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Monitoring Report for
CSMRI Creekside Facility
First Quarter 2005

1. Introduction

This report presents the results of the first quarter 2005 results for air monitoring, groundwater monitoring, and surface water monitoring conducted at the Colorado School of Mines Research Institute (CSMRI) Creekside facility, Golden, Colorado. The monitoring was conducted by the S.M. Stoller Corporation (Stoller) under the guidance of the Colorado School of Mines (CSM).

2. Sampling and Analysis

Stoller obtained groundwater samples from four monitoring wells at the Creekside facility on February 25, 2005. Groundwater samples were obtained from monitoring wells CSMRI-1, CSMRI–2, CSMRI-4, and CSMRI-5. The monitoring well locations are shown on Figure 1. Also on February 25, samples were collected from the two surface water sample locations, CSM-SW-01 and CSM-SW-02, shown on Figure 1. Sampling was also conducted on filters from two onsite air monitor stations, AS-East and AS-West, located as shown on Figure 1.

2.1 Atmospheric Monitoring

Particulate monitoring was conducted at two locations within the Creekside property at the locations shown on Figure 1. The particulate monitoring samples were obtained from stations AS-East and AS-West. The monitoring was conducted using high-volume air sampling pumps with 47-millimeter-diameter filters. The pumps were run continuously from February 15 to March 17, 2005. The pump filters are collected monthly and sent to the laboratory for analysis. Samples were collected following the procedures outlined in the Long-Lived Airborne Radioparticulate Survey procedures document in -dix A. The samples from each pump were analyzed for gross alpha, gross beta, uranium natural, Ra226, Th-230, and Th-232.

The pumps are placed about 4 feet off the ground. The pumps are located in protective housing that prevents precipitation from contacting the samplers but still allows air circulation around the samplers. Because the air samplers were brought on line in mid-February, only one set of air data is available for this quarter's report. Three additional sets of air data will be included in the second quarter 2005 report.

2.2 Groundwater Sampling

Groundwater samples were obtained from monitoring wells CSMRI-1, CSMRI–2, CSMRI-4, and CSMRI-5. The wells are located as shown on Figure 1. Samples were collected following the procedures outlined in the Groundwater Sampling procedures document in Appendix B. Sample collection forms that record the conditions of the well water as it is developed and the quantity removed during development are provided in Appendix C.

2.3 Surface Water Sampling

Surface water samples were collected from two locations along Clear Creek, one upstream of the Site, and one downstream of the Site. Samples were collected on February 25, at which time the flow was approximately 30 cubic feet per second (USGS Surface Water website). Surface water samples were collected following the Surface Water Sampling procedures in Appendix D from the locations as shown on Figure 1. A graph of the flow in Clear Creek for mid-April through mid-May is attached as Figure 2.

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 lab 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
- Compound quantitation and reporting limits (full validation only)

All data collected during this quarter by Stoller met all the criteria for these parameters. The data validation reports are attached in Appendix E.

2.4.1 Atmospheric Analyses

Laboratory analyses of the air monitoring filters were performed by Paragon Laboratories, Inc. of Fort Collins, Colorado. The filters for each of the two 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 U. The results of these analyses are shown in Appendix F. A summary of the results is presented in Table 2-1.

2.4.2 Groundwater Quality Analyses

Laboratory analyses were conducted by Paragon Laboratories, Inc. The groundwater and surface water samples were analyzed for the metals AG, AS, BA, CA, CD, CR, HG, K, MG, MO, NA, PB, SE, V, and ZN as well as the radioisotopes Ra-226, Ra-228, Th-228, Th-230, Th-232, U-234, U-235, U-238, and total U.

A duplicate sample, equipment blank, and trip blank also were analyzed for quality control purposes and are described in the Data Validation Report. Results of these analyses are included as Appendix F, and the chain-of-custody documentation is included as Appendix G. 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 Mg/l. Groundwater samples were measured onsite for temperature, pH, and specific conductance during the development and sampling process. Onsite measurement parameters are presented on the sample collection log forms in Appendix C.

2.4.3 Surface Water Analyses

A summary of surface water results for radioisotopes and metals is presented in Table 2-4 and Table 2-5, respectively. Surface water parameters are reported as total concentration in Mg/l. 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 log forms in Appendix C.

2.5 Health and Safety Program

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

3. Results

Results from samples collected from the CSMRI Site during the first quarter of 2005 are summarized on Tables 2-1 through 2-5. Table 2-6 presents historical data for select contaminants of potential concern (COPCs) in groundwater at the Site. Each type of sample collected from the site is discussed in detail in the following sections.

3.1 Atmospheric Results

Results from the two air sampling stations are summarized in Table 2-1. AS-West is in the western portion of the site, essentially upwind from the impacted area, and AS-East is in the eastern portion of the site downwind from the impacted area. The results indicate no significant difference between the two sample locations. This indicates limited airborne emissions from the site during this sampling period.

3.2 Groundwater Conditions

Groundwater wells are located in areas likely to detect any impacts to groundwater emanating from the site as well as locations that represent background water quality. Wells CSM-GW-02 and CSM-GW-04 are located downgradient from the site near Clear Creek. Well CSM-GW-05 is located along Clear Creek upstream from the site, and well CSM-GW-04 is located offsite on the side of the site away from Clear Creek.

3.3 Groundwater Quality

There is only one groundwater maximum contaminant level (MCL) exceedance in well CSMRI-4 for MO. All other compounds in all other wells are below the MCLs. The groundwater beneath the site is not used for drinking water.

3.3.1 Comparison of Upgradient and Downgradient Groundwater Quality

Wells CSMRI-2 and -4 are downgradient from the site, and wells CSMRI-1 and -5 are upgradient from the site. Metals concentrations in the upgradient wells compare to the concentrations in the downgradient wells for the metals that have MCLs. Metals that do not have MCLs (CA, K, MG, and NA) are more prevalent in the downgradient wells. This may indicate different aquifer water is being sampled. For radionuclides, the downgradient well CSMRI-4 has levels of uranium isotopes above the upgradient wells but below the MCLs.

3.3.2 Comparison with Previous Groundwater Quality Analyses

Table 2-6 compares current groundwater results with those from past sampling events for a select group of compounds. The data indicate a slight decreasing trend in contaminant concentrations over time, indicating an improving groundwater quality.

3.3.3 Comparison with Colorado Groundwater Standards

The statewide dissolved concentration standard of 5 picocuries per liter (pCi/l) for Ra-226 and Ra-228 in groundwater set by the State of Colorado Water Quality Control Commission is not exceeded in any of the monitoring wells sampled. The statewide dissolved concentration standard of 60 pCi/l for Th-228, Th-230, and Th-232 in groundwater also is not exceeded in any of the monitoring wells sampled.

3.4 Surface Water Quality

Surface water samples are collected from two locations at the site. One location is upstream from the site and the other is downstream from the site.

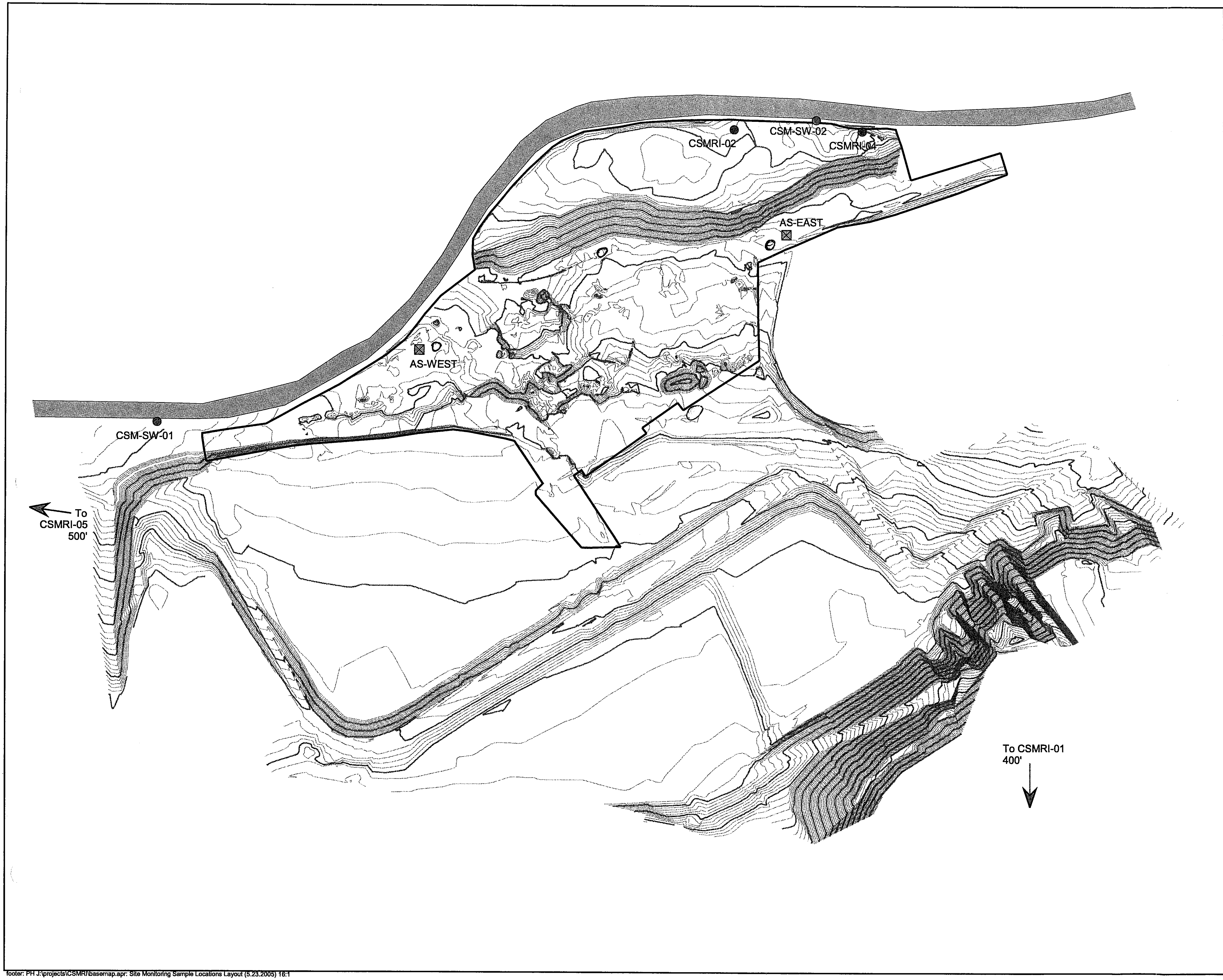
The upstream and downstream surface-water concentrations of all metals and radionuclides determined at the CSMRI Creekside facility from stations CSM-SW-01 and CSM-SW-02 were essentially the same. The only metal detected above the detection limit was ZN, and the radioisotope analyses indicate higher concentrations upstream from the site than downstream from the site.

4. Activities for First Quarter 2005

First quarter 2005 activities at the site included the sampling and monitoring described above as well as maintenance of the cover over the bagged soil and stormwater control devices.

5. References

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



Explanation

- ● Wells
- ☒ Air Sample Locations
- ● Surface Water Sample Locations
- 1 Foot Contours
- 5 Foot Index Contour
- Property Boundary
- ▨ Clear Creek

N
W E
S

100 0 100 200 Feet

1 inch = 150 feet

Figure 1
Site Monitoring Sample Locations

Colorado School of Mines

Stoller

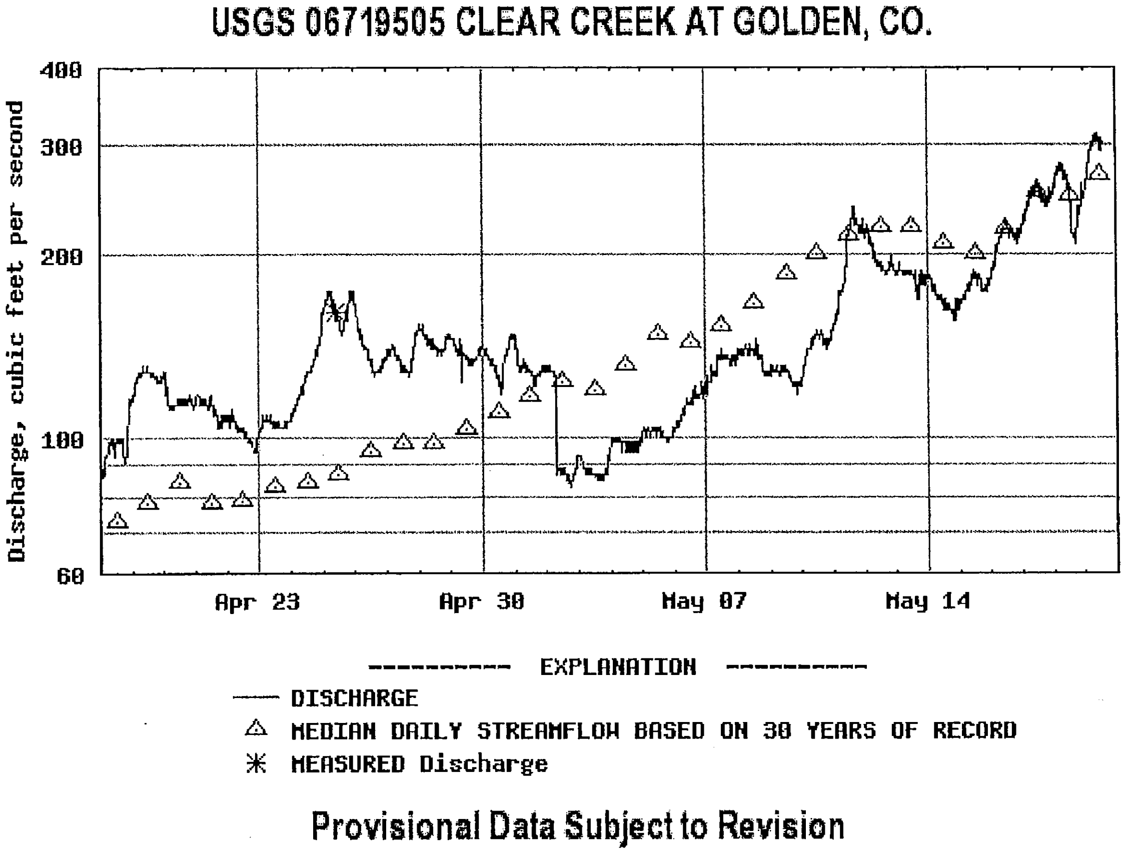


Figure 2
Clear Creek Gauging Graph

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
AS-East	3/17/05	$1.2\text{x}10^{-15}$	$1.18\text{x}10^{-14}$	$1.2\text{x}10^{-16}$	$6.0\text{x}10^{-17}$	$6.0\text{x}10^{-18}$	$4.0\text{x}10^{-17}$	$2.3\text{x}10^{-16}$	$1.2\text{x}10^{-17}$	$7.0\text{x}10^{-17}$	$3.1\text{x}10^{-16}$
AS-West	3/17/05	$1.2\text{x}10^{-15}$	$1.38\text{x}10^{-14}$	$2.3\text{x}10^{-16}$	$2.0\text{x}10^{-18}$	0	$3.0\text{x}10^{-17}$	$3.8\text{x}10^{-16}$	$6.0\text{x}10^{-18}$	$6.0\text{x}10^{-17}$	$4.5\text{x}10^{-16}$
Unrestricted use limit		NA	NA	$9\text{x}10^{-13}$	~~NA~~	$2\text{x}10^{-14}$	~~$4\text{x}10^{-16}$~~	~~NA~~	~~NA~~	~~NA~~	$9\text{x}10^{-14}$
6CCR1007-1 Part 4 App. B Table 2					$3\text{x}10^{-14}$ $2\text{x}10^{-14}$	$2\text{x}10^{-14}$ $3\text{x}10^{-14}$	$4\text{x}10^{-15}$ $6\text{x}10^{-15}$	$1\text{x}10^{-12}$ $5\text{x}10^{-14}$	$1\text{x}10^{-12}$ $6\text{x}10^{-14}$	$1\text{x}10^{-12}$ $6\text{x}10^{-14}$	$9\text{x}10^{-13}$ ← class W $9\text{x}10^{-14}$ ← class Y

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)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (ug/l)
CSMRI-1	2/25/05	-0.11	0.81	0.007	0.07	0.01	0.77	0.043	0.53	1.61
CSMRI-2	2/25/05	0.8	1.85	0.07	-0.02	0.01	0.6	0.05	0.16	0.53
CSMRI-4	2/25/05	-0.03	0.16	0.019	-0.009	0.013	9.7	0.53	8.2	24.7
CSMRI-5	2/25/05	1.06	0.53	0.009	0.007	0.034	1.22	0.056	0.93	2.8
MCL		Total Ra 5		Total Th 60						30

pCi/l - picocuries per liter
ug/l – micrograms per liter

Table 2-3
Summary of Metals in Groundwater
(All results in micrograms 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
CSMRI-2	2/25/05	ND	ND	0.11	72	ND	ND	ND	7.1	32	ND	19	ND	ND	ND	0.02
CSMRI-4	2/25/05	ND	ND	ND	72	ND	ND	ND	5.1	31	0.017	29	ND	ND	ND	0.12
CSMRI-5	2/25/05	ND	ND	ND	54	ND	ND	ND	3.4	22	ND	27	ND	ND	ND	0.067
Detection Limits		0.01	0.01	.1	1.0	0.005	0.01	0.0002	1.0	1.0	0.01	1.0	.003	0.005	1.0	1.0
MCLs		--	0.01	2	--	0.005	0.01	0.0002	--	--	0.01	--	0.015	0.005	--	--

ND – non detect

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
AS-East	3/17/05	$1.3x10^{-15}$	$1.3x10^{-14}$	$1.4x10^{-16}$	$6.8x10^{-17}$	$7.1x10^{-17}$	$4.1x10^{-17}$	$2.5x10^{-16}$	$1.3x10^{-17}$	$8.2x10^{-17}$	$3.5x10^{-16}$
AS-West	3/17/05	$1.4x10^{-15}$	$1.5x10^{-14}$	$2.5x10^{-16}$	$2.5x10^{-17}$	0	$3.3x10^{-17}$	$4.2x10^{-16}$	$7.1x10^{-18}$	$7.3x10^{-17}$	$5.0x10^{-16}$
Unrestricted use limit		NA	NA	$9x10^{-13}$	NA	$2x10^{-14}$	$4x10^{-16}$	NA	NA	NA	$9x10^{-14}$

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)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (ug/l)
CSMRI-1	2/25/05	-0.11	0.81	0.007	0.07	0.01	0.77	0.043	0.53	1.61
CSMRI-2	2/25/05	0.8	1.85	0.07	-0.02	0.01	0.6	0.05	0.16	0.53
CSMRI-4	2/25/05	-0.03	0.16	0.019	-0.009	0.013	9.7	0.53	8.2	24.7
CSMRI-5	2/25/05	1.06	0.53	0.009	0.007	0.034	1.22	0.056	0.93	2.8
MCL		Total Ra 5		Total Th 60						30

pCi/l - picocuries per liter
ug/l – micrograms per liter

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	2/25/05	ND	ND	ND	28	ND	ND	ND	2.8	9.4	ND	29	ND	ND	ND	0.032
CSMRI-2	2/25/05	ND	ND	0.11	72	ND	ND	ND	7.1	32	ND	19	ND	ND	ND	0.02
CSMRI-4	2/25/05	ND	ND	ND	72	ND	ND	ND	5.1	31	0.017	29	ND	ND	ND	0.12
CSMRI-5	2/25/05	ND	ND	ND	54	ND	ND	ND	3.4	22	ND	27	ND	ND	ND	0.067
Detection Limits		0.01	0.01	.1	1.0	0.005	0.01	0.0002	1.0	1.0	0.01	1.0	0.003	0.005	0.01	0.02
MCLs		--	0.01	2	--	0.005	0.1	0.002	--	--	0.01	--	0.015	0.05	--	--

ND – non detect

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)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (ug/l)
SW-1	2/25/05	0	0.58	0.018	-0.026	-0.001	0.89	0.083	0.65	1.97
SW-2	2/25/05	0.45	0.06	0.011	-0.016	0.033	0.8	0.066	0.42	1.29

pCi/l - picocuries per liter
ug/l – micrograms per liter

Table 2-5
Summary of Metals in Surface Water
(All results in micrograms 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
SW-2	2/25/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17
Detection Limits		0.01	0.01	0.1	1.0	0.005	0.01	0.0002	1.0	1.0	0.01	1.0	0.003	0.005	0.01	1.0
MCLs		0.01	0.01	2	--	0.005	0.01	0.0002	--	--	0.01	--	0.015	0.005	0.01	--

ND – non detect

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)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (ug/l)
SW-1	2/25/05	0	0.58	0.018	-0.026	-0.001	0.89	0.083	0.65	1.97
SW-2	2/25/05	0.45	0.06	0.011	-0.016	0.033	0.8	0.066	0.42	1.29

pCi/l - picocuries per liter
ug/l – micrograms per liter

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	2/25/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2
SW-2	2/25/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17
Detection Limits		0.01	0.01	0.1	1.0	0.005	0.01	0.0002	1.0	1.0	0.01	1.0	0.003	0.005	0.01	1.0
MCLs		0.01	0.01	2	--	0.005	0.01	0.0002	--	--	0.01	--	0.015	0.005	0.01	--

ND – non detect

Table 2-6
CSMRI Historical Groundwater Data
(All results in picocuries per liter)

Well ID (d)	Analyte	1/1991 (a)	6/1991 (a)	3/1999 (b)	6/1999 (b)	10/1999 (b)	2/2003 (c)	4/2003 (c)	2/2005 (e)
CSMRI - 1	Ra-226			0.1	0.3	0.2	<0.55	<0.45	-0.11
	U Total			2.09	2.59	1.44	2.4	2.88	1.61 ug/l
	Th-230			0.4	0.2	0.2	<0.19	0.21	0.07
CSMRI - 2	Ra-226		1.9	1.9	1.4	1.4	1.4	2.8	0.81
	U Total	11	5.7	0.55	1.46	0.71	1.2	1.27	0.53 ug/l
	Th-230		0	0.1	0.1	0.9	<0.17	0.43	-0.02
CSMRI - 3	Ra-226		0.6	1.5	1.2	1.6	<0.75	<0.81	--
	U Total	17	10.4	8.41	12.4	10	12	12	--
	Th-230		0	0.3	0.3	1.1	<0.12	<0.15	--
CSMRI - 4	Ra-226		1	<0.4	0.6	0.4	<0.85	<0.42	-0.03
	U Total	86	57.3	23.4	58.6	33.7	16	34.2	24.7 ug/l
	Th-230		0	0.7	0.3	0.4	<0.099	<0.15	-0.009
CSMRI - 5	Ra-226		0.6	2.4	3.3	2.7	<0.49	1.1	1.06
	U Total	14	16.8	3.6	3.6	4	2.8	2.28	2.8 ug/l
	Th-230		0	0.2	0.2	1.4	0.062	<0.14	0.007

Notes:
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 calculated from concentration reported by Paragon.
d - Well Identification numbers changed from the 1991 data to the 1999 data. Data presented account for this change
e. S.M. Stoller samples
f. Well CSMRI-3 abandoned prior to this sampling event

Appendix A
Long-Lived 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. **IF** the location is a major fixed facility,

       THEN, the actual altitude should be used.

    b. **IF** the altitude is not well known,

       THEN, 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. **IF** the specific work location and radionuclide type are not specified in Table 2,

      THEN 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. **IF** the air sampler used is equipped with a programmable flow totalizer,

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

      THEN,

      1. Do not post the area as an Airborne Radioactivity Area.
      2. 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. Perform step 7.1[5] of this procedure.

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

      THEN,

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

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

      THEN,

      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. **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. 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:

(πr^2h) 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.

990 South Public Road, Suite A
Lafayette, CO 80026
(303) 546-4300

Sample Collection Log

Project Name: Colorado School of Mines	Sample location: CSM RI-2
Project Number: 3991-010	Date: 2/24/05, 2/25/05
Sample Type: [✓ GW] SW Rinse Duplicate Other:	Sampler: Nick Malczyk

Purge Volume Calculations

Measured TD =	95.10 ft
	(+.28)
Total Depth =	95.38 ft
Depth to Water =	74.12 ft
Initial Water Column =	21.26 ft
Initial Water Volume =	3.40 gal
3X Water Volume =	10.20 gal

Sample Collection

Analysis	Container	Preservative	Date	Time
Diss. Metals	500mL Poly	filter/ HNO_3	2/25/05	1430
Radium 226	1 gal cube	filter/ HNO_3	2/25/05	1435

Lab: Paragon - Fort Collins

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp (C)	pH (SU)	Conductivity (uS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Appearance
1226	Initial	13.17	7.29	508	6.6	180.3	5.82	clear
1235	1.7	13.05	7.43	518	671	122.3	6.22	brown
1249	3.4	13.23	7.26	563	666	115.5	5.36	
1300	5.1	12.97	7.31	550	665	114.2	7.40	
1312	6.8	12.90	7.32	587	620	131.6	6.85	

Alkalinity

pH = 5.58

Over range pH = 3.74

Total Alkalinity = 11x10 = 110 ppm

Comments: Purged 7.0 gal before well went dry. water depth 85.76 on 2/25/05

SM Stoller Corp.

990 South Public Road, Suite A
Lafayette, CO 80026
(303) 546-4300

Sample Collection Log

Project Name: Colorado School of Mines

Sample location: CSMRI - 1

Project Number: 3991-010

Date: 2/25/05

Sample Type: [✓ GW] SW Rinse Duplicate Other:

Sampler: Nick Malczyk

Purge Volume Calculations

Measured TD = 24.93 ft

(+.28) Total Depth = 25.21 ft

Depth to Water = 7.42 ft

Initial Water Column = 17.79 ft

Initial Water Volume = 2.85 gal

3X Water Volume = 8.54 gal

Sample Collection

Analysis	Container	Preservative	Date	Time
Diss. Metals	500mL Poly	Filter/ HNO3	2/25/05	1020
Radium 226	1 gal cube	Filter/ HNO3	2/25/05	1025

Lab: Paragon - Fort Collins

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp (C)	pH (SU)	Conductivity (uS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Appearance
0957	Initial	6.27	6.72	381	334	270.4	9.33	brown
1001	1.43	3.97	6.75	351	811	247.3	11.25	
1005	2.85	3.69	6.84	354	832	236.8	11.46	
1008	4.29	3.57	6.87	351	726	227.3	11.77	
1011	5.72	3.73	6.91	357	795	227.5	11.48	
1015	7.15	3.69	6.91	356	nm ~~786~~ 784	227.4	11.37	
1018	8.54	3.69	6.96	354	666	248.4	12.27	
								nrm

Alkalinity

pH = 3.84

Over range pH = n/a

Total Alkalinity = 24 ppm

Comments: well recharged quickly

nrm

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Sample Collection Log

Project Name: Colorado School of Mines	Sample location: CSMRI-4
Project Number: 3991-010	Date: 2/24/05
Sample Type: [✓ GW] SW Rinse Duplicate Other:	Sampler: Nick Malczyk

Purge Volume Calculations		Sample Collection				
		Analysis	Container	Preservative	Date	Time
Measured TD = Total Depth =	17.22 ft (+.28) 17.50 ft	Diss. Metals	500mL Poly	filter/HNO3	2/24/05	1435
Depth to Water =	7.27 ft	Radium 226	1 gal cube	filter/HNO3	↓	1440
Initial Water Column =	10.23 ft	/	/	/	/	/
Initial Water Volume = 3X ~~Water Volume~~ =	1.64 gal 4.91 gal	/	/	/	/	/
		Lab: Paragon - Fort Collins				

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp (C)	pH (SU)	Conductivity (uS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Appearance
1356	Initial	7.82	6.85	641	18.5 ~~170~~ nm	170.6	8.97	clear
1400	.82	6.48	6.91	675	~~+~~ 132 nm	145.1	9.97	cloudy brown
1407	1.64	5.98	6.84	663	178	151.7	7.51	↓
1409	2.46	6.43	6.87	688	185	144.8	8.08	
1410	3.28	6.27	6.86	691	179	143.7	7.60	
1416	4.10	5.95	6.87	681	133	143.1	7.57	
1418	4.91	6.52	6.84	689	224	150.6	5.81	
								nm

Alkalinity

pH = 4.82

Over range pH = NA

Total Alkalinity = 155 ppm

Comments: PVC is bent or broken below water level. It doesn't affect bailing or sampling. Quick recharge

nm

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Sample Collection Log

Project Name: Colorado School of Mines	Sample location: CSMRI-5
Project Number: 3991-010	Date: 2/24/05
Sample Type: [✓ GW] SW Rinse Duplicate Other:	Sampler: Nick Malczyk

Purge Volume Calculations

Measured TD =		10.96 ft
	(+.28)	
Total Depth =		11.24 ft
Depth to Water =		6.51 ft
Initial Water Column =		4.73 ft
Initial Water Volume =		0.76 gal
3X Water Volume =		2.27 gal

Sample Collection

Analysis	Container	Preservative	Date	Time
Diss. Metals	500mL Poly	filter/ HNO_3	2/24/05	1535
Radium 226	1 gal cube	filter/ HNO_3	↓	1540

Lab: Paragon - Fort Collins

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp (C)	pH (SU)	Conductivity (uS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Appearance
1507	Initial	8.64	6.91	556	86.0	109.5	5.82	dark grey
1511	.76	7.95	6.91	545	375	90.2	7.15	↓
1514	1.52	7.88	6.92	544	277	89.2	7.69	
1518	2.27	8.01	6.92	544	254	85.3	7.18	
								NM

Alkalinity

pH = 4.56

Over range pH = NA

Total Alkalinity = 120 ppm

Comments: well recharges quickly

NM

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Sample Collection Log

Project Name: Colorado School of Mines

Sample location: SW-1

Project Number: 3991-010

Date: 2/25/05

Sample Type: GW [✓ SW] Rinse Duplicate Other:

Sampler: Nick Malczyk

Purge Volume Calculations

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

Sample Collection

Analysis	Container	Preservative	Date	Time
Diss. Metals	500mL Poly	Filter/HNO3	2/25/05	1300
Radium 226	1 gal cube	Filter/HNO3	↓	1305

Lab: Paragon - Fort Collins

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp (C)	pH (SU)	Conductivity (uS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Appearance
1250	Initial	3.39	6.51	343	5	245.8	16.00	clear
								nm

Alkalinity

pH = 3.80

Over range pH = NA

Total Alkalinity = 19 ppm

Comments: This was the upstream SW sample, taken near CSMRI-1

nm

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Sample Collection Log

Project Name: Colorado School of Mines

Sample location: SW-2

Project Number: 3991-010

Date: 2/25/05

Sample Type: GW [✓ SW] Rinse Duplicate Other:

Sampler: Nick Malczyk

Purge Volume Calculations

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

Sample Collection

Analysis	Container	Preservative	Date	Time
Diss. Metals	500mL Poly	filter/ HNO3	2/25/05	1405
Radium 226	1 gal cube	filter/ HNO3	2/25/05	1410
/	/	/	/	/
/	/	/	/	/

Lab: Paragon - Fort Collins

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temp (C)	pH (SU)	Conductivity (uS/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Appearance
1350	Initial	3.98	7.05	339	4.6	237.1	15.66	clear
								nm

Alkalinity
pH = 3.84

Over range pH = n/A

Total Alkalinity = 24 ppm

Comments: This was the downstream SW sample. Sample location was down hill from the dead-end on 11th st.

nm

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Sample Collection Log

Project Name: Colorado School of Mines	Sample location: Equipment Blank
Project Number: 3991-010	Date: 2/25/05
Sample Type: GW SW [✓ Rinse] Duplicate Other:	Sampler: Nick Malczyk

Purge Volume Calculations

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

Sample Collection

Analysis	Container	Preservative	Date	Time
Diss. Metals	500mL Poly	Filter/HNO_3	2/25/05	1325
Radium 226	1 gal cube	Filter/HNO_3	↓	1330

Lab: Paragon - Fort Collins

Purge Volumes and Field Water Quality Measurements

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

Alkalinity

pH = —

Over range pH = —

Total Alkalinity = — ppm

Comments: used teflon bailer for equipment blank

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

DRAFT

DATA VALIDATION REPORT

To: Steve Brinkman- Stoller
From: Richard Thurman
Project/Site: CSMRI Monitoring
Project No.: 3991-030 Air Filters
SDG No.: 0503198

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 714R9 for isotopes of uranium and thorium by alpha spectrometry, PA SOP 783R5 for Radium-226 by Radon Emanation counting, and PA SOP 724R8 for Gross Alpha and Gross Beta by gas proportional counting for SDG 0503198 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of 2 air filter samples collected on March 17, 2005 for the CSMRI/ 3991-030 project. The samples were analyzed for uranium and thorium by alpha spectrometry on April 12 and April 13, 2005, Radium-226 by Radon Emanation counting on April 11, 2005, and Gross Alpha and Gross Beta by gas proportional counting on March 24, 2005 by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Laboratory Sample Number	Client Sample Number	Matrix
0503198-1	AS-EAST	Filter
0503198-2	AS-WEST	Filter

Data validation was conducted in accordance with the Analytical Services Division of the Rocky Flats Technology Site's (RFETS) 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.

The radiological data were evaluated based on the following parameters:

- Data Completeness
- Holding Times and Preservation
- Sample Preparation Raw Data
- Instrument Initial Calibrations

- * Instrument Performance Checks
- * Preparation Blanks
- * Duplicate Sample Results
- * Laboratory Control Samples (LCS) Results
- * Compound Quantitation and Reporting Limits (full validation only)

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

Data Completeness

The data package was complete and all results remain unqualified as a result of the validation process.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met. However, holding time requirements are not applicable to radiochemistry analyses unless the isotopes of interest have short half-lives.

The water samples were found to be preserved in nitric acid and cooled to 4.8 degrees centigrade upon receipt by the laboratory. No action was taken.

Sample Preparation Raw Data

Laboratory bench sheets were examined and all documentation is complete including initial and final volumes and aliquots used for analysis.

For Gross Alpha and Gross Beta analysis, the filter samples were placed on stainless steel planchets and analyzed by gas proportional counting. No action was taken.

The filter samples were digested according to PA SOP773 R9 and PA SOP 777 R8 with modifications to the method described in QASS 289797 for the alpha spectrometry analyses of uranium and thorium. Due to limited sample volume, a 0.334 filter equivalent was used. Due to the small aliquot size, the required detection limit (RDL) for Thorium-230 and Thorium-228 of 0.1 pCi/sample was not achieved for either of the filter samples even with an extended count duration of 1000 minutes. No action was taken.

The filter samples were muffled and digested, prior to Radium-226 by radon emanation analysis, according to PA SOP 773 R8 and QASS 289797. No action was taken.

Calibrations

The instruments were calibrated at the required frequency.

Initial Calibration

All instruments were calibrated properly using NIST traceable SRM.

Instrument Performance Checks

All isotopes were within criteria.

Preparation Blanks

Preparation blanks were prepared and analyzed at the required frequency for all isotopes.

All of the isotopes that were analyzed had activities that were below their respective minimum detectable concentrations (MDCs) in the preparation blanks with the exception of Uranium-238 by alpha spectrometry. The Uranium-238 activity in the method blank slightly exceeded its MDC (but not the RDL of 0.1 pCi/sample) and was less than three times the MDC. Sample Uranium-238 activities were less than three times (3X) the blank activity. The data validation guidelines do not require qualification of sample results if the method blank detections are below the RDL and therefore no action was taken.

MDCs for method blanks for Thorium-230 and Thorium-228 exceeded the RDL (0.1 pCi/sample). No action was taken since the blank aliquots were reduced to match the sample aliquots.

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. All isotopic activities for LCS and LCS duplicate were within the limits of the statistical test for equivalency. No action is required.

Due to insufficient sample volume to perform a laboratory duplicate, an analysis duplicate was analyzed for Gross Alpha and Gross Beta using sample AS-EAST. All original sample and analysis duplicate activities were within the limits of the statistical test for equivalency. No action is 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

The laboratory analyzed laboratory control samples for Uranium-238, Uranium-234, and Thorium-230 for alpha spectrometry, Radium-226 by radon emanation, and Gross Alpha and Gross Beta by gas proportional counting. 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. All results were reported on an "as received" basis in units of pCi/ sample. No action was taken.

Uranium-238 and Uranium-234 activities were detected above their MDCs in both of the filter samples. The activities ranged from approximately two times (2X) the RDL of 0.1 pCi/sample to approximately ten times (10X) the RDL for Uranium-238 and Uranium-234.

The laboratory provided a calculated value in pCi/sample for total uranium in each sample based on the measured values by alpha spectrometry of the individual uranium isotopes and their specific activities. No action was required.

No Thorium-232, Thorium-230, or Thorium-228 activities were observed above their MDCs in any of the samples. Due to the reduced aliquot size of 0.334 grams, the RDL of 0.1 pCi/sample was not achieved for Thorium-230 and Thorium-228. Count time was extended to 1000 minutes. No action was taken.

No Radium-226 was detected in either of the filter samples. No action was required.

Gross Alpha and Gross Beta activities were detected above the MDCs in both the filter samples. No action was required.

Sample AS-WEST in this SDG that was analyzed for isotopic thorium had a tracer peak resolution that exceeded 2.3% (>100 KeV full width at half maximum). However, the reviewer deemed that no action was necessary because the sample activities were below MDCs. No action was taken.

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported for both filter samples in units of pCi/sample.

Overall Comments

Uranium-238 activity in the method blank exceeded the MDC, but was below the RDL of 0.1 pCi/sample and was less than three times (3X) the MDC. The data validation guidelines do not require qualification of sample results if the method blank detections are below the RDL and therefore no action was taken.

The results were unremarkable. Activities for Uranium-238 and Uranium-234 by alpha spectrometry and Gross Alpha by gas proportional counting exceeded their MDCs, but only slightly exceeded the RDLs. No Thorium-232, Thorium-230, Thorium-228, or Radium-226 activities were observed above their MDCs.

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.

DRAFT

DATA VALIDATION REPORT

To:	Steve Brinkman- Stoller
From:	Richard Thurman
Project/Site:	CSMRI Monitoring
Project No.:	3991-010 Groundwater Wells
SDG No.:	0502232

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 714R9 for isotopes of uranium and thorium by alpha spectrometry, PA SOP 783R5 for Radium-226 by Radon Emanation counting, and PA SOP 724R8 for Radium-228 by gas proportional counting for SDG 0502232 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of 7 water samples collected on February 25, 2005 for the CSMRI/ 3991-010 project. The samples were analyzed for uranium and thorium by alpha spectrometry on March 10, 2005, Radium-226 by Radon Emanation counting on March 14, 2005, and Radium-228 by gas proportional counting on March 10, 2005 by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Laboratory Sample Number	Client Sample Number	Matrix
0502232-1	CSMRI-1	Water
0502232-2	CSMRI-2	Water
0502232-3	CSMRI-4	Water
0502232-4	CSMRI-5	Water
0502232-5	SW-1	Water
0502232-6	SW-2	Water
0502232-7	Equipment Blank	Water

Data validation was conducted in accordance with the Analytical Services Division of the Rocky Flats Technology Site's (RFETS) 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.

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
- Compound Quantitation and Reporting Limits (full validation only)

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

Data Completeness

The data package was complete and all results remain unqualified as a result of the validation process.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met. However, holding time requirements are not applicable to radiochemistry analyses unless the isotopes of interest have short half-lives.

The water samples were found to be preserved in nitric acid and cooled to 4.8 degrees centigrade upon receipt by the laboratory. No action was taken.

Calibrations

The instruments were calibrated at the required frequency.

Initial Calibration

All instruments were calibrated properly using NIST traceable SRM.

Instrument Performance Checks

All isotopes were within criteria.

Preparation Blanks

Preparation blanks were prepared and analyzed at the required frequency for all isotopes.

All of the isotopes that were analyzed had activities that were below their respective MDCs in the preparation blanks with the exception of Uranium-234, Uranium-235, and Thorium-232 by alpha spectrometry. The Uranium-234, Uranium-235, and Thorium-232 activities in the method blank slightly exceeded their respective MDC but not the RDL of 1.0 pCi/L. Sample activities for these isotopes either greatly exceeded the blank activities or else were less than their MDCs and no action was required. The data validation guidelines do not require qualification of sample results if the method blank detections are below the RDL and therefore no action was taken.

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, Radium-226 by radon emanation, and Radium-228 by gas proportional counting. All isotopic activities for LCS and LCS duplicate were within the limits of the statistical test for equivalency. No action is 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

The laboratory analyzed laboratory control samples for Uranium-238, Uranium-234, and Thorium-230 for alpha spectrometry, Radium-226 by radon emanation, and Radium-228 by gas proportional counting. 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.

Uranium-238 and Uranium-234 activities were detected above their MDCs in all of the client samples except the equipment blank. The activities ranged from below the RDL of 1.0 pCi/L to approximately ten times (10X) the RDL in sample CSMRI-4 for Uranium-

238 and uranium-234.

The laboratory provided a calculated value on a mass basis (in ug/L) for total uranium in each sample based on the measured values by alpha spectrometry of the individual uranium isotopes and their specific activities. No action was required.

No Thorium-232, Thorium-230, or Thorium-228 activities were observed above their MDCs in any of the samples. No action was necessary.

No Radium-226 was detected in any of the water samples with the exception of samples CSMRI-2 and CSMRI-5. To prevent a possible low bias from calculated barium yields that were between 100% and 110%, the laboratory used a default yield of 100% when the barium yield exceeded 100%. Since impact was minimal due to lack of sample activity above the MDCs , no action was required.

No Radium-228 was detected in any of the water samples with the exception of sample CSMRI-2. To prevent a possible low bias from calculated barium yields that were between 100% and 110%, the laboratory used a default yield of 100% when the barium yield exceeded 100%. No action was required.

Sample CSMRI-2 in this SDG that was analyzed for isotopic thorium had a tracer peak resolution that exceeded 2.4% (>100 KeV full width at half maximum). However, the reviewer deemed that no action was necessary because the sample activities were below MDCs. No action was taken.

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

Overall Comments

The activities of Uranium-234, Uranium-235, and Thorium-232 in the method blank exceeded the MDC, but were below the RDL of 1.0 pCi/L. The data validation guidelines do not require qualification of sample results if the method blank detections are below the RDL and therefore no action was taken.

The results were unremarkable. Activities for isotopes of uranium by alpha spectrometry exceeded their MDCs, were in their natural abundance ratios, and were equivalent to the required detection limit (1.0 pCi/L). No Thorium-232, Thorium-230, Thorium-228, Radium-226, or Radium-228 activities were observed above their MDCs with the exception of one sample with Radium-226 activity at a level of approximately twice the RDL.

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 G
Chain-of-Custody Documentation

Paragon Analytics
A Division of DataChem Laboratories, Inc.
225 Commerce Drive Fort Collins, CO 80524
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) ____________

Chain-of-Custody

Date 2/25/05 Page 1 of 2 **Originator:** Retain pink copy

Project Name / No.: CO School of Mines **Sampler(s):** Nick 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: 990 South Public Rd, Suite A
Lafayette, CO 80026

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

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type)	No. of Containers	VOCs SW8260B E624 E524.2	BTEX (only) SW8021B	SVOCs SW8270C E625	OC Pesticides SW8081A E608	PCBs SW8082 E608	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 SW6010B SW7471	Total Metals by ICP SW6010B 7470 7471 E200 ILMO__	Dissolved Metals by ICP SW6010B 7470 E200 ILMO__	Total Metals by ICP/MS SW6020 E200.8 ILMO__	Dissolved Metals by ICP/MS SW6020 E200.8 ILMO__	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 GRO DRO SW8015B (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 89 D5811-00 Strontium 90 D5811-00	Gamma Isotopes E901.1
CSMRI-1	2/25/05	1020		W	HNO3	1											X														
↓	↓	1025		↓	↓	↓																							X		
CSMRI-2	2/25/05 ~~2/24/05~~ MM	1430		↓	↓	↓											X														
↓	↓	1435		↓	↓	↓																							X		
CSMRI-4	2/24/05	1435		↓	↓	↓											X														
↓	↓	1440		↓	↓	↓																							X		
CSMRI-5	2/24/05	1535		↓	↓	↓											X														
↓	↓	1540		↓	↓	↓																							X		
SW-1	2/25/05	1300		↓	↓	↓											X														
↓	↓	1305		↓	↓	↓																							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:

Relinquished By: (1)
Signature
Printed Name Nick Malczyk
Date 2/25/05 Time 1630
Company Stoller

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

Received By: (1)
Signature Steve Lafferty
Printed Name Steve Lafferty
Date 2.25.05 Time 1630
Company Paragon

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

Paragon Analytics
A Division of DataChem Laboratories, Inc.

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

Accession Number (LAB ID): ____

Chain-of-Custody Date 2/25/05 Page 2 of 2 **Originator: Retain pink copy**

Project Name / No.: CO School of Mines **Sampler(s):** Nick Melczyk 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: 990 South Public Rd, Suite A
Lafayette, CO 80026

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

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type)	No. of Containers	VOCs SW8260B E624 E524.2	BTEX (only) SW8021B	SVOCs SW8270C E625	OC Pesticides SW8081A E608	PCBs SW8082 E608	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 SW6010B SW7471	Total Metals by ICP SW6010B 7470 7471 E200 ILMO__	Dissolved Metals by ICP SW6010B 7470 E200 ILMO__	Total Metals by ICP/MS SW6020 E200.8 ILMO__	Dissolved Metals by ICP/MS SW6020 E200.8 ILMO__	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 GRO DRO SW8015B (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 89 D5811-00 Strontium 90 D5811-00	Gamma Isotopes E901.1					
SW-2	2/25/05	1405		W	HNO3	1											X																			
↓	↓	1410		↓	↓	↓																							X							
Equipment Blank	2/25/05	1325															X																			
↓	↓	1330		↓	↓	↓																							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:

Form 202r5.xls (4/6/04)

Relinquished By: (1)
Signature
Printed Name Nick Melczyk
Date 2/25/05 Time 1630
Company Stoller

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

Received By: (1)
Signature Sheri Lafferty
Printed Name Sheri Lafferty
Date 2.25.05 Time 1630
Company Paragon

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