18	1.6E-17	7.5E-17	1.4E-16	1.4E-17	3.0E-17	1.9E-16
	7/12/05	8.8 E-16	1.4E-14	2.7E-17	7.6E-18	2.3E-17	3.4E-17	2.2E-16	2.3E-17	7.6E-17	3.2E-16
	8/16/05	1.2E-15	1.5E-14	2.0E-16	2.1E-17	1.0E-16	1.1E-17	4.9E-16	1.8E-17	6.4E-18	7.3E-17
	9/14/05	1.4E-15	1.5E-14	-1.1E-17	5.9E-17	7.0E-17	7.0E-18	8.1E-17	0	3.8E-17	1.2E-16
	10/11/05	1.62E-15	1.6E-14	2.29E-15	2.77E-17	3.16E-17	7.11E-18	1.86E-16	5.02E-17	9.88E-17	3.32E-16
	11/10/05	1.85E-15	1.48-14	8.18E-17	-2.13E-17	-2.13E-17	2.49E-17	9.25E-17	1.07E-17	2.49E-17	1.28E-16
	12/20/05	7.90E-16	1.03E-14	2.67E-17	1.33E-17	-5.87E-17	1.87E-17	9.87E-17	1.60E-17	5.07E-17	1.63E-16
	1/19/06	5.09E-16	7.36E-15	1.07E-16	1.07E-17	9.96E-17	7.11E-18	1.53E-16	0	8.54E-17	2.42E-16
	2/16/06	7.85E-16	1.04E-14	-6.10E-17	3.43E-17	-2.29E-17	4.95E-17	8.38E-17	-1.14E-17	4.95E-17	1.22E-16

Table 2-7
Historical Summary of Radioisotopes in Air (Stoller)

(All results in microCuries per milliliter)

Sample Station	Sample Date	Gross Alpha	Gross Beta	Ra-226	Th-228	Th-230	Th-232	U-234	U-235	U-238	Total U
	3/15/06	8.46E-16	1.27E-14	-5.53E-17	7.90E-18	7.51E-17	3.16E-17	8.30E-17	2.37E-17	2.37E-17	1.34E-16
	4/14/06	1.07E-15	1.23E-14	-1.53E-16	3.20E-17	-4.62E-17	1.42E-17	8.18E-17	1.42E-17	6.05E-17	1.56E-16
	5/15/06	5.95E-16	1.23E-14	9.98E-17	1.38E-17	-5.16E-17	2.75E-17	1.96E-16	6.19E-17	6.88E-17	3.27E-16
	6/15/06	9.57E-16	1.41E-14	-1.38E-17	1.03E-17	2.44E-16	6.88E-18	8.26E-17	1.38E-17	5.51E-17	1.51E-16
	7/17/06	3.60E-15	1.23E-14	5.67E-16	2.67E-17	4.33E-17	9.67E-17	3.93E-16	3.67E-17	1.17E-16	5.47E-16
	8/7/06	2.29E-15	1.57E-14	2.24E-16	1.22E-16	-6.60E-17	3.56E-17	3.20E-16	1.02E-17	1.22E-16	4.57E-16
	9/13/06	1.07E-15	1.41E-14	-1.38E-17	1.01E-16	-2.60E-17	2.31E-17	2.31E-17	1.44E-17	8.65E-18	4.61E-17
	10/23/2006	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
	11/15/2006	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
	12/13/2006	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
	1/18/2007	1.37E-15	7.79E-15	4.15E-17	***6.82E-17***	***5.93E-17***	***-2.96E-18***	***5.63E-17***	***2.96E-18***	***2.96E-18***	***6.22E-17***
	2/17/2007	1.19E-15	1.52E-14	2.10E-16	***9.96E-17***	***4.87E-16***	***3.20E-17***	***1.03E-16***	***2.13E-17***	***1.42E-17***	***1.42E-16***
	3/16/2007	6.88E-16	1.09E-14	2.77E-17	6.72E-17	3.56E-17	7.51E-17	7.51E-17	-3.95E-18	1.15E-16	1.90E-16
	4/23/2007	1.66E-15	1.14E-14	-4.49E-17	5.62E-17	-1.97E-17	1.40E-17	4.49E-17	5.62E-18	3.09E-17	8.14E-17
	5/30/2007	1.44E-15	1.33E-14	-6.63E-17	2.88E-17	-1.21E-16	2.88E-17	2.60E-17	-2.88E-18	2.88E-17	5.19E-17
	6/28/2007	8.35E-16	1.50E-14	6.62E-17	8.83E-17	0.00	4.05E-17	4.41E-17	2.58E-17	5.15E-17	1.18E-16
Unrestricted use limit*		NE	NE	9E-13	3E-14	2E-14	4E-15	1E-12	1E-12	1E-12	9E-13

* 6 CCR 1007-1 Part 4, Appendix 4B, Table 4B-2, assuming Class W
NE – Not Established
Bold Italicized data are qualified.

Table 2-8
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
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
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
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
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

Table 2-8
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)
	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
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
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
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
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
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
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
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
NE – Not Established
NT – not tested
µg/l – micrograms per liter

Table 2-9
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	.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
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)
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	0.00085	23	ND	ND	0.00086 (B)	0.0082 (B)
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
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

Table 2-9
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
	12/20/05	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
CSMR-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)
CSMR-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
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
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)
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)
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)
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 2-10
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
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
MCL*		Total Ra = 5		NE	Th 230 + Th 232 = 60**		NE	NE	NE	30

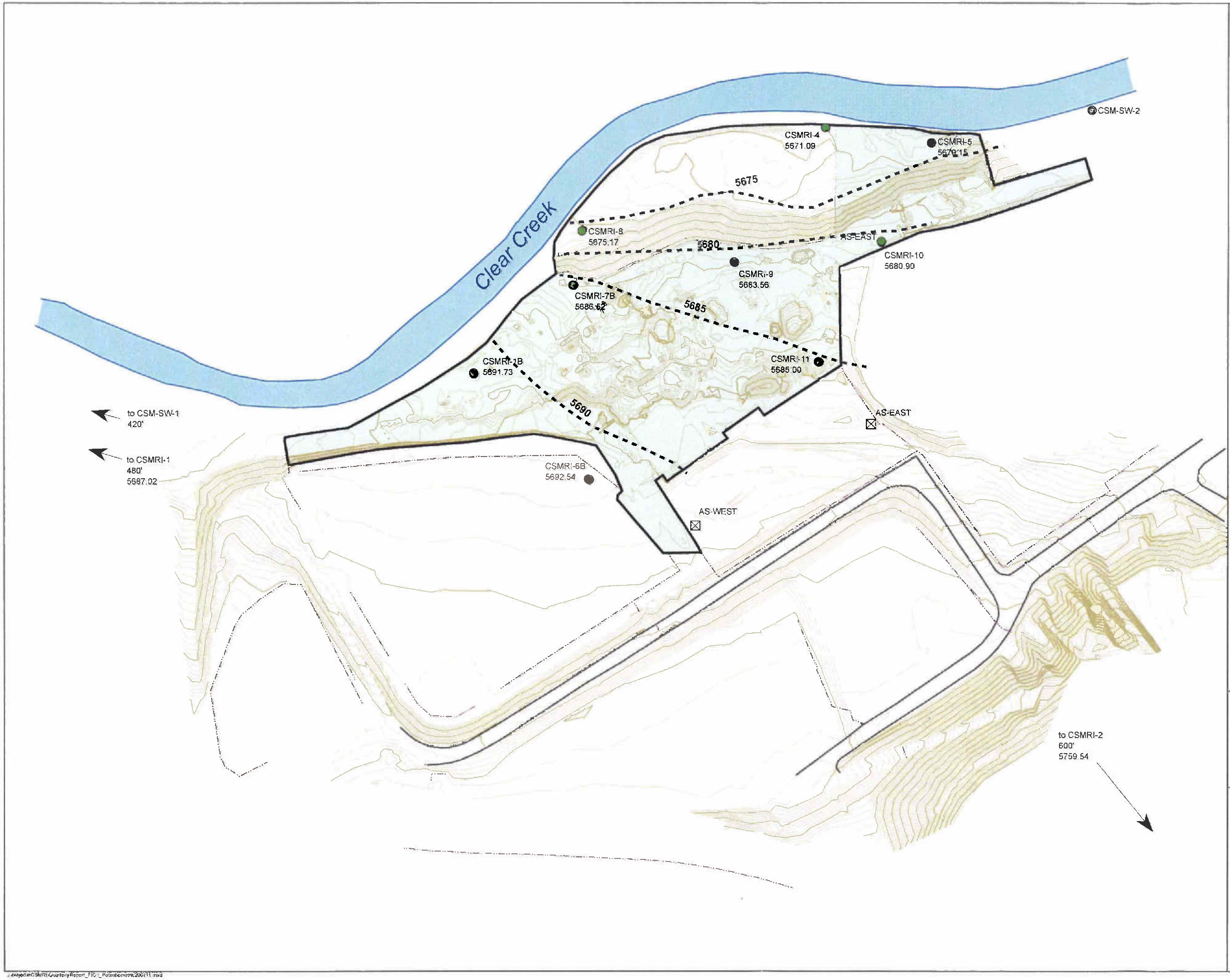
*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-31 Reg 31 – Colorado Surface Water Standards
pCi/l - picoCuries per liter
µg/l – micrograms per liter

Table 2-11
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
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
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



Explanation

● Well

☒ Air Sample Station

⊕ Surface Water Sample Location

- - - - Groundwater Elevation - Nov. 2007

—— CSMRI Creekside Site

-·-·- Fences

—— Roads

—— Topography (5 ft Intervals)

—— Topography (1 ft Intervals)

▭ Site Areas

N
W E
S

Scale: 1" = 150'

0 100 200 400 Feet

Figure 1

Groundwater Potentiometric Surface Map - November 2007

CSMRI
December 2007
Quarterly Report

Stoller

projects\CSMRI\QuarterlyReport_FIG1_Potentiometric200711.mxd

Figure 2
Hydrographs
CSMRI-1, CSMRI-4 and CSMRI-5

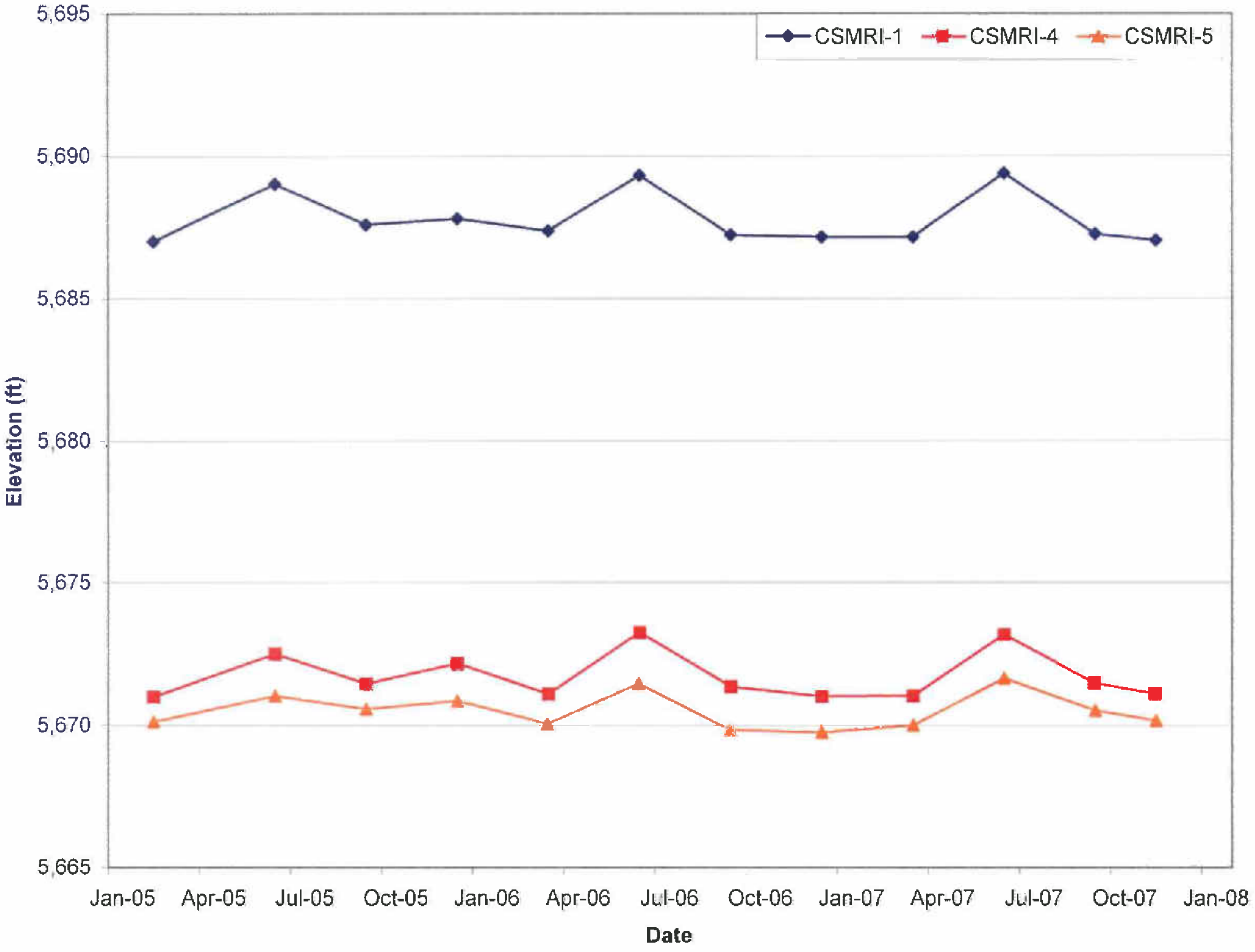


Figure 3
Hydrograph
CSRMI-2

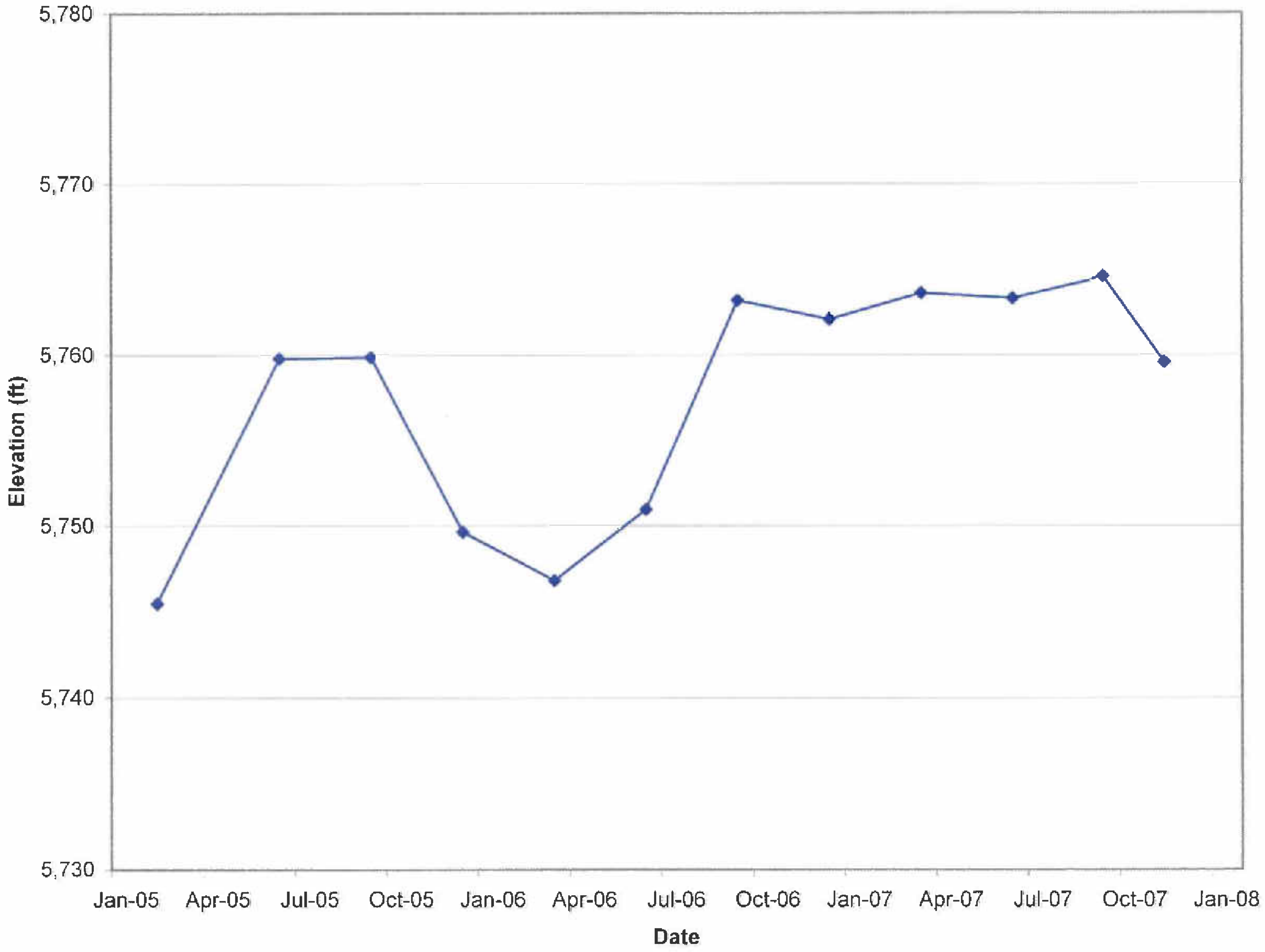


Figure 4
Clear Creek Gauging Graph

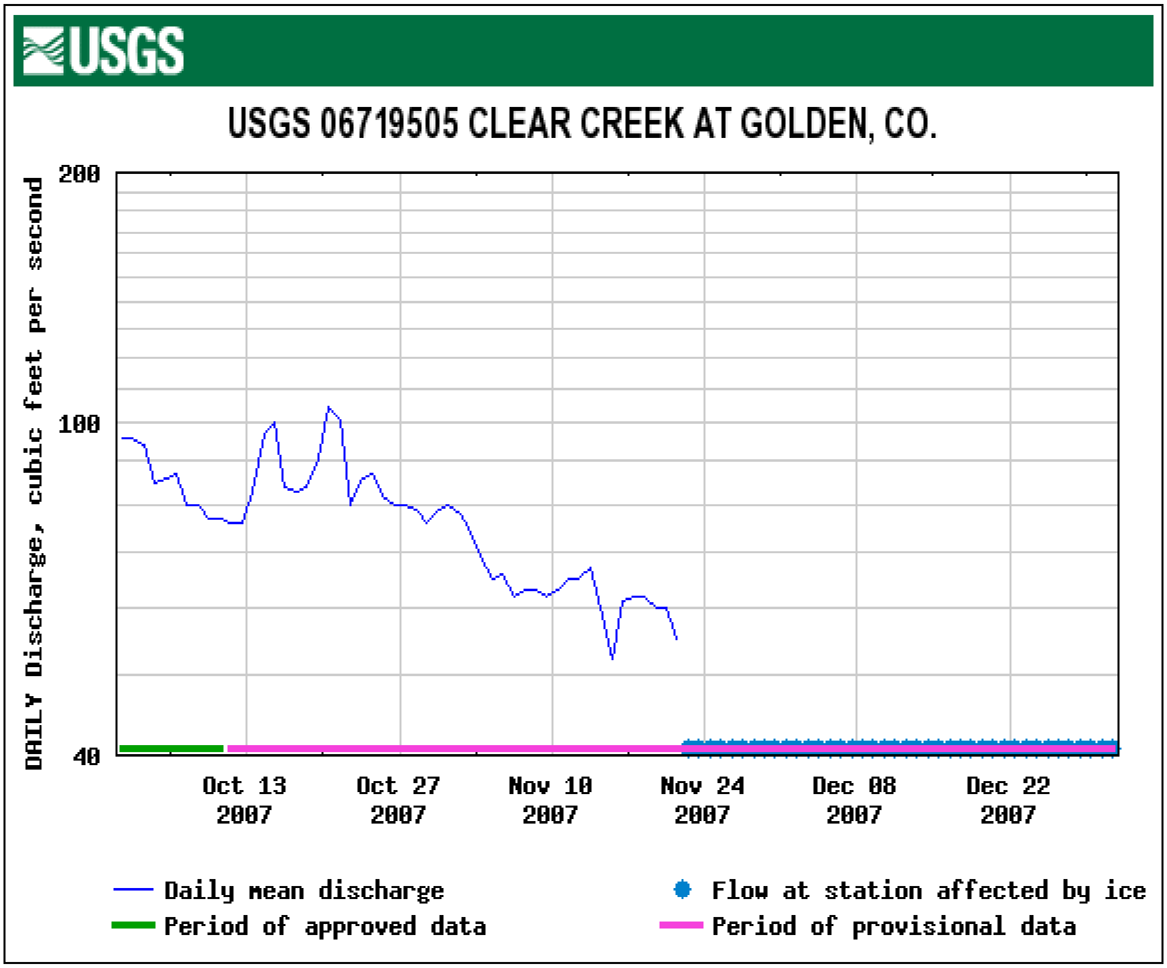


Figure 5
CSMRI-4
Historical Total Uranium Concentration

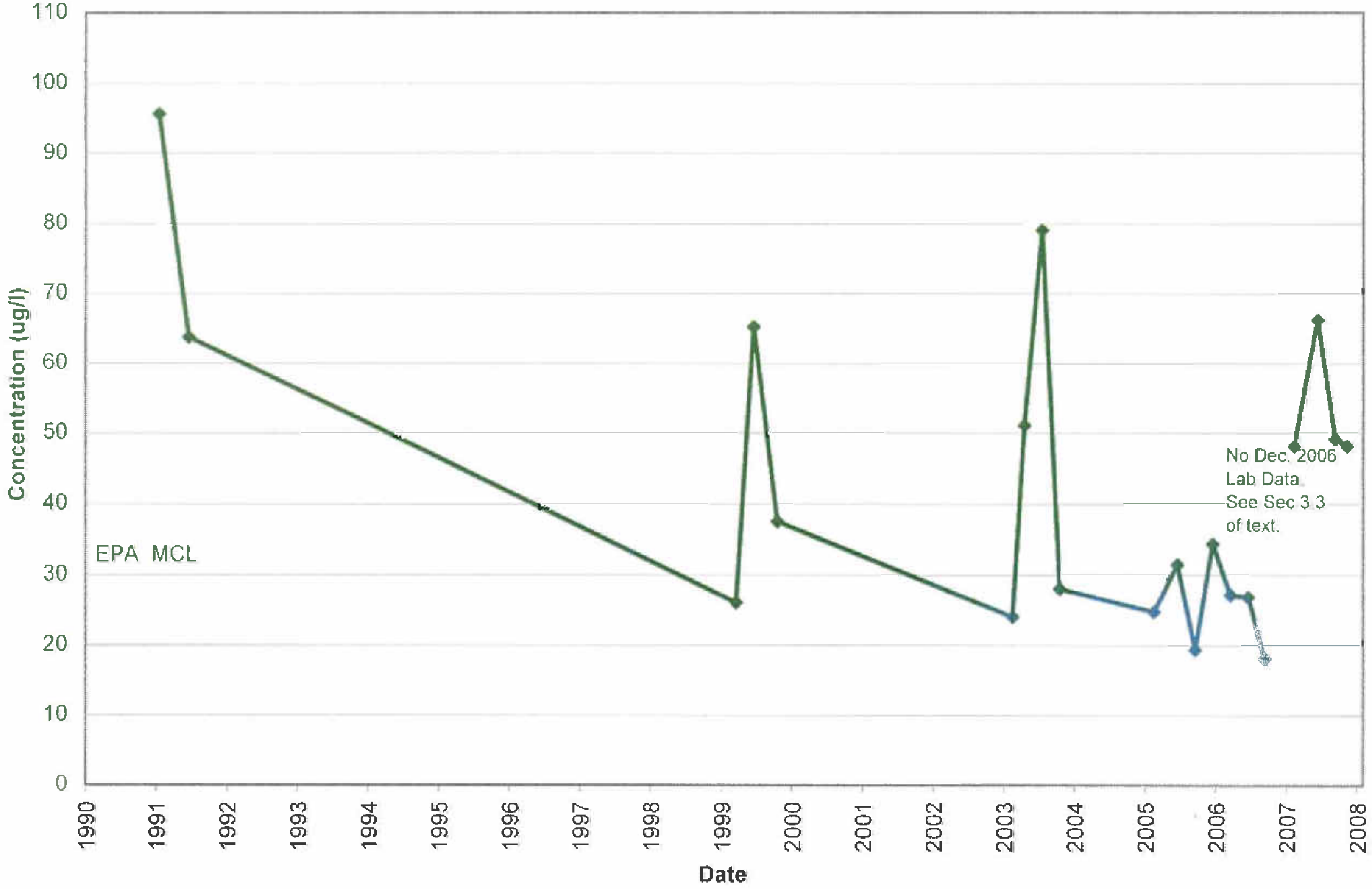
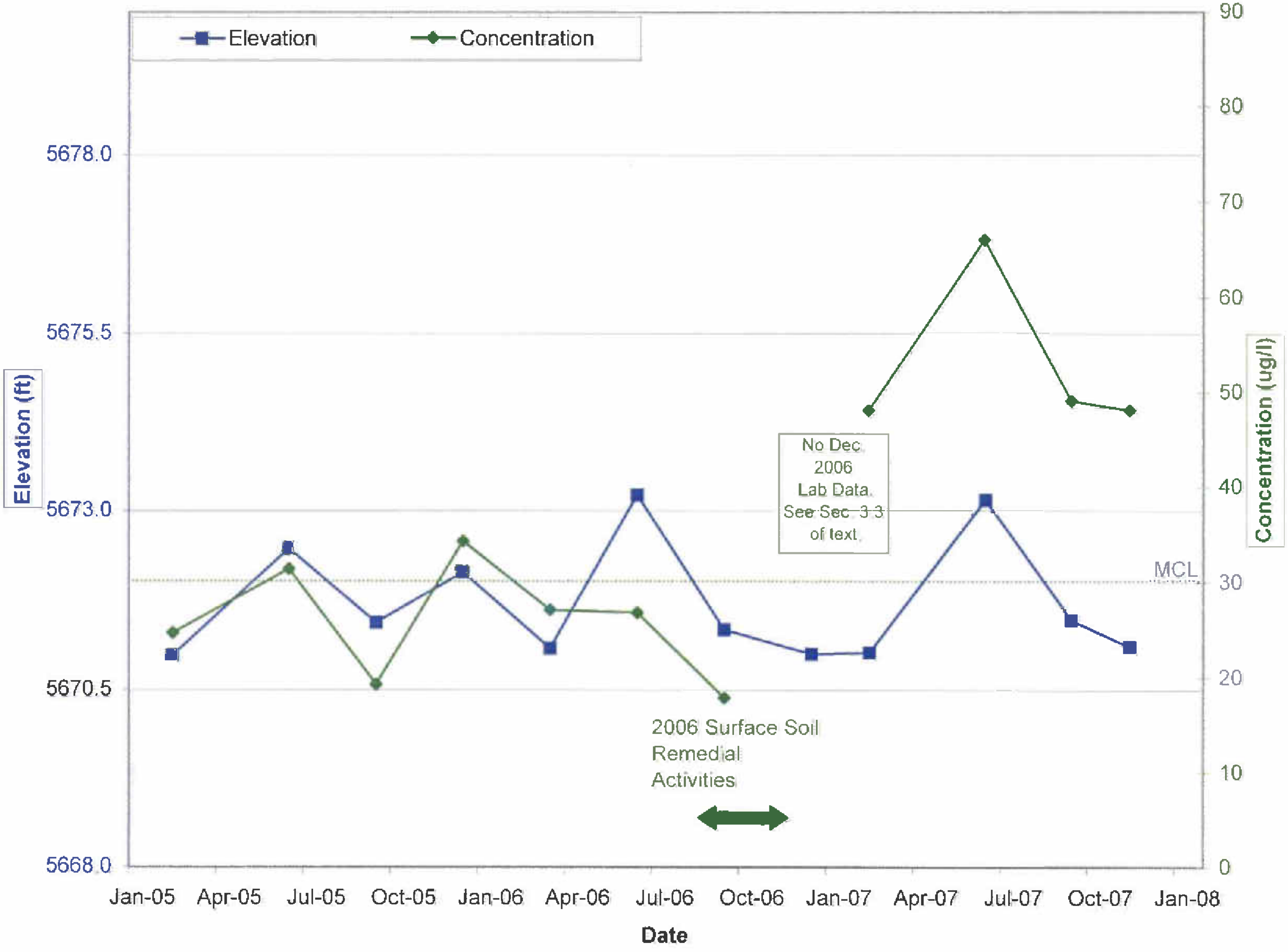


Figure 6
CSMRI-4
Total Uranium Concentration and Potentiometric Elevation



Appendix A

Long-Lived Airborne Radioparticulate Survey Procedures

Long-Lived Airborne Radioparticulate Surveys

1.0 Introduction

1.1 Purpose

The purpose of this procedure is to provide instructions for taking breathing zone and general area air samples to determine airborne concentrations of long-lived particulate radionuclides. It also provides instructions on reviewing the results to determine if radiological posting is required.

1.2 Scope

This procedure addresses the requirements for monitoring airborne radioactivity. It includes monitoring methods, documentation, and result analysis. This procedure does not address use of continuous air monitors, how to establish radiological posting, or access control requirements.

1.3 Applicability

This procedure is applicable to monitoring for long-lived airborne radioparticulates. This procedure is not applicable to air sampling for determining radon or radon decay product concentrations, airborne tritium concentrations, or concentrations of non-radiological materials.

2.0 Precautions, Limitations, and Notes

2.1 Precautions

Handle samples with care to prevent cross-contamination.

Do not allow an air sampler to pick up debris from the floor, ground, or other surface.

Do not operate air samplers in explosive atmospheres or where there is >25% oxygen content.

Exhaust air samplers away from workers, contaminated surfaces, and open containers of radioactive (or other hazardous) material.

2.2 Limitations

This procedure only applies to radionuclides with half-lives of 405 days (1.11 years) or longer.

2.3 Definitions

High Volume Air Sampler – Air sampler capable of collecting greater than 3 ft^3/min.

Low Volume Air Sampler – Air sampler capable of collecting greater than 10 L/min but less than 3 ft^3/min.

Personal Air Sampler – Air sampler capable of being worn by personnel and measuring the wearer's breathing zone. These samplers are usually capable of collecting 10 L/min or less.

Breathing Zone – The general volume of air breathed by the worker(s). The breathing zone for a personal air sample is defined as the imaginary globe of a two-foot radius surrounding a person's head. The breathing zone of an area is the general volume of air to which occupants are expected to be exposed—typically at a height of 1 to 2 meters.

Annual Limit on Intake (ALI) – The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP Publication 23) that would result in a committed effective dose equivalent of 5 rems (0.05 sievert) or a committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue.

Derived Air Concentration (DAC) – For the radionuclides listed in Appendix A of 10 CFR 835, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2,000 hours (assuming a breathing volume of 2,400 m^3). For the radionuclides listed in Appendix C of 10 CFR 835, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite atmospheric cloud.

3.0 Prerequisite Actions

Verify air sampling equipment has been calibrated and has not exceeded the calibration due date.

4.0 Monitoring Requirements

4.1 General

1. Air sampling is required in occupied areas when, under typical conditions, an individual's intake is likely to exceed 2% of an ALI. For continuously occupied areas, this is 2% of a DAC, while 50% occupancy is 4% of a DAC, while <20% occupancy is 10% of a DAC. The Radiological Control Manager is responsible for determining the appropriate air sample location and frequency of collection.
2. Evaluate air sample results as quickly as practicable to evaluate the need for respiratory protection, area evacuation, worker intake, and worker relief from respirator use.
3. Air samples do not need to be counted any further when the activity is at or below the detection limits of the instrument counting the sample. For automated scalers with built-in algorithms, this value is calculated for each sample (e.g. Protean, Tennelec). For manual scaler systems such as the Ludlum 2000, Ludlum 2929, and E-600, this corresponds to the default detection limits, which are set at 5% of the applicable DAC.

4.2 Area Sampling

1. Use high volume air samplers (greater than 3 cubic feet per minute) to obtain sensitive and prompt determinations of "instantaneous" (short time duration) air concentrations.
2. Use low volume air samplers when monitoring over an extended time period (i.e., several hours).

4.3 Personal Monitoring

Use lapel air samplers for accurate breathing zone monitoring of personnel.

5.0 Sample Volumes and Collection Time Determination

1. Determine the altitude of the sampling location using the categories in Table 1.
   a. <u>IF</u> the location is a major fixed facility,

      <u>**THEN**</u>, the actual altitude should be used.

   b. <u>IF</u> the altitude is not well known,

      <u>**THEN**</u>, estimate it to the nearest thousand feet using a topographic map or equivalent.

   c. Record the altitude of the sampling location on the Airborne Radioactivity Data Sheet.

      NOTE: *It is recognized that temperatures change during field operations, and that accurate temperature measurements may be difficult. Therefore, a simplified method has been adopted which uses descriptive categories of very cold (<10 °F), cold (10-35 °F), cool (35-55 °F), room temperature (55-80 °F), and hot (>80 °F).*

2. Determine the temperature of the sampling location using the categories in Table 1.

   Record the temperature at the sampling location on the Airborne Radioactivity Data Sheet.

3. Select the appropriate pressure and temperature correction factor in Table 1.

   Record the selected pressure and temperature correction factor on the Airborne Radioactivity Data Sheet.

Table 1. Pressure (altitude) and Temperature Correction Factors

Facility	Altitude (ft)	Temperature Range (°F)				
		<10 very cold	10 - 35 cold	35 - 55 cool	55 - 80 room temp	>80 hot
	0	1.10	1.07	1.04	1.00	0.96
	1,000	1.08	1.05	1.02	0.98	0.95
	2,000	1.06	1.04	1.00	0.96	0.93
	3,000	1.04	1.02	0.98	0.95	0.91
Moab	4,000	1.02	1.00	0.96	0.93	0.90
Grand Jct.	4,565	1.01	0.99	0.95	0.92	0.89
	5,000	1.01	0.98	0.95	0.91	0.88
	6,000	0.99	0.96	0.93	0.89	0.86
MMS[a]	6,900	0.97	0.95	0.91	0.88	0.85
	7,000	0.97	0.94	0.91	0.88	0.85
	8,000	0.95	0.93	0.89	0.86	0.83
	9,000	0.93	0.91	0.88	0.85	0.81
	10,000	0.91	0.89	0.86	0.83	0.80

[a] *Monticello Mill*

4. Select the applicable DAC for the specified work locations or radionuclide type from Table 2.
   a. <u>IF</u> the specific work location and radionuclide type are not specified in Table 2,

      <u>THEN</u> contact the health physicist to obtain the appropriate DAC.

   b. Record the applicable DAC on the Airborne Radioactivity Data Sheet.

5. Select the sample volume (mL) from Table 2 (or from the graphs in Appendix A when the work location and radionuclide type are not specified in Table 2), corresponding to the counting instrument planned for use in counting the air sample.

6. Correct the selected sample volume for the altitude and temperature conditions at the sample location.

   Divide the selected sample volume by the pressure and temperature correction factor obtained in step 5.0[3] to obtain the corrected total sample volume.

$$SV_C = \frac{SV_U}{PT_{CF}}$$

where SV_C = Corrected total sample volume (mL)

SV_U = Uncorrected sample volume (from Table 2)

PT_{CF} = Pressure and temperature correction factor (from Table 1).

Table 2. Minimum Flow Rates and Sampling Time Required to Achieve Minimum Sample Volumes[a]

Project Name or Radionuclide	DAC (µCi/mL)	Air Sample Volume (milliliters)			
		Protean / Tennelec	Ludlum 2000	Ludlum 2929	E-600
GJO[b]	5×10^{-11}	6.3×10^{5}	6.3×10^{5}	6.3×10^{5}	Not Available
GJORAP[b]	5×10^{-11}	6.3×10^{5}	6.3×10^{5}	6.3×10^{5}	Not Available
Moab	5×10^{-11}	6.3×10^{5}	6.3×10^{5}	6.3×10^{5}	Not Available
Monticello[b]	5×10^{-11}	6.3×10^{5}	6.3×10^{5}	6.3×10^{5}	Not Available
UMTRA VPs[b]	5×10^{-11}	6.3×10^{5}	6.3×10^{5}	6.3×10^{5}	Not Available
Uranium "yellowcake"	2×10^{-11}	1.6×10^{6}	1.6×10^{6}	1.6×10^{6}	Not Available
TRU[c]	2×10^{-12}	1.6×10^{7}	1.6×10^{7}	1.6×10^{7}	Not Available
Mixed Fission Products and Mixed Activation Products[d]	2×10^{-9}	1.7×10^{4}	Not Applicable	8.3×10^{5}	Not Available

[a] Sample volumes are "uncorrected values" based upon air sampler pump calibration at 70 °F and sea level altitude (29.92 inched of Hg.).

[b] Based on the DAC for uranium mill tailings derived in Stoller Health and Safety Calculation.

[c] Based upon Pu-239, Pu-240, or Pu-242 as the most restrictive radionuclide of this type likely to be encountered.

[d] Based upon Sr-90 as the most restrictive radionuclide of this type likely to be encountered.

6.0 Long-Lived Radioparticulate Air Sampling

6.1 Preparation of Sampling Apparatus

1. <u>IF</u> the air sampler used is equipped with a programmable flow totalizer,

   <u>THEN</u> set the flow totalizer to collect the corrected total volume.

2. Determine the necessary sample collection time at the flow rate of interest.

   NOTE: *If the time required to collect the corrected sample volume exceeds the expected work duration, contact the health physicist for guidance.*

3. Disassemble the filter housing apparatus.

4. Inspect all sealing surfaces, gaskets, o-rings, and seals.

   Replace any gaskets, o-rings, or seals, which show evidence of damage or deterioration.

   NOTE: *The Millipore RW 19, 47 mm filters are not identified as to which side is the flow side of the filter. The filters must be removed from the containers with the top of the filter being the side of the filter to be placed facing the atmosphere being sampled.*

5. Place the filter over the support screen in the filter housing apparatus and install the retaining ring securely over the filter.

6. Inspect the assembled filter housing apparatus to ensure that the filter did not buckle or tear during installation and that it is securely seated in the housing to provide a leak-tight seal.

7. Place a clean cover over the filter housing face to protect the filter from physical damage and incidental contamination until ready for use.

8. Attach the filter housing to the air sampler.

6.2 Collecting the Air Sample

1. Locate the air sampler on the person or in the area selected for the collection of the sample and in the breathing zone of the individual/occupants of the area being sampled.

   NOTE: *When conditions warrant the collection of a personal air sample, an area air sample is also required.*

2. Remove the protective cover from the air sample filter apparatus.
3. Turn the air sampler "ON" and collect the desired sample volume.

   Record the start time and date on the Airborne Radioactivity Data Sheet.

4. Turn the air sampler "OFF."

   Record the stop time and date on the Airborne Radioactivity Data Sheet.

5. **IF** the air sample is collected to monitor an area rather than an individual,

   THEN,

   a. Record the location where the air sample was collected on a Radiological Survey Map, or on the Airborne Radioactivity Data Sheet.

   b. Annotate the air sample filter ID number and time of collection in the remarks section of the Radiological Survey Map or on the Airborne Radioactivity Data Sheet.

6.3 Preparing the Sample Filter for Counting

1. Remove the sample filter media from the filter housing apparatus being careful to prevent damage and cross-contamination.
2. Place the filter in a clean filter envelope or sample container.
3. Label the envelope or sample container with a unique sample (filter) ID number.
4. Record the following data on the Airborne Radioactivity Data Sheet at a minimum.
   a. Location, including: site, area, and specific location for area samples
   b. Name and ID number if individual monitored for personal samples
   c. RWP#, if applicable
   d. Sample (filter) ID number
   e. Air sampler type, model, and serial number
   f. Name and signature of technician collecting the sample
   g. Sampler flow rate (in mL/minute)
   h. Pressure and Temperature correction factor
   i. Sample time (in minutes)
   j. Volume sampled (in mL)
   k. Remarks or special conditions pertinent to the sample
5. Transport the filter media with the associated Airborne Radioactivity Data Sheet to the counting room for analysis.

7.0 Sample Analysis

7.1 Counting Samples With Short-Lived Radionuclides Present

NOTE: *If at any time during the counting sequence of an area air sample from a posted Airborne Radioactivity Area, it is determined that occupancy is not necessary, only the count for the record need be performed (step 7.1[5]).*

1. Count the sample and calculate activity concentration within 90 minutes.
    a. **<u>IF</u>** the airborne concentration is <5% of the DAC,

       <u>THEN</u>,

        1. Do not post the area as an Airborne Radioactivity Area.
        2. Proceed to step 7.1[6] of this procedure.

    b. **<u>IF</u>** the airborne concentration is <10% but >5% of the DAC,

       <u>THEN</u>,

        1. Do not post the area as an airborne radioactivity area.
        2. Perform step 7.1[5] of this procedure.

    c. **<u>IF</u>** the airborne concentration is <400% but >10% of the DAC,

       <u>THEN</u>,

        1. Do not post the area as an airborne radioactivity area.
        2. Perform step 7.1[2] of this procedure.

    d. **<u>IF</u>** the airborne concentration is >400% of the DAC,

       <u>THEN</u>,

        1. Notify the Radiological Control Manager and follow his/her instructions for follow-up sampling and posting of the area.
        2. Perform step 7.1[2] of this procedure.

           NOTE: *If an area is posted as an Airborne Radioactivity Area, and follow up area air samples indicate airborne radioactivity concentrations to be < 10% of the DAC, further analysis of the initial air sample(s) need only be completed for count of record (step 7.1[5]).*

2. Recount the sample and calculate activity concentration at least 6 hours after the first count or during the next work shift.
    a. **<u>IF</u>** the airborne concentration is <5% of the DAC,

       <u>THEN</u>,

        1. Do not post the area as an Airborne Radioactivity Area.
        2. **<u>IF</u>** the area was previously posted as an Airborne Radioactivity Area,

           <u>THEN</u>, depost the area.
        3. Proceed to step 7.1[6] of this procedure.

b. **IF** the airborne concentration is <10% but >5% of the DAC,

   THEN,

   1. Do not post the area as an airborne radioactivity area.
   2. **IF** the area was previously posted as an Airborne Radioactivity Area,

      THEN, depost the area.
   3. Perform step 7.1[5] of this procedure.

c. **IF** the airborne concentration is <100% but >10% of the DAC,

   THEN,

   1. **IF** posting was not required by step [1] above,

      THEN do not post the area as an Airborne Radioactivity Area.
   2. Perform step 7.1[3] of this procedure.

d. **IF** the airborne concentration is >100% of the DAC,

   THEN,

   1. Post the area as an Airborne Radioactivity Area.
   2. Perform step 7.1[4] of this procedure.
   3. Notify the Radiological Control Manager.

3. Recount the sample and calculate activity concentration 72 hours after sample collection (or if more than 72 hours has elapsed, prior to allowing the area to be occupied).

   a. **IF** the airborne concentration is <5% of the DAC,

      THEN,

      1. Do not post the area as an Airborne Radioactivity Area.
      2. **IF** the area was previously posted as an Airborne Radioactivity Area,

         THEN, depost the area.
      3. Proceed to step 7.1[6] of this procedure.

   b. **IF** the airborne concentration is <10% but >5% of the DAC,

      THEN,

      1. Do not post the area as an Airborne Radioactivity Area.
      2. **IF** the area was previously posted as an Airborne Radioactivity Area,

         THEN, depost the area.
      3. Proceed to step 7.1[5] of this procedure.

   c. **IF** the airborne concentration is <100% but >10% of the DAC,

      THEN,

      1. **IF** posting was not required by step 7.1[1] or [2] above,

         THEN do not post the area as an Airborne Radioactivity Area.
      2. Perform step 7.1[4] of this procedure.

d. **IF** the airborne concentration is >100% of the DAC,

THEN,

1. Post the area as an Airborne Radioactivity Area.
2. Perform step 7.1[4] of this procedure.
3. Notify the Radiological Control Manager.

4. Recount the sample and calculate activity concentration each shift worked.

    a. **IF** the airborne concentration is <5% of the DAC,

    THEN,

    1. Do not post the area as an Airborne Radioactivity Area.
    2. **IF** the area was previously posted as an Airborne Radioactivity Area,

        THEN, depost the area.
    3. Proceed to step 7.1[6] of this procedure.

    b. **IF** the airborne concentration is <10% but >5% of the DAC,

    THEN,

    1. Do not post the area as an Airborne Radioactivity Area.
    2. **IF** the area was previously posted as an Airborne Radioactivity Area,

        THEN, depost the area.
    3. Proceed to step 7.1[5] of this procedure.

    c. **IF** the airborne concentration is >10% of the DAC,

    THEN,

    1. Post the area as an airborne radioactivity area.
    2. **IF** continued occupancy is required in the posted Airborne Radioactivity Area,

        THEN repeat step 7.1[4] of this procedure for each shift worked.
    3. Perform step 7.1[5] of this procedure after 7 days from the time of sample collection.

5. Recount the sample ≥7 days after collection for record.

    IF the airborne concentration is >5% of the DAC,

    THEN, notify the Radiological Control Manager and Dosimetry.

6. Record sample results on the Airborne Radioactivity Data Sheet.
7. Sign and date the Airborne Radioactivity Data Sheet.

7.2 Counting Personal Samples

1. Count the sample and calculate activity concentration during the next work shift (but not sooner than 6 hours) after sample collection.

    a. **IF** the airborne concentration is <5% of the DAC,

    THEN perform step 7.2[4] of this procedure.

  b. **IF** the airborne concentration is <100% but >5% of the DAC,

  THEN perform step 7.2[3] of this procedure.

  c. **IF** the airborne concentration is >10% of the DAC,

  THEN,

    1. Perform step 7.2[2] of this procedure.
    2. Notify the Radiological Control Manager.

2. Recount the sample and calculate activity concentration 72 hours after sample collection.

  a. **IF** the airborne concentration is <5% of the DAC,

  THEN, perform step 7.2[4] of this procedure.

  b. **IF** the airborne concentration is >5% of the DAC,

  THEN, perform step 7.2[3] of this procedure.

3. Recount the sample >7 days after collection for record.

  IF the airborne concentration is >5% of the DAC,

  THEN, notify the Radiological Control Manager.

4. Record sample results on the Airborne Radioactivity Data Sheet.
5. Forward the completed Airborne Radioactivity Data Sheet and Radiological Survey Map, if used, for review and signature.

8.0 Records

8.1 Records Generated By This Procedure

Airborne Radioactivity Data Sheet
Radiological Survey Map
Chain of Sample Custody

8.2 Record Review

1. Review the completed sample documentation to ensure completeness, legibility, and reproducibility.
2. Compare the sample data with similar data to determine if trends are developing or unexpected results were obtained.
3. Notify the Radiological Control Manager of any trends or unexpected results.

8.3 Record Disposition

Maintain the documentation generated by this procedure in accordance with the project-specific QAPP.

9.0 References

Title 10, *Code of Federal Regulations*, Part 835, "Occupational Radiation Protection."

DOE 10 CFR 835 Implementation Guide, G-10 CFR 835/E2 - Rev. 1, "Workplace Air Monitoring."

Stoller Radiological Control Manual

Stoller Health and Safety Manual

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

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

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

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

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

4.8.1.1 Groundwater Sampling Using a Bailer

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

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

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

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

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

4.8.1.2 Groundwater Sampling Using a Peristaltic Pump

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

4.8.1.3 Groundwater Sampling Using a Downhole Bladder Pump

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

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

4.8.1.4 Groundwater Sampling Using a Push Type Sampler

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

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

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

4.8.2 Sample Filtering and Preservation

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

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

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

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

4.8.3 QA/QC Samples

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

4.8.3.1 Duplicates

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

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

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

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

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

4.8.3.2 Matrix Spike and Matrix Spike Duplicate

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

MS and MSD samples shall be collected as follows.

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

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

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

4.8.3.3 Replicates and Splits

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

4.8.3.4 Field Equipment Rinses

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

4.8.3.4.1 Bailed Wells

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

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

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

4.8.3.4.2 Pumped Wells

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

4.8.3.5 Distilled Water Blanks

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

4.9 Sample Handling and Control

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

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

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

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

5.0 Records

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

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

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

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

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

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

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

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

6.0 References

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

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

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

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

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

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

APPENDIX A

STANDARD GROUNDWATER FORMS

Appendix C
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: 4107-520	Date: 11/27/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations		
Measured TD =	24.98	(ft)
	(+.28)	
Total Depth =	25.26	(ft)
Depth to Water =	NA ~~24.98~~ 7.40	(ft)
Initial Water Column =	17.86	(ft)
Initial Water Volume =	2.86	(gal)
3 X Water Volume	8.57	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO$_3$ 4°C	11/27/07	1240	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO$_3$ 4°C	11/27/07	1245	x 2
				NA	
				NA	

Lab: Paragon - Fort Collins

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
1222	1.47	47.5	6.75	402				cloudy brown
1225	2.86	47.1	6.82	349				
1227	4.29	47.3	6.80	341				
1229	5.72	47.3	6.81	356				
1231	7.15	47.4	6.79	375				
1233	8.58	47.3	6.82	365				
				NA	NA	NA	NA	NA

Volume purged: 8.58 gal

Comments: Routine sampling

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: CSMR1-1B
Project Number: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations		
Measured TD =	23.41 (+.28)	(ft)
Total Depth =	23.69	(ft)
Depth to Water =	20.41	(ft)
Initial Water Column =	3.28	(ft)
Initial Water Volume =	0.52	(gal)
3 X Water Volume	1.57	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO$_3$ 4°C	11/27/07	1340	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO$_3$ 4°C	11/27/07	1345	x ~~2~~ 1 HP

Lab: Paragon - Fort Collins

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
9:00	0.52	54.3	7.23	1236				brown
9:07	1.04	54.3	7.24	1007				brown

Volume purged: 1.04 gal

Comments: Has odor. Only one radium sample collected.

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: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

Measured TD =	95.11 (+.28)	(ft)
Total Depth =	95.39	(ft)
Depth to Water =	60.01	(ft)
Initial Water Column =	35.38	(ft)
Initial Water Volume =	5.66	(gal)
3 X Water Volume	16.98	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500mL Plastic	F/HNO3 4°C	11/27/07	11:00	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO3 4°C	11/27/07	11:15	x 2

Lab: Paragon - Fort Collins

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
9:43	~~5.66~~ 2.83	54.1	7.65	590				light brown
10:00	5.66	53.3	7.48	626				light brown
10:08	8.49	54.2	7.32	614				light brown

Volume purged: 10.5 gal

Comments: Went dry @ 10.5 gal

11/27/07 Water Depth - 81.07

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: CSMRI-4
Project Number: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

Measured TD =	17.30	(ft)
	(+.28)	
Total Depth =	17.58	(ft)
Depth to Water =	7.16	(ft)
Initial Water Column =	~~10~~ 10.42	(ft)
Initial Water Volume =	1.67	(gal)
3 X Water Volume	5.00	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO$_3$ 4°C	11/26/07	14:50	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO$_3$ 4°C	11/26/07	15:00	x 2
				nm	
				nm	

Lab: Paragon - Fort Collins

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
14:42	0.84	53.2	7.21	1109				clear
14:44	1.67	52.9	7.10	1045		HP	HP	clear
14:46	2.51	53.3	7.01	1063	HP			clear
14:48	3.35	53.5	6.98	1055				clear
14:50	4.19	53.5	6.97	1062				clear
14:52	5.03	53.3	7.00	1057				clear
				HP				

Volume purged: 5.03 gal

Comments:

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: SSMP1-5
Project Number: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk/Helena Pagano

Purge Volume Calculations

Measured TD =	10.98	(ft)
	(+.28)	
Total Depth =	11.26	(ft)
Depth to Water =	6.46	(ft)
Initial Water Column =	4.80	(ft)
Initial Water Volume =	0.77	(gal)
3 X Water Volume	2.30	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO$_3$ 4°C	11/26/07	15:25	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO$_3$ 4°C	11/26/07	15:35	x 2

Lab: Paragon - Fort Collins

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
15:14	0.77	44.5	6.98	995				slightly clear
15:16	1.54	44.2	7.04	1010	HP	HP	HP	slightly clear
15:18	2.31	45.3	7.00	1021				slightly clear
			HP					

Volume purged: 2.31 gal

Comments: Routine sampling

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: CSMRI-6B
Project Number: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

Measured TD =	37.93 (+.28)	(ft)
Total Depth =	38.21	(ft)
Depth to Water =	32.92	(ft)
Initial Water Column =	5.29	(ft)
Initial Water Volume =	0.85	(gal)
3 X Water Volume	2.54	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO3 4oz	11/27/07	1320	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO3 4oz	11/27/07	1325	x 2

Lab: Paragon - Fort Collins

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
9:15	0.85	51.4	7.24	1202				brown
9.25	1.70	51.7	7.29	1145	HP	HP	HP	brown
9.29	~~3.40~~	56.8	7.38	1134				brown
	2.55							
				HP				

Volume purged: 2.55 gal

Comments: Insufficient water to sample. ~~on~~ 11/26/07

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: CSMRI-7B
Project Number: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

Measured TD =	16.81 (+.28)	(ft)
Total Depth =	17.09	(ft)
Depth to Water =	16.56	(ft)
Initial Water Column =	0.53	(ft)
Initial Water Volume =	0.08	(gal)
3 X Water Volume	0.25	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO3 4°C	Not Sampled	Not Sampled	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO3 4°C	Not Sampled	Not Sampled	x 2

Lab: Paragon - Fort Collins

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
8:42	0.08	54.6	7.13	1073	NP	NP	NP	light brown
				NP				

Volume purged: 0.08 gal

Comments: Insufficient recharge for sampling.

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: 4107-520	Date: 11/24/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

Measured TD =	17.03 (+.28)	(ft)
Total Depth =	17.31	(ft)
Depth to Water =	8.43	(ft)
Initial Water Column =	8.88	(ft)
Initial Water Volume =	1.42	(gal)
3 X Water Volume	4.26	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO3 4°C	11/24/07	9:00	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO3 4°C	11/24/07	9:15	x 2

Lab: Paragon - Fort Collins

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
12:41	0.71	50.0	6.92	1631				brown
12:43	1.42	50.2	7.26	1619				brown
12:45	2.13	50.3	7.24	1570				brown
12:47	2.84	50.9	7.20	1510				brown
12:49	3.55	51.4	7.20	1526				brown
12:51	4.26	51.8	7.22	1479				brown

Volume purged:

Comments: Routine sampling

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: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

Measured TD =	32.92 (+.28)	(ft)
Total Depth =	33.20	(ft)
Depth to Water =	24.15	(ft)
Initial Water Column =	9.05	(ft)
Initial Water Volume =	1.44	(gal)
3 X Water Volume	4.32	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO$_3$ 4°C	11/26/07	12:25	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO$_3$ 4°C	11/26/07	12:30	x 2

Lab: Paragon - Fort Collins

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
12:11	0.72	54.3	6.99	1144				murky brown
12:13	1.44	54.4	6.99	1147				murky brown
12:15	2.16	55.3	7.00	1137				murky brown
12:17	2.88	54.8	7.13	1117				murky brown
12.19	3.60	54.9	7.03	1149				murky brown
12.21	4.32	54.9	7.07	1146				murky brown

Volume purged: 4.32 gal

Comments: Routine sampling

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: CSMRI-10
Project Number: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations		
Measured TD =	27.84	(ft)
Total Depth =	(+.28) 28.12	(ft)
Depth to Water =	23.40	(ft)
Initial Water Column =	4.72	(ft)
Initial Water Volume =	0.76	(gal)
3 X Water Volume	2.27	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500mL Plastic	F/HNO$_3$ 4°C	11/26/07	14:10 ~~11:50~~	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO$_3$ 4°C	11/26/07	14:20 ~~11:52~~	x 2

Lab: Paragon - Fort Collins

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
11:42	0.76	54.0	7.03	997				Murky brown
11:44	1.52	54.3	7.03	981	HP	HP	HP	Murky brown
11:46	2.28	54.0	7.15	983				Murky brown
				HP				

Volume purged: 2.28 gal

Comments: Routine sampling

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: CSMP1- 11
Project Number: 4107-520	Date: 11/26/07
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations		
Measured TD =	36.15	(ft)
Total Depth =	(+.28) 36.43	(ft)
Depth to Water =	29.40	(ft)
Initial Water Column =	7.03	(ft)
Initial Water Volume =	1.12	(gal)
3 X Water Volume	3.37	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO3 4°C	11/26/07	13:50 ~~11:25~~	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO3 4°C	11/26/07	~~11:30~~ 13:55	x 2

Lab: Paragon - Fort Collins

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
11:10	0.56	52.1	7.35	1003				Murky brown
11:13	1.12	52.5	7.18	1013	HP	HP	HP	Murky brown
11:15	1.68	52.8	7.14	1015				Murky brown
11:17	2.24	53.0	7.09	1010				Murky brown
11:19	2.80	53.5	7.18	1015				Murky brown
11:21	3.36	53.0	7.14	1025				Murky brown
				HP				

Volume purged: 3.36 gal

Comments: Routine sampling

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: 4107-520	Date: 11/27/07
Sample Type: GW SW [✓ EB] Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

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

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500mL Plastic	F/HNO_3 4°C	11/27/07	1210	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO_3 4°C	11/27/07	1215	x 2
				nm	
				nm	

Lab: Paragon - Fort Collins

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: —

Comments:

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: SW-1
Project Number: 4107-520	Date: 11/27/07
Sample Type: GW [✓ SW] EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

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

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500 mL Plastic	F/HNO3 4°C	11/27/07	1300	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO3 4°C	11/27/07	1305	x 2

Lab: Paragon - Fort Collins

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
1220	0.50	36.5	6.83	358	—	—	—	clear

Volume purged:
0.50 gal

Comments: Routine sampling

upstream W

SM Stoller Corp.

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

Project Name: Colorado School of Mines	Sample Location: ~~River~~ nm ~~CSMRI~~ nm SW-2
Project Number: 4107-520	Date: 11/26/07
Sample Type: GW [✓ SW] EB Duplicate Other:	Sampler: Nick Malczyk / Helena Pagano

Purge Volume Calculations

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

Sample Collection

Analysis	Container	Preservative	Date	Time	
Dissolved Metals	500mL Plastic	F/HNO3 4°C	11/26/07	10:40	x 1
Radium Thorium Uranium	1 Gal Cube	F/HNO3 4°C	11/26/07	10:45	x 2
				nm	
				nm	

Lab: Paragon - Fort Collins

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
10:30	450mL	35.0	8.21	369				clear
~~10:40~~ HP								
				HP	HP	HP	HP	nm

Volume purged: N/A

Comments: Routine sampling

Appendix D
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 E
Data Validation Reports

DATA VALIDATION REPORT

To: Steve Brinkman/Robert Hill
From: John Garrett
Date: January 26, 2008
Project/Site: Colorado School of Mines
Project No.: 4107
SDG No.: 0711237

This report presents the inorganic metals data validation for the data obtained for one CSMRI water sample collected on November 26, 2007 and November 27, 2007 and submitted to Paragon Analytics, Inc on the same day 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 6020B and Paragon Procedure PA SOP 827R6 for dissolved metals by Inductively Coupled Plasma (ICP-MS) mass spectrometry analysis and mercury results that were obtained by SW-846, 3rd Edition, Method 7470A and PA SOP 812R14 by Cold Vapor Atomic Absorption (CVAA) analysis for SDG 0711237 from Paragon Analytics, Inc. (Fort Collins, CO). The water samples were analyzed for dissolved ICP trace metals on December 6, 2007, dissolved ICP-MS uranium on December 6, 2007 and dissolved mercury by CVAA December 5, 2007. 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
0711237-1	SW-2	Water	November 26, 2007
0711237-2	CSMRI-9	Water	November 26, 2007
0711237-3	CSMRI-11	Water	November 26, 2007
0711237-4	CSMRI-10	Water	November 26, 2007
0711237-5	CSMRI-4	Water	November 26, 2007
0711237-6	CSMRI-5	Water	November 26, 2007
0711237-7	CSMRI-8	Water	November 27, 2007
0711237-8	CSMRI-2	Water	November 27, 2007
0711237-9	EQIPMENT BLANK	Water	November 27, 2007
0711237-10	CSMRI-1	Water	November 27, 2007
0711237-11	SW-2	Water	November 27, 2007
0711237-12	CSMRI-6B	Water	November 27, 2007
0711237-13	CSMRI-1B	Water	November 27, 2007

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

The metals and mercury 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 all found to be field filtered and had a pH less than 2. Samples were 9.8 degrees centigrade upon receipt by the laboratory.

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 metals and within 80-120% for mercury by CVAA. 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 and mercury. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

All %Ds were less than 10% for all ICP metals with the exception of zinc.

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 30, 2008
Project/Site: Colorado School of Mines
Project No.: 4107
SDG No.: 0712129

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 714R10 for Isotopic/Total Uranium and Isotopic Thorium by alpha spectrometry, PA SOP 783R7 for Radium-226 by Radon Emanation Counting, PA SOP 724R9 for Gross Alpha and Gross Beta by gas proportional counting, for SDG 0712129 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of 2 filter samples for the Colorado School of Mines/4107 project collected on November 27, 2007and December 14, 2007. The filter samples were analyzed for Isotopic/Total Uranium on January 9, 2008 and January 11, 2008, Isotopic Thorium on January 9, 2008 by alpha spectrometry, Radium-226 by Radon Emanation Counting on January 15, 2008, and Gross Alpha and Gross Beta by gas proportional counting on December 20, 2007. 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
AS-East	0712129-1	Filter	November 27, 2007
AS-East	0712129-2	Filter	December 14, 2007

Data validation was conducted in accordance with the Analytical Services Statement of Work for the following modules: the Determination of Radionuclides by Alpha Spectrometry, Module RC01-v2, October 1, 2002, and the Determination of Gross Alpha and Beta by Gas Proportional Counting, Module RC04-v2, October 1, 2002, and U.S. DOE Quality Systems for Analytical Services Revision 2.2 (QSAS rev. 2.2).

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 714R10 for Isotopic/Total Uranium and Isotopic Thorium by alpha spectrometry, PA SOP 783R7 for Radium-226 by Radon Emanation counting, PA SOP 724R9 for Gross Alpha and Gross Beta by gas proportional counting, for SDG 0712129.

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 of the isotopes that were analyzed had MDC's that were below their respective RDL's in their QC batch preparation blanks.

Duplicate Sample Analysis

Due to insufficient sample volume to perform a laboratory duplicate, a duplicate LCS was analyzed for isotopic uranium and thorium by alpha spectrometry, and Radium-226 by radon emanation. A duplicate analysis of sample 0712129-1 AS-EAST was performed in lieu of a prepared duplicate for the analysis of Gross Alpha and Gross Beta by gas proportional counting. All isotopic activities for LCS and LCS duplicate and for original and duplicate 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.

The laboratory reports that measurable amounts of Uranium-234 in the samples may cause a small amount of characteristic activity in the Uranium-235 region of interest due to poorly resolved alpha activity at the boundary between the 2 regions. To minimize the potential for high bias in the Uranium-235 analytical results, the Uranium-235 ROI has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final Uranium-235 results. The laboratory reports Total Uranium and no action is necessary.

The laboratory provided a calculated value (in pCi/sample) for total uranium in each filter sample based on the measured values by alpha spectrometry of the individual uranium isotopic activities. No action was required.

Overall Comments

The results were unremarkable. No activities for isotopes of uranium and thorium by alpha spectrometry were observed above the RDL in any samples. No Radium-226 activities were observed above their MDCs. The Gross Alpha and Gross Beta activity was observed above three times (3X) the MDCs in all filter samples and considered detected. No action was required.

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, 2008
Project/Site:	Colorado School of Mines
Project No.:	4107
SDG No.:	0711237

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 714R11 for Isotopic Thorium by alpha spectrometry, PA SOP 783R8 for Radium-226 by Radon Emanation Counting, and PA SOP 724R10 for Radium-228 by gas proportional counting for SDG 0711237 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of 13 water samples for the Colorado School of Mines/4107 project collected on November 26, 2007 and November 27, 2007. The samples were analyzed for Isotopic Thorium on December 7, 2007 and December 9, 2007 by alpha spectrometry, Radium-226 by Radon Emanation Counting on December 19, 2007, Radium-228 by gas proportional counting on December 2, 2007, December 28, 2007 and January 9, 2007 for water. 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
0711237-1	SW-2	Water	November 26, 2007
0711237-2	CSMRI-9	Water	November 26, 2007
0711237-3	CSMRI-11	Water	November 26, 2007
0711237-4	CSMRI-10	Water	November 26, 2007
0711237-5	CSMRI-4	Water	November 26, 2007
0711237-6	CSMRI-5	Water	November 26, 2007
0711237-7	CSMRI-8	Water	November 27, 2007
0711237-8	CSMRI-2	Water	November 27, 2007
0711237-9	EQIPMENT BLANK	Water	November 27, 2007
0711237-10	CSMRI-1	Water	November 27, 2007
0711237-11	SW-2	Water	November 27, 2007
0711237-12	CSMRI-6B	Water	November 27, 2007
0711237-13	CSMRI-1B	Water	November 27, 2007

Data validation was conducted in accordance with the Analytical Services Statement of Work for the following modules: the Determination of Radionuclides by Alpha

Spectrometry, Module RC01-v2, October 1, 2002, and U.S. DOE Quality Systems for Analytical Services Revision 2.2 (QSAS rev. 2.2).

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 714R11 for Isotopic Thorium by alpha spectrometry, PA SOP 783R8 for Radium-226 by Radon Emanation counting, and PA SOP 724R10 for Radium-228 by gas proportional counting for SDG 0711237.

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

Due to insufficient sample volume to perform a laboratory duplicate, a duplicate LCS was analyzed for Radium-228. All isotopic activities for LCS and LCS duplicate and for original and duplicate 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 in sample CSMRI-1B 0711237-13 MDC exceeded the RDL of 1 pCi/L at 1.08 pCi/L. The sample activity was greater than the MDC at 1.16 pCi/L and is qualified as [J] Estimated.

No activities for isotopes thorium by alpha spectrometry were observed above the RDL in any samples. Radium-226 activities were observed above their MDCs and the RDL in samples CSMRI-5 and CSMRI-8. Radium-228 activities were observed above their MDCs and the RDL in samples CSMRI-2 and CSMRI-8. No action was required.

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 F
Results of Analyses CD

Appendix G
Chains of Custody

Paragon 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) 11/28/07

Chain-of-Custody Date ~~11/27/07~~ Page 1 of 3 **Original** **Retain pink copy!**

Project Name/No.: CO Schwld Mng **Sampler(s):** N Malczyk Turnaround (circle one) [✓ **Standard**] or **Rush (Due** ______) Dispose: **Date** ______ or **Return to Client**

Report To: Steve Brinkman
Phone: (303) 994-1883
Fax: (303) 443-1408
E-mail: sbrinkman@stoller.com
Company: SM Stoller
Address: 105 Technology Dr #190
Broomfield, CO 80021

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	Iso-Th, U, Total-U		
SW-2	11/26/07	1040		W	HNO_3	1											X																			
↓	↓	1045		↓	↓	2																							X					X		
CSMRT-9	↓	1225		↓	↓	1											X																			
↓	↓	1230		↓	↓	2																							X					X		
CSMRT-11	↓	1350		↓	↓	1											X																			
↓	↓	1355		↓	↓	2																							X					X		
CSMRT-10	↓	1410		↓	↓	1											X																			
↓	↓	1420		↓	↓	2																							X					X		
CSMRT-11	↓	1450		↓	↓	1											X																			
↓	↓	1500		↓	↓	2																							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:

all samples were filtered

Relinquished By: (1)
Signature NM
Printed Name ~~Nick Malczyk~~
Date ~~11/27/07~~ Time ______
Company ~~Stoller~~ NM

Relinquished By: (2)
Signature Helena Pagan
Printed Name Helena Pagan
Date 11/28/07 Time 9:45 AM
Company Stoller

Received By: (1)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Received By: (2)
Signature
Printed Name [illegible]
Date 11-28-07 Time [illegible]
Company [illegible]

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

P· ·gon Analytics
A D· ·i of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 805
800-443-1511 or (970) 490-1511 (970) 490-1522 Fa

11/28/07
Accession Number (LAB ID) ______

Chain-of-Custody

Date ~~[illegible]~~ Mm Page 2 of 3 **Origina.** **Retain pink copy!**

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

Report To:
Phone:
Fax:
E-mail:
Company:
Address:

see page 1

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	Iso-Th, U, Total-U		
CSMRI-5	11/26/07	1525		W	HNO3	1											X																			
↓	↓	1535		↓	↓	2																							X					X		
CSMRI-8	11/27/07	0900				1											X																			
↓	↓	0915				2																							X					X		
CSMRI-2		1100				1											X																			
↓		1115				2																							X					X		
Equipment Blank		1210				1											X																			
↓		1215				2																							X					X		
CSMRI-1		1240				1											X																			
↓	↓	1245		↓	↓	2																							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:

all samples were filtered

Relinquished By: (1)
Signature ~~[illegible]~~
Printed Name ~~Nick Mehrzyk~~
Date ~~11/27/07~~ Time ______
Company ~~Stoller~~ Mm

Relinquished By: (2)
Signature Melissa Pope
Printed Name [illegible]
Date 11/28/07 Time 7:45 AM
Company Stoller

Received By: (1)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Received By: (2)
Signature [illegible]
Printed Name [illegible]
Date 11·28·07 Time 945
Company Paragon

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

Paragon Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 805
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) 11/28/07

Chain-of-Custody Date ~~11/27/07~~ Page 3 of 3 **Original** **Retain pink copy!**

Project Name/No.: CO School of Mines **Sampler(s):** N Malenk Turnaround (circle one) [✓ **Standard**] or **Rush (Due ____)** Dispose: **Date** ____ or **Return to Client**

Report To:
Phone:
Fax:
E-mail:
Company: see page 1
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	ISO-Th, U, Table		
SW-1	11/27/07	1300		W	HNO3	1											X																			
↓		1305				2																							X					X		
CSMRI-6R		1320				1											X																			
↓		1325				2																							X					X		
CSMRI-1B		1340				1											X																			
↓	↓	1345		↓	↓	1																							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:

all samples were filtered

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

Relinquished By: (1)
Signature
Printed Name Nick Malenk
Date 11/27/07 Time
Company Stoller NM

Received By: (1)
Signature
Printed Name
Date Time
Company

Relinquished By: (2)
Signature
Printed Name
Date 11/28/07 Time 9:15 am
Company Stoller

Received By: (2)
Signature
Printed Name
Date 11-28-07 Time
Company Paragon

sample time	Sample ID	Collection Start Date	Collection Start Time	Starting Flow Rate (L/min.)	Collection Stop Date	Collection Stop Time	Ending Flow Rate (L/min.)	Count Date	Time at Start of Count	Alpha Counts	Counting Time (min.)	Background Count Rate (cpm)	Scaler S/N	Prol. S/N
1035	AS-East	10/9/07	1047	57 Lpm	11/27/07	1354	55 Lpm							
1045	AS-West	↓	not running	—	↓	not running								
1355	AS-East	11/27/07	1357	56 Lpm										
—	AS-West	↓	not running											