

**Monitoring Results
Natural Gas Wells
Near Project Rulison
Second Quarter 2014**

**U.S. Department of Energy Office of Legacy Management
Grand Junction, Colorado**

Date Sampled: March 20, 2014

Background

Project Rulison was the second Plowshare Program test to stimulate natural gas recovery from deep, low-permeability formations. On September 10, 1969, a 40-kiloton-yield nuclear device was detonated 8,426 feet (1.6 miles) below ground surface in the Williams Fork Formation at what is now the Rulison, Colorado, Site. Following the detonation, a series of production tests were conducted. Afterward, the site was shut down and then remediated, and the emplacement well (R-E) and the reentry well (R-Ex) were plugged.

Purpose

As part of the U.S. Department of Energy (DOE) Office of Legacy Management (LM) mission to protect human health and the environment, LM is monitoring natural gas wells that are near the Rulison site for radionuclides associated with the detonation. The very low permeability of the Williams Fork Formation limits contaminant migration, and institutional controls restrict subsurface access in the detonation zone. When companies apply for a permit to drill wells within 3 miles of the site, the Colorado Oil and Gas Conservation Commission notifies DOE, and the State of Colorado and DOE have an opportunity to review and comment on drilling permits and gas well development practices to help protect human health and the environment from the Rulison-related contaminants. The DOE *Rulison Monitoring Plan* (LMS/RUL/S06178) provides guidance for sample collection frequency based on distance from the Rulison detonation point, the types of analyses, and the reporting thresholds.

Summary of Results

Analytical results of production water samples collected in March 2014 were all below the screening levels specified in the *Rulison Monitoring Plan*. No gas samples were collected during this sampling event.

During the first-quarter sampling event conducted on December 19, 2013, severe weather conditions at the Rulison site affected monitoring activities; natural gas valves at a local production station were frozen and not functioning properly. The intermittent closure of the production line valves caused significantly higher-than-normal wellhead pressures. At some wells, the high wellhead pressure prevented the production water plunger from traveling up the wells to purge production water. The higher wellhead pressures also contributed to a 10- to 15-degree increase in wellhead natural gas temperatures. During the March 2014 monitoring event, pressures and line temperatures had returned to normal ranges.

The March sampling effort consisted of sampling 13 wells. Nine wells (Battlement Mesa [BM] 26-33B, 26-33C, 26-34A, 26-34B, 26-34D, 26-22C, 26-22D, 35-32A, and 36-13) produced the full volume of production water for analysis. Three wells (BM 26-34C, 26-22B, and 36-13B) each produced approximately 250 milliliters (mL) of production water, which is enough sample volume for only tritium and chloride analyses. Well BM 26-33D had no production water for analysis.

Table 1 lists the 13 wells, and Table 2 lists the sequential sample collection information.

Table 1. Sample Collection Locations

Pad	Collection Location	Well Name
26N	Wellhead separator	BM 26-33B–D, BM 26-34A–D
26K	Wellhead separator	BM 26-22B–D
35C	Wellhead separator	BM 35-32A
36L	Wellhead separator	BM36-13B
36B	Wellhead separator	BM36-13

Table 2. Samples Collected

Sequence	Pad	Well Name	Location			Sample Phase		Well	
			API # 05-045-	Type	Subtype	Gas	Liquid	T (°F)	P (psi)
1	26N	BM 26-33B	15743	WL	NGSA	No	Yes	69	271
2	26N	BM 26-33C	15742	WL	NGSA	No	Yes	52	250
3	26N	BM 26-33D	15739	WL	NGSA	No	No	71.5	268
4	26N	BM 26-34A	15744	WL	NGSA	No	Yes	66.3	275
5	26N	BM 26-34B	15745	WL	NGSA	No	Yes	66.8	231
6	26N	BM 26-34C	15741	WL	NGSA	No	Yes ^a	61	262
7	26N	BM 26-34D	15748	WL	NGSA	No	Yes	63.4	261
8	26K	BM 26-22B	16086	WL	NGSA	No	Yes ^a	68	271
9	26K	BM 26-22C	16087	WL	NGSA	No	Yes	61	263
10	26K	BM 26-22D	16074	WL	NGSA	No	Yes	63	265
11	35C	BM 35-32A	10919	WL	NGSA	No	Yes	61	272
12	36L	BM 36-13B	15469	WL	NGSV	No	Yes ^a	68	279
13	36B	BM 36-13	10840	WL	NGSV	No	Yes	67	281

Notes:

^a Approximately 250 mL of production water.

Abbreviations:

API American Petroleum Institute
 NGSA Natural gas well—angle
 NGSV Natural gas well—vertical
 P (psi) pressure in pounds per square inch
 T (°F) temperature in degrees Fahrenheit
 WL well

Sample Locations

The bottom-hole locations of the 13 gas wells planned for sample collection are between 0.75 mile and 1.07 miles from the Project Rulison detonation point. All gas wells sampled are producing gas from the Williams Fork Formation at a depth near that of the Rulison detonation point.

Sample Collection

A produced-water sample is collected at the wellhead from a tap on the common line connecting two gas-liquid separators and the accumulation tank. The produced water collected from one well separator is isolated from the other well separator by valves. Lines from each of the two separators are purged of produced water and condensate prior to sample collection. Each sample is collected in a new, 1-gallon plastic container.

When a gas sample is collected, the sample is collected from a tap on the gas line at the separator output. The line between the tap and the sample bottle is purged before sample collection. Each gas sample is collected in an evacuated 18-liter bottle furnished by the laboratory.

Monitoring Protocol

The *Rulison Monitoring Plan* provides guidance regarding the type and frequency of sample collection as a function of distance and heading from the Rulison detonation point; it also specifies the types of analyses. A copy of the monitoring plan is available at <http://www.lm.doe.gov/Rulison/Documents.aspx>. Table 3a lists gas-phase screening concentrations for tritium and carbon-14, and Table 3b lists liquid-phase screening concentrations for tritium, gross alpha, gross beta, and the suite of radionuclides identified by high-resolution gamma spectrometry.

Table 3a. Gas-Phase Concentrations for Tritium Sample Results

Analyte	Reporting Units	Screening Concentration	Action Concentration	Comment
Tritium	TU	19,293	TBD	5.183×10^{-6} pCi cc ⁻¹ TU ⁻¹
¹⁴ Carbon	pMC	2 pMC	5 pMC	6.54×10^{-5} pCi/cc and 16.4×10^{-5} pCi/cc, respectively

Abbreviations:

pCi/cc	picocuries per cubic centimeter
pCi cc ⁻¹ TU ⁻¹	picocuries per cubic centimeter of methane gas per tritium unit
pMC	percent modern carbon
TBD	to be determined
TU	tritium unit

Table 3b. Liquid-Phase Screening Concentrations for Tritium and Other Radionuclides

Analyte	Reporting Units	Screening Concentration	Action Concentration	Comment
Tritium	pCi/L	800	TBD	20,000 pCi/L = EPA drinking water standard
Lab Method				
Gross alpha	pCi/L	3× background	TBD	
Gross beta	pCi/L	3× background	TBD	
High-resolution gamma spectrometry	pCi/L	20	TBD	Based on cesium-137

Notes:

See the *Rulison Monitoring Plan*, Table 2, for response scenarios to use when the screening concentrations, action concentrations, or both, are exceeded.

The derived air effluent concentration for a 50 millirem per year dose from tritium exposure is 0.10 pCi (tritium)/cc (methane).

Abbreviations:

EPA U.S. Environmental Protection Agency
 pCi/L picocuries per liter
 TBD to be determined

Results

Twelve of the total 13 sampling locations produced enough production water to analyze for some or all of the Rulison-related contaminants. Nine locations provided enough production water for all analyses; three locations (BM 26-34C, BM 26-22B, and BM 36-13B) provided approximately 250 mL of sample, which is sufficient for only tritium and chloride analyses. One location (BM 26-33D) provided no production water.

Production water analytical results are tabulated by well in Appendix A.

Laboratory Qualifiers

A “detect” is a result greater than the laboratory’s reporting threshold or minimum detectable concentration (MDC).

A “nondetect” is a result that is less than the laboratory’s MDC for that sample. The laboratory assigns the qualifier “U” to a nondetect result.

Data Validation Qualifiers

A detect result less than 3 times the sample MDC is assigned the data validation qualifier “J” (estimated quantity).

A laboratory detect result less than 3 times the 1-sigma total propagated uncertainty is considered a nondetect. Data validation assigns the qualifier U to this result.

Results Summaries

Table 4a is a summary of analytical results for liquid-phase tritium, Table 4b is a summary of results for liquid-phase gross alpha and gross beta, and Table 4c shows results for potassium-40 analyses. Sample volumes not adequate for laboratory analysis are counted as not applicable (NA).

Table 4a. Summary of Tritium Samples Based on Laboratory-Assigned Qualifiers

Collection Location	Total Samples (gas/liquid) Collected	Tritium Results (gas phase)			Tritium Results (liquid phase)			Carbon-14 (gas phase)		
		Detect	Nondetect	NA	Detect	Nondetect	NA	Detect	Nondetect	NA
Natural gas wells	0/12	0	0	13	0	12	1	0	0	13

Notes:

As planned, no gas samples were collected during this sampling event. At the BM 36-33D well, no production water was collected, which is signified by NA. Approximately 250 mL of production water, enough for only chloride and tritium analyses, was collected at wells BM 26-34C, BM 26-22B, and BM 36-13B.

Table 4b. Summary of Gross Alpha and Gross Beta Liquid-Phase Samples Based on Laboratory-Assigned Qualifiers

Collection Location	Total Liquid Samples Collected	Gross Alpha Results			Gross Beta Results		
		Detect	Nondetect	NA	Detect	Nondetect	NA
Natural gas wells	13	4	5	4	9	0	4

Notes:

Data validation assigned a J qualifier to all four gross-alpha detect results.
 Data validation assigned a J qualifier to all nine gross-beta detect results.
 Three sample locations (BM 26-34C, BM 26-22B, and BM 36-13B) provided insufficient amounts of production water for gross alpha and gross beta analysis. No production water was collected from well BM 26-33D.

Table 4c. Summary of Potassium-40 Liquid-Phase Samples Based on Laboratory-Assigned Qualifiers

Collection Location	Total Liquid Samples Collected	Potassium-40 Results		
		Detect	Nondetect	NA
Natural gas wells	13	2	7	4

Notes:

Data validation assigned a J qualifier to both potassium-40 detect results. Three sample locations (BM 26-34C, BM 26-22B, and BM 36-13B) produced insufficient amounts of production water for potassium-40 analysis. No production water was collected from well BM 26-33D.

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Data Review and Validation Report

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Data Validation Package

March 2014
Produced Water Sampling at the
Rulison, Colorado, Site

July 2014



U.S. DEPARTMENT OF
ENERGY

Legacy
Management

Available for sale to the public from:

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Attachment 1—Data Presentation

Produced Water Data

Attachment 2—Trip Report

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Sampling Event Summary

Site: Rulison, Colorado, Site March 20, 2014

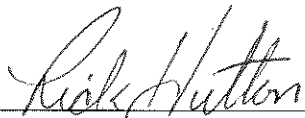
Sampling Period: Month Day, Year

The U.S. Department of Energy Office of Legacy Management conducted sampling at the Rulison, Colorado, Site on March 20, 2013, in accordance with the 2010 *Rulison Monitoring Plan*. The Monitoring Plan provides guidance regarding the type and frequency of sample collection as a function of distance and heading from the Rulison detonation point; it also specifies the types of analyses. Produced water samples are analyzed for radionuclides to determine if contamination is migrating from the Rulison detonation zone to producing gas wells. Samples were submitted for analysis as follows:

- Produced water samples were submitted under requisition 14036004 to ALS Laboratory Group in Fort Collins, Colorado, for the determination of chloride, gross alpha/beta, gamma emitting nuclides, and tritium.

Sampling and analyses were conducted as specified in the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351, continually updated).


Sample radionuclide results are compared to the screening levels listed in the Monitoring Plan to determine if any further action is merited. None of the results for the 12 wells sampled during this event exceeded the screening levels specified in the Monitoring Plan. The produced water sample results are presented in Attachment 1.



Rick Hutton

Site Lead

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Date



Rulison, Colorado, Site, Sample Location Map

Data Assessment Summary

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Water Sampling Field Activities Verification Checklist

Project	<u>Rulison, Colorado</u>	Date(s) of Water Sampling	<u>March 20, 2014</u>
Date(s) of Verification	<u>June 30, 2014</u>	Name of Verifier	<u>Stephen Donovan</u>

	Response (Yes, No, NA)	Comments
1. Is the SAP the primary document directing field procedures? List any Program Directives or other documents, SOPs, instructions.	<u>Yes</u>	
2. Were the sampling locations specified in the planning documents sampled?	<u>No</u>	<u>Gross alpha/beta, gamma emitting nuclide samples were not collected from wells BM 26-22B, BM 26-34C, and BM 36-13B due to the limited volume of produced water available.</u>
3. Were calibrations conducted as specified in the above-named documents?	<u>NA</u>	<u>Field measurements were not required.</u>
4. Was an operational check of the field equipment conducted daily? Did the operational checks meet criteria?	<u>NA</u>	
5. Were the number and types (alkalinity, temperature, specific conductance, pH, turbidity, DO, ORP) of field measurements taken as specified?	<u>NA</u>	
6. Were wells categorized correctly?	<u>NA</u>	<u>This sampling event did not include groundwater.</u>
7. Were the following conditions met when purging a Category I well: Was one pump/tubing volume purged prior to sampling? Did the water level stabilize prior to sampling? Did pH, specific conductance, and turbidity measurements meet criteria prior to sampling? Was the flow rate less than 500 mL/min?	<u>NA</u>	<u>This sampling event did not include groundwater.</u>

Water Sampling Field Activities Verification Checklist (continued)

	Response (Yes, No, NA)	Comments
8. Were the following conditions met when purging a Category II well: Was the flow rate less than 500 mL/min? Was one pump/tubing volume removed prior to sampling?	NA	This sampling event did not include groundwater.
9. Were duplicates taken at a frequency of one per 20 samples?	No	
10. Were equipment blanks taken at a frequency of one per 20 samples that were collected with non-dedicated equipment?	NA	
11. Were trip blanks prepared and included with each shipment of VOC samples?	NA	
12. Were the true identities of the QC samples documented?	Yes	
13. Were samples collected in the containers specified?	Yes	
14. Were samples filtered and preserved as specified?	Yes	
15. Were the number and types of samples collected as specified?	Yes	
16. Were chain of custody records completed and was sample custody maintained?	Yes	
17. Was all pertinent information documented on the field data sheets?	Yes	
18. Was the presence or absence of ice in the cooler documented at every sample location?	NA	Sample cooling was not required.
19. Were water levels measured at the locations specified in the planning documents?	NA	

Laboratory Performance Assessment

General Information

Requisition No. (RIN): 14036004
 Sample Event: March 20, 2014
 Site(s): Rulison Site
 Laboratory: ALS Laboratory Group, Fort Collins, Colorado
 Work Order No.: 1403415
 Analysis: Radiochemistry and Wet Chemistry
 Validator: Stephen Donovan
 Review Date: June 17, 2014

This validation was performed according to the *Environmental Procedures Catalog*, (LMS/POL/S04325, continually updated) "Standard Practice for Validation of Environmental Data." The procedure was applied at Level 3, Data Validation. See attached Data Validation Worksheets for supporting documentation on the data review and validation. All analyses were successfully completed. The samples were prepared and analyzed using accepted procedures based on methods specified by line item code, which are listed in Table 1.

Table 1. Analytes and Methods

Analyte	Line Item Code	Prep Method	Analytical Method
Chloride	WCH-B-011	EPA 300.0	EPA 300.0
Gamma Spectrometry	GAM-A-001	PA SOP713R11	PA SOP713R11
Gross Alpha/Beta	GPC-A-001	PA SOP702R19	PA SOP724R10
Tritium	LCS-A-001	PA SOP700R10	PA SOP704R9

Data Qualifier Summary

Analytical results were qualified as listed in Table 2. Refer to the sections below for an explanation of the data qualifiers applied.

Table 2. Data Qualifier Summary

Sample Number	Location	Analyte	Flag	Reason
1403415-2	BM 26-22C	Cesium-134	U	Nuclide identification criteria
1403415-2	BM 26-22C	Uranium-235	U	Nuclide identification criteria
1403415-2	BM 26-22C	Gross Alpha	J	Less than the determination limit
1403415-2	BM 26-22C	Gross Beta	J	Less than the determination limit
1403415-3	BM 26-22D	Gross Alpha	J	Less than the determination limit
1403415-4	BM 26-33B	Gross Alpha	U	Less than the decision level
1403415-4	BM 26-33B	Gross Beta	J	Less than the determination limit
1403415-5	BM 26-33C	Actinium-228	U	Nuclide identification criteria
1403415-5	BM 26-33C	Gross Beta	J	Less than the determination limit
1403415-6	BM 26-34A	Actinium-228	U	Nuclide identification criteria

Table 2 (continued). Data Qualifier Summary

Sample Number	Location	Analyte	Flag	Reason
1403415-6	BM 26-34A	Potassium-40	J	Less than the determination limit
1403415-6	BM 26-34A	Gross Beta	J	Less than the determination limit
1403415-7	BM 26-34B	Actinium-228	U	Nuclide identification criteria
1403415-7	BM 26-34B	Uranium-235	U	Nuclide identification criteria
1403415-7	BM 26-34B	Gross Alpha	J	Less than the determination limit
1403415-7	BM 26-34B	Gross Beta	J	Less than the determination limit
1403415-9	BM 26-34D	Actinium-228	U	Nuclide identification criteria
1403415-9	BM 26-34D	Gross Alpha	J	Less than the determination limit
1403415-9	BM 26-34D	Gross Beta	J	Less than the determination limit
1403415-10	BM 26-32A	Actinium-228	U	Nuclide identification criteria
1403415-11	BM 36-13	Actinium-228	U	Nuclide identification criteria
1403415-11	BM 36-13	Potassium-40	J	Less than the determination limit
1403415-11	BM 36-13	Gross Beta	J	Less than the determination limit

Sample Shipping/Receiving

ALS Laboratory Group in Fort Collins, Colorado, received 12 water samples on March 25, 2014, accompanied by a Chain of Custody form. The Chain of Custody form was checked to confirm that all of the samples were listed with sample collection dates and times, and that signatures and dates were present indicating sample relinquishment and receipt. Copies of the shipping labels were included in the receiving documentation. The Chain of Custody form was complete with no errors or omissions.

Preservation and Holding Times

The sample shipment was received intact at ambient temperature which complies with requirements. All samples were received in the correct container types and had been preserved correctly for the requested analyses. Sample analysis was completed within the applicable holding times.

Detection and Quantitation Limits

The method detection limit (MDL) was reported for all metal, organic, and wet chemical analytes as required. The MDL, as defined in 40 CFR 136, is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The practical quantitation limit (PQL) for these analytes is the lowest concentration that can be reliably measured, and is defined as 5 times the MDL.

For radiochemical analytes (those measured by radiometric counting) the MDL and PQL are not applicable, and these results are evaluated using the minimum detectable concentration (MDC), Decision Level Concentration (DLC), and Determination Limit (DL). The MDC is a measure of radiochemical method performance and was calculated and reported as specified in *Quality Systems for Analytical Services*. The DLC is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater

than zero, and is estimated as 3 times the one-sigma total propagated uncertainty. Results that are greater than the MDC, but less than the DLC are qualified with a “U” flag (not detected). The DL for radiochemical results is the lowest concentration that can be reliably measured, and is defined as 3 times the MDC. Results not previously “U” qualified that are less than the DL are qualified with a “J” flag as estimated values.

The reported MDLs for the wet chemical analytes and MDCs for radiochemical analytes met the detection limit requirements with the following exceptions. The required detection limits were not met for several gross alpha and gross beta samples because of the elevated levels of dissolved solids in the samples.

Laboratory Instrument Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for all analytes. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear curve. Compliance requirements for continuing calibration checks are established to ensure that the instrument continues to be capable of producing acceptable qualitative and quantitative data. All laboratory instrument calibrations were performed correctly in accordance with the cited methods. All calibration and laboratory spike standards were prepared from independent sources.

Method EPA 300.0, Chloride

Calibration for chloride was performed using five calibration standards on March 10, 2014. The calibration curve correlation coefficient values were greater than 0.995 and the absolute values of the intercepts were less than 3 times the MDL. Initial and continuing calibration verification checks were made at the required frequency with all calibration checks meeting the acceptance criteria.

Gamma Spectrometry

Activity concentrations above the MDC were reported in some instances where minimum nuclide identification criteria were not met. Such tentative identifications result when the software attempts to calculate net activity concentrations for analytes where either one or both of the following criteria are not satisfied: one or more characteristic peaks for a nuclide must be identified above the critical level, or the minimum library peak abundance must be attained. Sample results for gamma-emitting radionuclides that do not meet the identification criteria are qualified with a “U” flag as not detected.

Method and Calibration Blanks

Method blanks are analyzed to assess any contamination that may have occurred during sample preparation. Calibration blanks are analyzed to assess instrument contamination prior to and during sample analysis. All radiochemical method blank results were below the Decision Level Concentration.

Laboratory Control Sample

Laboratory control samples were analyzed at the correct frequency to provide information on the accuracy of the analytical method and the overall laboratory performance, including sample preparation. All control sample results were acceptable.

Laboratory Replicate Analysis

Laboratory replicate sample results demonstrate acceptable laboratory precision. The relative percent difference value for the chloride matrix spike replicate met the acceptance criteria. The radiochemical relative error ratio (calculated using the one-sigma total propagated uncertainty) for the sample replicates was less than three for all duplicates.

Matrix Spike Analysis

Matrix spike and matrix spike duplicate (MS/MSD) samples are used to measure method performance in the sample matrix. The MS/MSD data are not evaluated when the concentration of the unspiked sample is greater than 4 times the spike concentration. The spike recoveries met the recovery and precision criteria for all analytes evaluated.

Completeness

Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable (EDD) File

The EDD file arrived on April 1, 2014. The Sample Management System EDD validation module was used to verify that the EDD files were complete and in compliance with requirements. The module compares the contents of the file to the requested analyses to ensure all and only the requested data are delivered. The contents of the EDD were manually examined to verify that the sample results accurately reflect the data contained in the sample data package.

SAMPLE MANAGEMENT SYSTEM

General Data Validation Report

RIN: 14036004 Lab Code: PAR Validator: Stephen Donovan Validation Date: 06/17/2014

Project: Rulison Site Analysis Type: Metals General Chem Rad Organics

of Samples: 12 Matrix: WATER Requested Analysis Completed: Yes

Chain of Custody

Present: OK Signed: OK Dated: OK

Sample

Integrity: OK Preservation: OK Temperature: OK

Select Quality Parameters

- Holding Times
- Detection Limits
- Field/Trip Blanks
- Field Duplicates

All analyses were completed within the applicable holding times.

There are 18 detection limit failures.

SAMPLE MANAGEMENT SYSTEM

RIN: 14036004 Lab Code: PAR

Non-Compliance Report: Detection Limits

Project: Rulison Site

Validation Date: 06/17/2014

Ticket	Location	Lab Sample ID	Method Code	Lab Method	Analyte Name	Result	Qualifier	Reported Detection Limit	Required Detection Limit	Units
MEU 010	BM 26-22C	1403415-2	GPC-A-001	724R11	GROSS BETA	161		57	4	pCi/L
MEU 010	BM 26-22C	1403415-2	GPC-A-001	724R11	GROSS ALPHA	61.8		56	2	pCi/L
MEU 011	BM 26-22D	1403415-3	GPC-A-001	724R11	GROSS BETA	214		56	4	pCi/L
MEU 011	BM 26-22D	1403415-3	GPC-A-001	724R11	GROSS ALPHA	88.4		51	2	pCi/L
MEU 005	BM 26-33B	1403415-4	GPC-A-001	724R11	GROSS BETA	95.3		54	4	pCi/L
MEU 005	BM 26-33B	1403415-4	GPC-A-001	724R11	GROSS ALPHA	51.4		51	2	pCi/L
MEU 006	BM 26-33C	1403415-5	GPC-A-001	724R11	GROSS BETA	119		45	4	pCi/L
MEU 006	BM 26-33C	1403415-5	GPC-A-001	724R11	GROSS ALPHA	38.1	U	47	2	pCi/L
MEU 019	BM 26-34A	1403415-6	GPC-A-001	724R11	GROSS BETA	222		76	4	pCi/L
MEU 019	BM 26-34A	1403415-6	GPC-A-001	724R11	GROSS ALPHA	51.1	U	74	2	pCi/L
MEU 008	BM 26-34B	1403415-7	GPC-A-001	724R11	GROSS BETA	97		56	4	pCi/L
MEU 008	BM 26-34B	1403415-7	GPC-A-001	724R11	GROSS ALPHA	78.2		64	2	pCi/L
MEU 009	BM 26-34D	1403415-9	GPC-A-001	724R11	GROSS BETA	132		56	4	pCi/L
MEU 009	BM 26-34D	1403415-9	GPC-A-001	724R11	GROSS ALPHA	72		58	2	pCi/L
MEU 012	BM 35-32A	1403415-10	GPC-A-001	724R11	GROSS BETA	132		43	4	pCi/L
MEU 012	BM 35-32A	1403415-10	GPC-A-001	724R11	GROSS ALPHA	29.7	U	46	2	pCi/L
MEU 013	BM 36-13	1403415-11	GPC-A-001	724R11	GROSS BETA	120		57	4	pCi/L
MEU 013	BM 36-13	1403415-11	GPC-A-001	724R11	GROSS ALPHA	32.7	U	55	2	pCi/L

SAMPLE MANAGEMENT SYSTEM
Radiochemistry Data Validation Worksheet

RIN: 14036004 **Lab Code:** PAR **Date Due:** 04/22/2014
Matrix: Water **Site Code:** RUL01 **Date Completed:** 04/02/2014

Sample	Analyte	Date Analyzed	Result	Flag	Tracer %R	LCS %R	MS %R	Duplicate
BM 26-33B	Actinium-228	03/28/2014						0.36
BM 26-33B	Americium-241	03/28/2014						0.79
Blank_Spike	Americium-241	03/29/2014				93.40		
BM 26-33B	Antimony-125	03/28/2014						0.56
BM 26-33B	Cerium-144	03/28/2014						0.26
BM 26-33B	Cesium-134	03/28/2014						0.76
BM 26-33B	Cesium-137	03/28/2014						0.08
Blank_Spike	Cesium-137	03/29/2014				103.00		
BM 26-33B	Cobalt-60	03/28/2014						1.45
Blank_Spike	Cobalt-60	03/29/2014				99.20		
BM 26-33B	Europium-152	03/28/2014						2.10
BM 26-33B	Europium-154	03/28/2014						0.43
BM 26-33B	Europium-155	03/28/2014						1.37
BM 26-33B	GROSS ALPHA	03/28/2014						0.08
Blank	GROSS ALPHA	03/29/2014	0.5270	U				
BM 26-34A	GROSS ALPHA	03/29/2014					80.2	
Blank_Spike	GROSS ALPHA	03/29/2014				104.00		
BM 26-33B	GROSS BETA	03/28/2014						0.35
Blank_Spike	GROSS BETA	03/29/2014				99.60		
BM 26-34A	GROSS BETA	03/29/2014					102.0	
Blank	GROSS BETA	03/29/2014	0.8760	U				
BM 26-34C	H-3	03/29/2014						0.96
Blank_Spike	H-3	03/29/2014				103.00		
BM 26-34B	H-3	03/29/2014					99.8	
Blank	H-3	03/29/2014	140.0000	U				
BM 26-33B	Lead-212	03/28/2014						0.10
BM 26-33B	Potassium-40	03/28/2014						0.20
BM 26-33B	Promethium-144	03/28/2014						0.56
BM 26-33B	Promethium-146	03/28/2014						1.79
BM 26-33B	Ruthenium-106	03/28/2014						0.25
BM 26-33B	Thorium-234	03/28/2014						0.39
BM 26-33B	Uranium-235	03/28/2014						0.49

SAMPLE MANAGEMENT SYSTEM
Radiochemistry Data Validation Worksheet

RIN: 14036004 **Lab Code:** PAR **Date Due:** 04/22/2014
Matrix: Water **Site Code:** RUL01 **Date Completed:** 04/02/2014

Sample	Analyte	Date Analyzed	Result	Flag	Tracer %R	LCS %R	MS %R	Duplicate
BM 26-33B	Yttrium-88	03/28/2014						0.96

SAMPLE MANAGEMENT SYSTEM
Wet Chemistry Data Validation Worksheet

RIN: 14036004 **Lab Code:** PAR **Date Due:** 04/22/2014
Matrix: Water **Site Code:** RUL01 **Date Completed:** 04/02/2014

Analyte	Date Analyzed	CALIBRATION				Method Blank	LCS %R	MS %R	MSD %R	DUP RPD	Serial Dil. %R
		Int.	R^2	CCV	CCB						
CHLORIDE	03/28/2014	0.000	1.0000	OK	OK	OK	98.00				

Sampling Quality Control Assessment

The following information summarizes and assesses quality control for this sampling event.

Sampling Protocol

The produced water samples were collected from a tap on a common line connecting the output of two separators (each servicing a well) and the nearby accumulation tanks. The collected water sample from one separator was isolated from the other separator by valves. Lines from each of the two separators were purged before sample collection.

Equipment Blank Assessment

An equipment blank was not required.

Field Duplicate Assessment

A field duplicate was not collected.

Certification

All laboratory analytical quality control criteria were met except as qualified in this report. The data qualifiers listed on the SEEPro database reports are defined on the last page of each report. All data in this package are considered validated and available for use.

Laboratory Coordinator: Stephen Donovan 7-11-2014
Stephen Donovan Date

Data Validation Lead: Stephen Donovan 7-11-2014
Stephen Donovan Date

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Attachment 1

Data Presentation

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Produced Water Data

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General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-10840 WELL BM 36-13

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	31	TI	U	#	27	14.2
Americium-241	pCi/L	03/20/2014	N001	-7.67	U		#	23	13.6
Antimony-125	pCi/L	03/20/2014	N001	4.1	U		#	9.7	5.59
Cerium-144	pCi/L	03/20/2014	N001	8.74	U		#	17	10.6
Cesium-134	pCi/L	03/20/2014	N001	-3.99	U		#	4.3	2.51
Cesium-137	pCi/L	03/20/2014	N001	-1.46	U		#	4.6	2.67
Chloride	mg/L	03/20/2014	N001	10000			#	200	
Cobalt-60	pCi/L	03/20/2014	N001	-.24	U		#	4.8	2.75
Europium-152	pCi/L	03/20/2014	N001	10.9	U		#	22	13.4
Europium-154	pCi/L	03/20/2014	N001	0.853	U		#	35	20.6
Europium-155	pCi/L	03/20/2014	N001	1.16	U		#	10	6
Gross Alpha	pCi/L	03/20/2014	N001	32.7	U		#	55	34.4
Gross Beta	pCi/L	03/20/2014	N001	120		J	#	57	40.9
Lead-212	pCi/L	03/20/2014	N001	7.05	U		#	12	7.52
Potassium-40	pCi/L	03/20/2014	N001	126		J	#	110	72.5
Promethium-144	pCi/L	03/20/2014	N001	-2.32	U		#	12	7.09
Promethium-146	pCi/L	03/20/2014	N001	-1.97	U		#	4.8	2.75
Ruthenium-106	pCi/L	03/20/2014	N001	-3.64	U		#	39	22.7

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-10840 WELL BM 36-13

Parameter	Units	Sample		Result	Qualifiers		Detection Limit	Uncertainty
		Date	ID		Lab	Data QA		
Thorium-234	pCi/L	03/20/2014	N001	5.97	U	#	120	72.6
Tritium	pCi/L	03/20/2014	N001	-286	U	#	350	203
Uranium-235	pCi/L	03/20/2014	N001	11	U	#	17	10.6
Yttrium-88	pCi/L	03/20/2014	N001	3.99	U	#	4.6	2.93

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-10919 WELL BM 35-32A

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	26.4	NQ	U	#	17	9.66
Americium-241	pCi/L	03/20/2014	N001	1.41	U		#	5.2	3.14
Antimony-125	pCi/L	03/20/2014	N001	1.49	U		#	9.5	5.64
Cerium-144	pCi/L	03/20/2014	N001	3.78	U		#	15	9.18
Cesium-134	pCi/L	03/20/2014	N001	0.367	U		#	4.2	2.49
Cesium-137	pCi/L	03/20/2014	N001	-1.36	U		#	4.7	2.71
Chloride	mg/L	03/20/2014	N001	9200			#	100	
Cobalt-60	pCi/L	03/20/2014	N001	1.65	U		#	5.2	3.11
Europium-152	pCi/L	03/20/2014	N001	8.71	U		#	24	14.6
Europium-154	pCi/L	03/20/2014	N001	-5.49	U		#	27	15.5
Europium-155	pCi/L	03/20/2014	N001	0.762	U		#	7.3	4.36
Gross Alpha	pCi/L	03/20/2014	N001	29.7	U		#	46	28.8
Gross Beta	pCi/L	03/20/2014	N001	132			#	43	35
Lead-212	pCi/L	03/20/2014	N001	-.787	U		#	13	7.66
Potassium-40	pCi/L	03/20/2014	N001	109	U		#	140	86.8
Promethium-144	pCi/L	03/20/2014	N001	0.525	U		#	5	2.96
Promethium-146	pCi/L	03/20/2014	N001	-1.61	U		#	4.6	2.67
Ruthenium-106	pCi/L	03/20/2014	N001	5.67	U		#	39	23

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-10919 WELL BM 35-32A

Parameter	Units	Sample		Result	Qualifiers		Detection Limit	Uncertainty
		Date	ID		Lab	Data QA		
Thorium-234	pCi/L	03/20/2014	N001	11.5	U	#	76	38.2
Tritium	pCi/L	03/20/2014	N001	-237	U	#	360	210
Uranium-235	pCi/L	03/20/2014	N001	-14.6	U	#	36	21.3
Yttrium-88	pCi/L	03/20/2014	N001	-4.18	U	#	18	10.6

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-15469 WELL BM 36-13B

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Chloride	mg/L	03/20/2014	N001	11000			#	200	
Tritium	pCi/L	03/20/2014	N001	-.293	U		#	360	213

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-15741 WELL BM 26-34C

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Chloride	mg/L	03/20/2014	N001	10000			#	200	
Tritium	pCi/L	03/20/2014	N001	-149	U		#	350	206

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-15742 WELL BM 26-33C

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	23.2	TI	U	#	22	11.5
Americium-241	pCi/L	03/20/2014	N001	- .793	U		#	4.2	2.48
Antimony-125	pCi/L	03/20/2014	N001	3.21	U		#	8.7	4.93
Cerium-144	pCi/L	03/20/2014	N001	4.9	U		#	14	8.23
Cesium-134	pCi/L	03/20/2014	N001	-2.34	U		#	3.8	2.19
Cesium-137	pCi/L	03/20/2014	N001	-2.88	U		#	3.9	2.21
Chloride	mg/L	03/20/2014	N001	9300			#	100	
Cobalt-60	pCi/L	03/20/2014	N001	0.576	U		#	3.8	2.25
Europium-152	pCi/L	03/20/2014	N001	-5.11	U		#	20	11.1
Europium-154	pCi/L	03/20/2014	N001	-3.58	U		#	22	12.7
Europium-155	pCi/L	03/20/2014	N001	1.71	U		#	5.7	3.43
Gross Alpha	pCi/L	03/20/2014	N001	38.1	U		#	47	30.2
Gross Beta	pCi/L	03/20/2014	N001	119		J	#	45	34.6
Lead-212	pCi/L	03/20/2014	N001	3.22	U		#	10	6.15
Potassium-40	pCi/L	03/20/2014	N001	53.4	U		#	110	65
Promethium-144	pCi/L	03/20/2014	N001	-.0404	U		#	3.7	2.18
Promethium-146	pCi/L	03/20/2014	N001	1.38	U		#	4	2.44
Ruthenium-106	pCi/L	03/20/2014	N001	9.62	U		#	33	20

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-15742 WELL BM 26-33C

Parameter	Units	Sample		Result	Qualifiers		Detection Limit	Uncertainty
		Date	ID		Lab	Data QA		
Thorium-234	pCi/L	03/20/2014	N001	10.9	U	#	72	43.6
Tritium	pCi/L	03/20/2014	N001	-282	U	#	360	209
Uranium-235	pCi/L	03/20/2014	N001	4.02	U	#	20	11.9
Yttrium-88	pCi/L	03/20/2014	N001	1.8	U	#	3.9	2.36

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-15743 WELL BM 26-33B

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	12.9	U		#	35	21.3
Americium-241	pCi/L	03/20/2014	N001	-4.43	U		#	7.2	4.06
Antimony-125	pCi/L	03/20/2014	N001	3.87	U		#	14	8.11
Cerium-144	pCi/L	03/20/2014	N001	4.08	U		#	22	13.2
Cesium-134	pCi/L	03/20/2014	N001	-1.98	U		#	6.1	3.49
Cesium-137	pCi/L	03/20/2014	N001	-.221	U		#	6	3.47
Chloride	mg/L	03/20/2014	N001	9500			#	200	
Cobalt-60	pCi/L	03/20/2014	N001	-3.01	U		#	7	3.73
Europium-152	pCi/L	03/20/2014	N001	-15.3	U		#	35	18.6
Europium-154	pCi/L	03/20/2014	N001	4.48	U		#	35	20.1
Europium-155	pCi/L	03/20/2014	N001	-.256	U		#	9.3	5.44
Gross Alpha	pCi/L	03/20/2014	N001	51.4		U	#	51	33.8
Gross Beta	pCi/L	03/20/2014	N001	95.3		J	#	54	37.4
Lead-212	pCi/L	03/20/2014	N001	4.94	U		#	11	6.92
Potassium-40	pCi/L	03/20/2014	N001	20.1	U		#	120	73.3
Promethium-144	pCi/L	03/20/2014	N001	-2.42	U		#	6.8	3.86
Promethium-146	pCi/L	03/20/2014	N001	-4.66	U		#	11	6.25
Ruthenium-106	pCi/L	03/20/2014	N001	-3.69	U		#	56	32.1

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-15743 WELL BM 26-33B

Parameter	Units	Sample		Result	Qualifiers		Detection Limit	Uncertainty
		Date	ID		Lab	Data QA		
Thorium-234	pCi/L	03/20/2014	N001	-21.1	U	#	81	48
Tritium	pCi/L	03/20/2014	N001	-29.6	U	#	360	212
Uranium-235	pCi/L	03/20/2014	N001	-.151	U	#	27	16
Yttrium-88	pCi/L	03/20/2014	N001	1.2	U	#	6.5	3.81

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-15744 WELL BM 26-34A

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	28	NQ	U	#	18	10.7
Americium-241	pCi/L	03/20/2014	N001	-625	U		#	5.3	3.14
Antimony-125	pCi/L	03/20/2014	N001	4.39	U		#	9.4	5.45
Cerium-144	pCi/L	03/20/2014	N001	-4.65	U		#	16	9.14
Cesium-134	pCi/L	03/20/2014	N001	-2.43	U		#	4.3	2.45
Cesium-137	pCi/L	03/20/2014	N001	-3.23	U		#	4.5	2.53
Chloride	mg/L	03/20/2014	N001	14000			#	200	
Cobalt-60	pCi/L	03/20/2014	N001	-1.28	U		#	5.4	3.08
Europium-152	pCi/L	03/20/2014	N001	-5.5	U		#	25	14.3
Europium-154	pCi/L	03/20/2014	N001	-7.06	U		#	26	15.1
Europium-155	pCi/L	03/20/2014	N001	3.87	U		#	7.3	4.46
Gross Alpha	pCi/L	03/20/2014	N001	51.1	U		#	74	46.7
Gross Beta	pCi/L	03/20/2014	N001	222		J	#	76	60.4
Lead-212	pCi/L	03/20/2014	N001	-2.12	U		#	12	7.37
Potassium-40	pCi/L	03/20/2014	N001	138		J	#	140	86.6
Promethium-144	pCi/L	03/20/2014	N001	-1.2	U		#	5	2.9
Promethium-146	pCi/L	03/20/2014	N001	-807	U		#	4.6	2.65
Ruthenium-106	pCi/L	03/20/2014	N001	-20.8	U		#	41	23.7

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-15744 WELL BM 26-34A

Parameter	Units	Sample		Result	Qualifiers		Detection Limit	Uncertainty
		Date	ID		Lab	Data QA		
Thorium-234	pCi/L	03/20/2014	N001	10.3	U	#	78	39.2
Tritium	pCi/L	03/20/2014	N001	-172	U	#	350	205
Uranium-235	pCi/L	03/20/2014	N001	10.5	U	#	16	9.7
Yttrium-88	pCi/L	03/20/2014	N001	-2.36	U	#	18	10.6

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-15745 WELL BM 26-34B

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	20.3	TI	U	#	19	11
Americium-241	pCi/L	03/20/2014	N001	-10.2	U		#	23	13.5
Antimony-125	pCi/L	03/20/2014	N001	0.065	U		#	9.7	5.39
Cerium-144	pCi/L	03/20/2014	N001	0.879	U		#	17	10.3
Cesium-134	pCi/L	03/20/2014	N001	-.266	U		#	4.2	2.47
Cesium-137	pCi/L	03/20/2014	N001	-.528	U		#	4.7	2.73
Chloride	mg/L	03/20/2014	N001	11000			#	200	
Cobalt-60	pCi/L	03/20/2014	N001	-1.16	U		#	4.8	2.76
Europium-152	pCi/L	03/20/2014	N001	13.9	U		#	20	12.7
Europium-154	pCi/L	03/20/2014	N001	-10.7	U		#	26	14.5
Europium-155	pCi/L	03/20/2014	N001	2.88	U		#	10	6.05
Gross Alpha	pCi/L	03/20/2014	N001	78.2		J	#	64	43.6
Gross Beta	pCi/L	03/20/2014	N001	97		J	#	56	38.2
Lead-212	pCi/L	03/20/2014	N001	5.09	U		#	12	7.22
Potassium-40	pCi/L	03/20/2014	N001	28.9	U		#	110	69
Promethium-144	pCi/L	03/20/2014	N001	-2.99	U		#	12	7.07
Promethium-146	pCi/L	03/20/2014	N001	-2.83	U		#	4.6	2.63
Ruthenium-106	pCi/L	03/20/2014	N001	-9.54	U		#	38	22.3

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-15745 WELL BM 26-34B

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Thorium-234	pCi/L	03/20/2014	N001	17.1	U		#	120	70.5
Tritium	pCi/L	03/20/2014	N001	-90.7	U		#	360	210
Uranium-235	pCi/L	03/20/2014	N001	13.4	TI	U	#	12	7.9
Yttrium-88	pCi/L	03/20/2014	N001	2.64	U		#	4.4	2.7

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-15748 WELL BM 26-34D

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	24.8		U	#	20	11
Americium-241	pCi/L	03/20/2014	N001	-.187	U		#	4.3	2.57
Antimony-125	pCi/L	03/20/2014	N001	4.56	U		#	8.6	4.85
Cerium-144	pCi/L	03/20/2014	N001	4.03	U		#	14	8.34
Cesium-134	pCi/L	03/20/2014	N001	-3.07	U		#	3.9	2.25
Cesium-137	pCi/L	03/20/2014	N001	-.354	U		#	3.7	2.15
Chloride	mg/L	03/20/2014	N001	12000			#	200	
Cobalt-60	pCi/L	03/20/2014	N001	-.496	U		#	3.9	2.21
Europium-152	pCi/L	03/20/2014	N001	2.05	U		#	20	11.9
Europium-154	pCi/L	03/20/2014	N001	-5.37	U		#	22	12.9
Europium-155	pCi/L	03/20/2014	N001	0.821	U		#	5.7	3.39
Gross Alpha	pCi/L	03/20/2014	N001	72		J	#	58	39.9
Gross Beta	pCi/L	03/20/2014	N001	132		J	#	56	41.3
Lead-212	pCi/L	03/20/2014	N001	7.01	U		#	10	6.33
Potassium-40	pCi/L	03/20/2014	N001	81.9	U		#	110	66.7
Promethium-144	pCi/L	03/20/2014	N001	-1.33	U		#	3.9	2.25
Promethium-146	pCi/L	03/20/2014	N001	-.276	U		#	4.1	2.41
Ruthenium-106	pCi/L	03/20/2014	N001	-5.93	U		#	33	19.3

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-15748 WELL BM 26-34D

Parameter	Units	Sample		Result	Qualifiers		Detection Limit	Uncertainty
		Date	ID		Lab	Data QA		
Thorium-234	pCi/L	03/20/2014	N001	-4.92	U	#	72	43.7
Tritium	pCi/L	03/20/2014	N001	123	U	#	360	219
Uranium-235	pCi/L	03/20/2014	N001	4.72	U	#	14	8.27
Yttrium-88	pCi/L	03/20/2014	N001	2	U	#	3.9	2.4

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-16074 WELL BM 26-22D

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	18.5	U		#	22	11.7
Americium-241	pCi/L	03/20/2014	N001	-20.4	U		#	28	16.2
Antimony-125	pCi/L	03/20/2014	N001	0.52	U		#	10	6.17
Cerium-144	pCi/L	03/20/2014	N001	-3.6	U		#	20	12
Cesium-134	pCi/L	03/20/2014	N001	-2.13	U		#	4.6	2.69
Cesium-137	pCi/L	03/20/2014	N001	0.935	U		#	4	2.42
Chloride	mg/L	03/20/2014	N001	12000			#	200	
Cobalt-60	pCi/L	03/20/2014	N001	1.42	U		#	4.6	2.76
Europium-152	pCi/L	03/20/2014	N001	-2.84	U		#	24	13.9
Europium-154	pCi/L	03/20/2014	N001	3.72	U		#	24	14.2
Europium-155	pCi/L	03/20/2014	N001	0.375	U		#	10	6.13
Gross Alpha	pCi/L	03/20/2014	N001	88.4		J	#	51	37.9
Gross Beta	pCi/L	03/20/2014	N001	214			#	56	50.2
Lead-212	pCi/L	03/20/2014	N001	8.4	U		#	12	7.34
Potassium-40	pCi/L	03/20/2014	N001	106	U		#	130	79.2
Promethium-144	pCi/L	03/20/2014	N001	-5.87	U		#	18	10.8
Promethium-146	pCi/L	03/20/2014	N001	0.902	U		#	4.8	2.86
Ruthenium-106	pCi/L	03/20/2014	N001	-14.4	U		#	40	23.1

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site
REPORT DATE: 06/30/2014
Location: 05-045-16074 WELL BM 26-22D

Parameter	Units	Sample		Result	Qualifiers		Detection Limit	Uncertainty
		Date	ID		Lab	Data QA		
Thorium-234	pCi/L	03/20/2014	N001	-28.2	U	#	130	76.5
Tritium	pCi/L	03/20/2014	N001	-24.2	U	#	360	213
Uranium-235	pCi/L	03/20/2014	N001	13.9	U	#	19	9.65
Yttrium-88	pCi/L	03/20/2014	N001	2.23	U	#	4.9	3

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-16086 WELL BM 26-22B

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Chloride	mg/L	03/20/2014	N001	9000			#	200	
Tritium	pCi/L	03/20/2014	N001	-83.8	U		#	360	213

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-16087 WELL BM 26-22C

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Actinium-228	pCi/L	03/20/2014	N001	17.3	U		#	30	18.3
Americium-241	pCi/L	03/20/2014	N001	27.9	U		#	130	80.4
Antimony-125	pCi/L	03/20/2014	N001	7.47	U		#	9.8	5.22
Cerium-144	pCi/L	03/20/2014	N001	7.69	U		#	23	14
Cesium-134	pCi/L	03/20/2014	N001	4.5	NQ	U	#	3.2	2.13
Cesium-137	pCi/L	03/20/2014	N001	-.323	U		#	4	2.35
Chloride	mg/L	03/20/2014	N001	10000			#	200	
Cobalt-60	pCi/L	03/20/2014	N001	1.09	U		#	4.1	2.41
Europium-152	pCi/L	03/20/2014	N001	4.33	U		#	19	11.1
Europium-154	pCi/L	03/20/2014	N001	-.268	U		#	20	11.8
Europium-155	pCi/L	03/20/2014	N001	7.23	U		#	16	10
Gross Alpha	pCi/L	03/20/2014	N001	61.8			J #	56	37.8
Gross Beta	pCi/L	03/20/2014	N001	161			J #	57	45
Lead-212	pCi/L	03/20/2014	N001	10.5	U		#	11	6.77
Potassium-40	pCi/L	03/20/2014	N001	85.6	U		#	120	75.6
Promethium-144	pCi/L	03/20/2014	N001	-.168	U		#	4.1	2.44
Promethium-146	pCi/L	03/20/2014	N001	-.344	U		#	4.8	2.83
Ruthenium-106	pCi/L	03/20/2014	N001	-12.6	U		#	72	42.9

General Water Quality Data by Location (USEE105) FOR SITE RUL01, Rulison Site

REPORT DATE: 06/30/2014

Location: 05-045-16087 WELL BM 26-22C

Parameter	Units	Sample		Result	Qualifiers			Detection Limit	Uncertainty
		Date	ID		Lab	Data	QA		
Thorium-234	pCi/L	03/20/2014	N001	-42.7	U		#	200	123
Tritium	pCi/L	03/20/2014	N001	-94.3	U		#	360	211
Uranium-235	pCi/L	03/20/2014	N001	24.5	NQ	U	#	22	14
Yttrium-88	pCi/L	03/20/2014	N001	-1.1	U		#	8.4	4.96

SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LAB QUALIFIERS:

- * Replicate analysis not within control limits.
- > Result above upper detection limit.
- A TIC is a suspected aldol-condensation product.
- B Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
- C Pesticide result confirmed by GC-MS.
- D Analyte determined in diluted sample.
- E Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
- H Holding time expired, value suspect.
- I Increased detection limit due to required dilution.
- J Estimated
- N Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compound (TIC).
- P > 25% difference in detected pesticide or Aroclor concentrations between 2 columns.
- U Analytical result below detection limit.
- W Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
- X,Y,Z Laboratory defined qualifier, see case narrative.

DATA QUALIFIERS:

- F Low flow sampling method used.
- L Less than 3 bore volumes purged prior to sampling.
- U Parameter analyzed for but was not detected.
- G Possible grout contamination, pH > 9.
- Q Qualitative result due to sampling technique.
- X Location is undefined.
- J Estimated value.
- R Unusable result.

QA QUALIFIER:

- # Validated according to quality assurance guidelines.

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Attachment 2

Trip Report

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**Trip Report
Natural Gas Wells
Near Project Rulison
Second Quarter 2014**

**U.S. Department of Energy Office of Legacy Management
Grand Junction, Colorado**

Date Sampled:

March 20, 2014

Background:

Project Rulison was the second Plowshare Program test to investigate using a nuclear device to stimulate natural gas recovery from deep and low-permeability formations. On September 10, 1969, a 40-kiloton-yield nuclear device was detonated 8,426 feet (1.6 miles) below the ground surface in the Williams Fork Formation at what is now the Rulison, Colorado, Site. Following the detonation, a series of production tests were conducted. Afterward, the site was shut down and later remediated, and the emplacement well (R-E) and reentry well (R-Ex) were plugged.

Purpose:

As part of the U.S. Department of Energy (DOE) Office of Legacy Management (LM) mission to protect human health and the environment, LM is monitoring natural gas wells that are near the Rulison site for radionuclides associated with the detonation. Even though the very low permeability of the Williams Fork Formation limits migration, institutional control restrictions limit subsurface access in the detonation zone. Oversight is permitted for wells within 3 miles of the site, which allows the State of Colorado and DOE to review drilling permits and gas well development practices to help protect human health and the environment from the Rulison-related contaminants. The DOE *Rulison Monitoring Plan* (LMS/RUL/S06178) provides guidance for sample collection frequency based on distance from the Rulison detonation point, the types of analyses, and the reporting thresholds. The purpose of this trip was to collect natural gas and production water from producing natural gas wells in the Battlement Mesa (BM) field. The sampled wells collect natural gas from the formation horizon where the Project Rulison detonation occurred. The well locations are within 1.5 miles of the detonation location.

Summary of Results:

The following wells were sampled: seven producing gas wells on Pad 26N, three gas wells on Pad 26K, one well on Pad 35C, one well on Pad 36L, and one well on Pad 36B.

For the 10 wells sampled on Pads 26N and 26K, the bottom-hole locations are between 0.76 mile and 1.1 miles from the Project Rulison vertical emplacement well 25-95 (R-E). Wells on Pads

35C and 36L are approximately 0.95 mile from the detonation point. The well on Pad 36B is approximately 0.55 mile southeast of well 25-95 (R-E). Surface projections of the bottom-hole well locations and Project Rulison surface ground zero at well 25-95 (R-E) (i.e., the detonation point) are shown in Figure 1.



Notes:

All wells sampled have been previously sampled by DOE.

The first two numerals in the well name designate the section number of the bottom-well location in the Battlement Mesa (BM) field.

The Project Rulison emplacement well, 25-95 (R-E) (i.e., ground zero), is located in Lot 11, Section 25.

Figure 1. Wells Sampled and Well 25-95 (R-E)

The wells are listed by sample-collection sequence in Table 1. Before sample collection at each well, each individual well's pressure and temperature (see Table 1) were read and recorded from surface transducers in the wells. Latitude and longitude values (not shown in Table 1) were compiled from survey plats included with the applications for permits to drill and from Colorado Oil and Gas Conservation Commission scout cards.

During the December 2013 monitoring event, weather conditions caused several production stations to freeze and cause higher than normal line pressures to be observed. At some wells the high wellhead pressure prohibited the production water plunger from traveling up the wells to purge production water. During the March, 2014 monitoring event, pressures and line temperatures returned to normal ranges.

A total of 9 production water samples for total analysis were collected. At three locations 26-34C, 26-22B and 36-13B, only 250 mL of production water were collected. At well location 26-33D no production water was collected. At the three locations where 250 ml of production water was collected, which is only enough material for tritium analysis. A duplicate sample was collected from well and is noted in Table 1. All other well functions were performing normally, so no impact to contaminant analysis data is expected.

Table 1. Samples Collected

Sample Collection Sequence	Pad	Well Name	Location			Sample Phase		Well	
			API # 05-045-	Type	Subtype	Gas	Liquid	T (°F)	P (psi)
1	26N	BM 26-33B	15739	WL	NGSA	No	Yes	69	271
2	26N	BM 26-33C	15742	WL	NGSA	No	Yes	52	250
3	26N	BM 26-33D	15743	WL	NGSA	No	No	71.5	268
4	26N	BM 26-34A	15744	WL	NGSA	No	Yes	66.3	275
5	26N	BM 26-34B	15745	WL	NGSA	No	Yes	66.8	231
6	26N	BM 26-34C	15741	WL	NGSA	No	Yes ¹	61	262
7	26N	BM 26-34D	15748	WL	NGSA	No	Yes	63.4	261
8	26K	BM 26-22B	16086	WL	NGSA	No	Yes ¹	68	271
9	26K	BM 26-22C	16087	WL	NGSA	No	Yes	61	263
10	26K	BM 26-22D	16074	WL	NGSA	No	Yes	63	265
11	35C	BM 35-32A	10919	WL	NGSV	No	Yes	61	272
12	36L	BM 36-13B	15469	WL	NGSV	No	Yes ¹	68	279
13	36B	BM 36-13	10840	WL	NGSV	No	Yes	67	281

Notes:

¹ BM 26-34C, BM 26-22B, and BM36-13B produced approximately 250 mL of production water, which is enough sample volume for only tritium analysis.

Abbreviations:

API American Petroleum Institute
 BM Battlement Mesa
 NGSA natural gas well–angle
 NGSV natural gas well–vertical
 P (psi) pressure in pounds per square inch
 T (°F) temperature in degrees Fahrenheit
 WL well

The produced water samples were collected from a tap on a common line connecting the output of two separators (each servicing a well) and the nearby accumulation tanks. The collected water sample from one separator was isolated from the other separator by valves. Lines from each of the two separators were purged before sample collection.

Water condensation is variable and often not desired for the planned analytes. Collected sample volumes (Table 2) varied due to the water vapor concentration in the gas, temperature, age of the well, the cycle times of the well plunger, and transfer to the accumulation tank. Analyses priorities are tritium, gross alpha/beta, technetium-99, and high-resolution gamma spectrometry.

If condensate was collected with a sample, which happens for most samples, the condensate naturally separated from water after a short time in the sample bottle. The condensate was decanted in the field and returned to the operator. Table 2 lists the estimated sample volumes before decanting.

Table 2. Collected Water Sample Volumes (Before Decanting)

Sample Ticket	Well Name	Planned Analytes	Sample Volume (L)
1	BM 26-33B	³ H, Gross α/β, Gamma spec, Cl ⁻ , ⁹⁹ Tc	≈ 2.5 L
2	BM 26-33C	³ H, Gross α/β, Gamma spec, Cl ⁻ , ⁹⁹ Tc	≈ 2.5L
3	BM 26-33D	NA	No Sample
4	BM 26-34A	³ H, Gross α/β, Gamma spec, Cl ⁻ , ⁹⁹ Tc	≈ 2.5 L
5	BM 26-34B	³ H, Gross α/β, Gamma spec, Cl ⁻ , ⁹⁹ Tc	≈ 2.5 L
6	BM 26-34C	³ H, only	≈ 250mLL
7	BM 26-34D		No Sample
8	BM 26- 22B	NA	No Sample
9	BM 26-22C	NA	No Sample
10	BM 26-22CD	NA	No Sample
11	BM 26-22D	NA	No Sample
12	BM 35-32A	³ H, Gross α/β, Gamma spec, Cl ⁻ , ⁹⁹ Tc	≈ 2.5 L
13	BM 36-13B	NA	No Sample
14	BM 36-13	³ H, Gross α/β, Gamma spec, Cl ⁻ , ⁹⁹ Tc	≈ 2.5 L

Notes:

Water sample information is listed in the order of collection.

The sample volume of water may include some condensate.

Wells BM 26-22B and BM 26-34A did not produce water for laboratory analyses; (historically these wells have not produced water during the sample collection).

Abbreviations:

- Cl⁻ chloride
- Gamma spec high-resolution gamma spectrometry analysis
- Gross α/β gross alpha and beta analyses
- ³H tritium
- L liter
- NA not applicable
- ⁹⁹Tc technetium-99

Equipment:

Each produced-water sample was collected in a new 1-gallon plastic bottle. After decanting, each water sample was poured into white high-density polyethylene bottles of appropriate volumes for analysis.