M.H. Chew & Associates, Inc.
Safety Professionals

7985 Vance Dr. Suite 307, Arvada, CO 80003
(303) 424-0007

# Independent Review of the

# Project Rulison Area Sampling - Annual Production Sampling Report Battlement Mesa 26-33C, Battlement Mesa 26-33B, & Rulison Federal 19-41C Tier I and Tier II Wells – June 2015

Prepared by
Robert L. Morris, CHP
Principal Health Physicist

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signature

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# 1. Executive Summary

The professional health physics staff of M. H. Chew & Associates, Inc., has performed an independent review of the laboratory reports, data quality assurance process and the conclusions presented in "Project Rulison Area Sampling - Annual Production Sampling Report Battlement Mesa 26-33C, Battlement Mesa 26-33B, & Rulison Federal 19-41C Tier I and Tier II Wells – June 2015" which was published in February 2106 by Olsson Associates on behalf of Caerus Oil and Gas, LLC.

The purpose of this review is to provide an independent assessment of the laboratory results, data quality assurance process, and the conclusions presented in the report. The report provides a summary of the voluminous data (approximately 1260 pages) resulting from sampling performed in accordance with the Rulison Sampling and Analysis Plan (RSAP) Revision 3 (*1*).

Our review concurs with the conclusion of the report that no Project Rulison-related radionuclides were detected in the three sampled wells.

Careful attention was given to the fact that tritium concentration above the method detection limit, but below the RSAP screening level, was found in a natural gas sample taken from I Battlement Mesa 26-33C Well on June 23, 2015. This is a Tier I well. A laboratory re-count of the same sample confirmed the result. At the same time Olsson Associates sampled this well, the US Department of Energy Office of Legacy Management (DOE) sampled the same well for the same analytes. The concentration of tritium in this natural gas sample was below the method detection limit. All prior samples from the same well were also below the method detection limit. On October 20, 2015, DOE re-sampled this well and found that the tritium in natural gas concentration was below the method detection limit. This review concurs with the report findings that the elevated result was most likely a false positive. At this time no action is required or recommended. However special attention should be given to this well when the next annual sample is collected in the summer of 2016.

Our review found an error in the report pertaining to the units of measurement for the sample re-count. The text states that the result was 17.047 ± 2.227 pCi/L. But according to the ISOTECH Laboratory report it should have been 17.047 ± 2.227 TU. We recommend that either the report be revised to correct the mistake or that an *errata* note explaining this mistake be associated with the hyperlink for the report when it is made available on the Colorado Oil and Gas Commission web site.

# 2. Introduction

The Colorado Oil and Gas Conservation Commission (COGCC) contracted with M. H. Chew & Associates, Inc., to review documents and practices associated with Project Rulison and Project Rio Blanco.

This document provides an independent review of the laboratory reports, data quality assurance process and the conclusions presented in "Project Rulison Area Sampling - Annual Production Sampling Report Battlement Mesa 26-33C, Battlement Mesa 26-33B, & Rulison Federal 19-41C Tier I and Tier II Wells – June 2015" ("the report") which was published in February 2106 by Olsson Associates on behalf of Caerus Oil and Gas, LLC.

The report presents data on three wells described in Table 1.

Table 1. Wells covered by the report.

| Pad | Well Name | Sampling Event | RSAP Category | RSAP Sector | First Production Date | Closest Well in Sector |
|---|---|---|---|---|---|---|
| 17M | Rulison Federal 19-4C | Year 6 Annual | Tier II | 2 | 07/15/2011 | Yes |
| 26N | Battlement Mesa 26-33B | Year 5 Annual | Tier I | 10 | 06/24/2010 | Yes |
| 26N | Battlement Mesa 26-33C | Year 5 Annual | Tier I | 9 | 05/27/2009 | Yes |

# 3. Concepts of Data Verification, Data Validation, and Data Assessment

Quality assurance systems are imposed on laboratory data to ensure accuracy and traceability to national standards, with the goal of supporting well informed, valid decisions. The U.S. EPA has formalized the data evaluation process for analysis of environmental samples intended for use in regulatory decision-making. The EPA process includes functional guidelines for data review. The EPA process has been widely adopted in other regulatory applications, and is appropriate for use at the Rulison Project. EPA QA/G-8 "Guidance on Environmental Data Verification and Data Validation" (*2*) is a good overview of the data quality assurance process.

Laboratories that conform to formal reporting standards are sometimes referred to as EPA Contract Laboratory Program (CLP) labs. Many laboratories do not conform to the EPA data evaluation process, especially those laboratories that do not specialize in environmental analyses. In those cases other quality assurance processes are applied to achieve the goal of accurate information sufficient to reach an appropriate decision. ISOTECH Laboratories does not conform to CLP protocol.

Clearly stated data quality objectives are the first part of the data evaluation process. Revision 3 of the RSAP (*1*) defines the data quality objectives which are comprised of the sample locations, kinds, frequency, minimum sensitivity and evaluation criteria. The specific requirements for data validation, including independent validation, are also in the RSAP.

Data verification, the next step in the quality assurance process, focuses on the aspects relevant to sample collection criteria that are specified in a standard, contract or plan. This is a systematic and mechanical determination of whether the samples were collected and handled in accordance with plan requirements (*2*). Data verification is typically part of the laboratory data review.

Data validation begins with the outputs from data verification. Data validation requires laboratory systems knowledge. Validation is to be done both by the laboratory and by a different party - one who is independent of the data collector and the data user. Validation is an analyte-specific and sample-specific process to determine the analytical quality of a specific data set (*2*). Validation is standard for laboratory reports that may be subject to legal proceedings because the data packages are likely to be self-sufficient when subjected to close scrutiny. Data qualifiers (codes that identify specific areas of concern) and nonconformance reports (NCR) may result from the validation review. These are discussed in the validation report.

Data quality assessment follows validation and is part of a decision making process. In this step the data are judged regarding their type, quality and quantity to effectively and credibly support a decision (*2*). Data quality assessment covers all components of decision making including planning, implementation and data review. It is not limited to review of analytical data.

# 4. Description of the Report

## *4.1. Description of the Report*

The report is a professionally prepared 28-page text including figures and tables. The report also includes four appendices that document the Isotech Laboratory results, GEL Laboratory results, data verification and validation reports, and DOE Office of Legacy Management results for the same wells. Including the appendices, the report is 1260 pages.

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## *4.2. Olsson Associates' Summary of Results*

The results of radiological sampling are summarized in section 3.1 of the report.

The following information was presented for tritium in natural gas:

> Isotech reported that tritium was not detected in the natural gas samples collected from the Battlement Mesa 26-33B and Rulison Federal 19-41C wells on June 23, 2015. The results for tritium were reported < 10.0 TU (32.4 pCi/L) in the gas samples from these wells.
>
> Isotech reported that tritium was detected in the gas sample collected from the Battlement Mesa 26-33C at 16.3 ± 2.2 TU (46 pCi/L to 60 pCi/L). This result was suspected to be a false positive since tritium was not detected in the produced water sample collected at the same time from this well. Isotech re-counted the water from combustion on the original Olsson gas sample and the reported result of the re-count was 17.047 ± 2.227 pCi/L.[1]
>
> This result appears to be a 'false positive' since tritium was not detected in the produced water sample collected by Olsson from the Battlement Mesa 26-33C, or the natural gas samples collected by the DOE from the Battlement Mesa 26-33C at the same time as Olsson's gas sample. No action is required per the RSAP since the result is less than the action level.
>
> The DOE re-sampled the natural gas from the Battlement Mesa 26-33C on October 20, 2015. Isotech reported that tritium was not detected (< 12.4 TU) in

[1] The authors of the report made an error in the units associated with the measurement. PDF page 44 of the report shows the result is 17.047 ± 2.220 TU.

the BM 26 33C gas re-sample. The DOE analytical results for both the June 2015 and October 2015 re-sampling are presented in Appendix D.

The following information was presented for carbon-14 in natural gas:

Isotech reported that the carbon-14 results were < 0.2 pMC in each of the three gas samples collected by Olsson on June 23, 2015. The laboratory results reported that carbon-14 was not detected, suggesting that the natural gas has been isolated from sources of modern carbon. The carbon-14 screening level is determined as background (plus or minus) 2 standard deviations; the action level is determined as background (plus or minus) 3 standard deviations. No action is necessary since carbon-14 was not detected in any of the three gas samples.

The following information was presented for tritium in produced water:

Isotech reported that tritium was not detected (< 10.0 TU) in the three produced water samples Olsson collected on June 23, 2015 from the Battlement Mesa 26-33B, Battlement Mesa 26-33C, and Rulison Federal 19-41C. This Istotech tritium detection limit is approximately 32.4 pCi/L, so the reporting limit is below the RSAP Table 5 Screening Level of 400 pCi/L in surface water/groundwater, and the Action Level of 15,000 pCi/L. The U.S. EPA MCL for tritium is 20,000 pCi/L in drinking water (approximately 617.3 TU).

The produced water is not a drinking water source. Historically, natural background tritium reportedly ranged from below detection (less than 700 pCi/L) to 1,984 pCi/L in pre-shot surface water sample results collected prior to Project Rulison that were due to higher atmospheric tritium concentrations at that time. Exposure to the natural gas and produced water by Caerus personnel, the public, and environment is limited since these fluids are contained within the well, and associated piping, tanks, and vessels. No action is necessary based on these results.

The following information was presented for gross alpha activity in produced water:

The GEL data for gross alpha indicate that gross alpha activity was not detected in the produced water samples from the Battlement Mesa 26-33B, Battlement Mesa 26-33C, and Rulison Federal 19-41C wells. The results were qualified with a "U" indicating that gross alpha activity was not detected. No action is required since alpha activity was not detected.

The following information was presented for gross beta activity in produced water:

Gross beta activity was detected in each of the three produced water samples. Gross beta activity is typically related to naturally occurring potassium-40 (40K) in the surface and subsurface rock. In this case potassium-40 and other naturally occurring radionuclides were reportedly detected at low levels in the produced water samples. Produced water samples previously collected from Tier I wells in

Sector 10 have shown high gross beta activities that appear related to potassium-40. No action is necessary.

The following information was presented for strontium-90 and technetium-99 activity in produced water:

The results for strontium-90 and technetium-99 show that these radionuclides were not detected in the June 23, 2015 produced water samples. No action is necessary.

The following information was presented for gamma spectroscopy results in produced water:

The results for the gamma spectroscopy shows that five gamma emitting radionuclides were detected at low-levels near the laboratory reporting limits. These included actinium-228, bismuth-214, lead-214, potassium-40, and radium-228. With the exception of potassium-40, these are all naturally occurring radionuclides that are daughter products of the uranium-238 and throrium-232 decay series. Potassium is common in clay minerals and the potassium-40 isotope is expected if potassium is present. Potassium-40 is one of the most abundant naturally occurring radionuclides. The low concentrations of these radionuclides are considered indicative of natural background radiation.

# 5. Scope of This Review

The following actions were taken to complete this review.

- The text of the main report was read in detail, taking special note of each sample in which radiological analytes were reported above method detection limits and to each identified quality concern and nonconformance.
- The ISOTECH laboratory data package in Appendix A (pdf pages 29 – 49) was carefully reviewed.
- The GEL laboratory data package in Appendix B (pdf pages 50 – 1167) was scanned with attention given to the results, case narratives and data qualifier codes.
- Appendix C, the "Diane Short and Associates Data Verification and Validation Report" (pdf pages 1168 – 1182) was read with attention to data qualifiers and nonconformance reports. The report in Appendix C is required by the RSAP and is independent of the laboratory verification and validation.
- Appendix D, DOE Office of Legacy Management analytical results and documents (pdf pages 1183 -1260) was read.

Special attention was given during the review to the information pertaining to tritium in natural gas data associated with Battlement Mesa 26-33C well.

# 6. Review and Evaluation

## *6.1. Tritium in Natural Gas from Battlement Mesa 26-33C Well*

The tritium in natural gas result for Tier I Battlement Mesa 26-33C Well sample taken on June 23, 2015, is above the method detection limit. Although the result is above the screening level it is not above the action level defined in RSAP.

### 6.1.1. How Tritium in Natural Gas is Measured and Reported

For sampling conducted in accordance with the RSAP, tritium in the methane (C1) fraction of natural gas is analyzed and reported by Isotech Laboratories as the tritium concentration in the water that results from the combustion of the hydrocarbons, principally methane. Prior to combustion, the water and water vapor in the gas is removed by passing the gas through a molecular sieve bed. This ensures that any tritium measured is associated with the hydrocarbon and not with produced water. Tritium in produced water is measured and reported in a different analytical procedure.

Isotech reports the tritium concentration in "tritium units" (TU) which is a unit of measure used in laboratories that specialize in determining the geologic age of groundwater. One TU equals 1 tritium atom per $10^{18}$ hydrogen atoms. This is approximately the same as 3.2 pCi/L in water. The nominal detection limit typically reported by Isotech ranges from 10 TU to 12.5 TU. A value of 10 TU is the same as 32 pCi/L in water. The RSAP screening level for tritium in natural gas is 7.5 pCi/L, which is the same as 24 TU.

The US Department of Energy Office of Legacy Management also samples Rulison Project wells for tritium in natural gas and ISOTECH analyses those samples. The reporting convention used by ISOTECH for DOE samples is different. Instead of reporting the tritium concentration in the water of combustion, the tritium concentration in the hydrocarbon fraction is reported. These values can be converted between reporting conventions using the conversion factor of $1.61 \times 10^{-3}$ $L_{water}/L_{methane}$ .

For example, a reported activity concentration of 10 TU in the water of combustion could be converted to 32 pCi/L in the water of combustion by multiplying 10 TU by 3.2. This could be converted to the equivalent concentration of tritium in the hydrocarbon form by multiply by 0.00161, and the result would be 0.052 pCi/$L_{methane}$.

For comparison, the EPA drinking water standard for tritium is 20,000 pCi/L.

### 6.1.2. Mistake in Reporting Units

The footnote in section 4.2 of this review points out a mistake in the report pertaining to the units of measurement for the sample re-count. The text states that the result was 17.047 ± 2.227 pCi/L. But according to the ISOTECH Laboratory report it should have been 17.047 ± 2.227 TU.

Although this mistake is confusing it does not invalidate the report.

Either one of the following two actions is recommended:

1. Request that Olsson Associates revise the report to correct the error, or
2. Add an *errata* note explaining this mistake to the hyperlink for the report when it is made available on the COGCC web site.

### 6.1.3. Evaluation of Elevated Result in Context of DOE Data

The tritium in natural gas result for Tier I Battlement Mesa 26-33C Well sample taken on June 23, 2015, was above the detection limit. The result was suspect because it was so low. A re-count was requested by Olsson Associates and the result was statistically the same.

The US Department of Energy Office of Legacy Management also samples this well and contracts ISOTECH Laboratory to perform the analysis.

Table 2 presents the tritium in natural gas data for this well taken during 2015 and 2015.

Table 2. Tritium in natural gas results associated with Battlement Mesa 26-33C Well

| Date | Sampled By | Result, TU | Result, $pCi/L_{water}$ | Result, $pCi/L_{methane}$ | Comment |
|---|---|---|---|---|---|
| 06/23/2015 | DOE | < 10.4 | < 33.2 | < 0.0535 | Originally reported in $pCi/L_{methane}$ |
| 06/23/2015 | Olsson | 16.287 ± 2.223 | 52.1 ± 7.11 | 0.084 ± 0.011 | Originally reported in TU |
| 06/23/2015 | Olsson | 17.047 ± 2.227 | 54.6 ± 7.13 | 0.088 ± 0.011 | Re-count. Originally reported in TU |
| 10/20/2015 | DOE | < 12.5 | < 40 | < 0.064 | N/A |

Figure 1 is extracted from an e-mail message sent by a DOE Office of Legacy Management official. The e-mail message is include on pdf page 1186 of the report. The figure shows the trend of tritium in natural gas results for Battlement

Mesa 26-33C Well. Except for the June 23, 2015 sample taken by Olsson Associates, all results are less than the detection level.

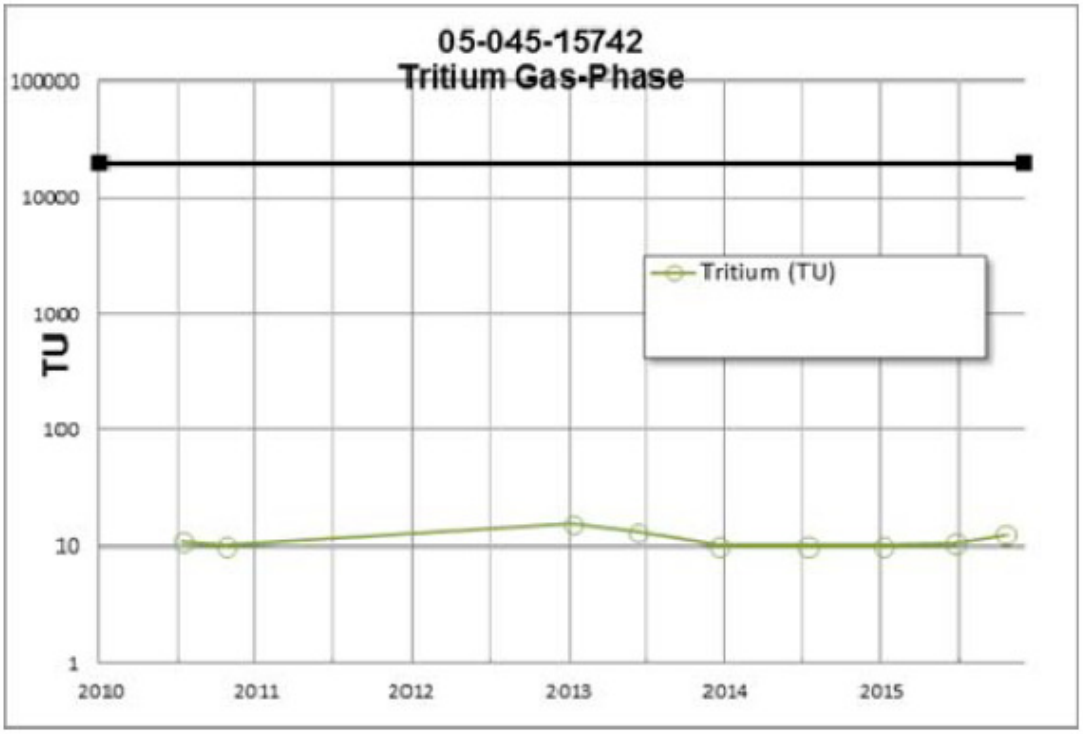


Figure 1. DOE Office of Legacy Management data trend for Battlement Mesa 26-33C Well. The solid black line at the top of the graph is the DOE screening level. Note the non-linear logarithmic scale on the Y-axis which accentuates lower values.

After review of the results in context of the DOE results, and considering that results are below the RSAP screening level, we concur with the judgement of the authors of the report that this is most likely a false positive result.

No specific action associated with re-sampling or notification is required or recommended at this time.

Careful attention should be given to future sample results from this well.

## *6.2. Other Results*

No problems are noted in other laboratory results.

### *6.3. Data Verification and Validation Reports*

Appendix C includes a formal data verification and validation of the GEL laboratory results. No significant findings were noted.

Appendix C does not include information regarding the ISOTECH laboratory report. This is understandable because ISOTECH does not produce a typical QA package prepared in accordance with the EPA Contract Laboratory Program (CLP). ISOTECH is a specialized laboratory, one of a few (or perhaps the only) laboratories capable of combusting natural gas then capturing the water of combustion for tritium analysis. Even though the typical CLP reviews are not possible for this laboratory report, it would be a good practice for Olsson Associates to request a quality review to the extent possible by Diane Short & Associates in case obvious problems are evident. This review should include documentation of chain of custody and calculation of instrument response to standards and samples,

## 7. Concurrence with the Report

M. H. Chew & Associates, Inc. radiation safety staff concurs with the findings of the report, that no Rulison-related radionuclides have been found in the sampled natural gas or produced water for the three wells.

# 8. References

1. URS, “Rulison sampling and analysis plan for operational and environmental radiologicalmonitoring within a three-mile radius of project rulison. Revision 3” (URS Corporation, Denver, CO, 2010). http://cogcc.state.co.us/Library/PiceanceBasin/Rulison/RulisonSAPRevision3.pdf
2. EPA, Office of Environmental Information, Ed. (U.S. Environmental Protection Agency, Washington, D.C., 2002). http://www.epa.gov/QUALITY/qs-docs/g8-final.pdf