CAMECO RESOURCES
CROW BUTTE OPERATION

86 Crow Butte Road
P.O. Box 169 **(308) 665-2215**
Crawford, Nebraska 69339-0169 **(308) 665-2341 – FAX**

August 28, 2019

ATTN: Document Control Desk Director
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Semiannual Radiological Effluent and Environmental Monitoring Report
Source Materials License No. SUA-1534, Docket No. 40-8943

Dear Document Control:

Enclosed please find one copy of the Semiannual Radiological Effluent and Environmental Monitoring Report for the Crow Butte Uranium Project. The report is provided in accordance with License Condition 11.1(B) of Source Materials License SUA-1534 and 10 CFR Part 40. This report covers the first and second quarters of 2019.

If you have any questions concerning the report, please feel free to call me at (308) 665-2215 Ext 117.

Sincerely,
CAMECO RESOURCES
CROW BUTTE OPERATION

Walter D. Nelson
SHEQ Coordinator

cc: Ron Burrows – NRC
CBO – File
ec: Amanda Jones – NDEQ Program Coordinator
CR – Electronic File

IE25
IE48
NMSSZO

CROW BUTTE URANIUM PROJECT

RADIOLOGICAL EFFLUENT AND ENVIRONMENTAL MONITORING REPORT

for

FIRST AND SECOND QUARTERS, 2019

USNRC Source Materials License SUA 1534

Table of Contents

CAMECO RESOURCES
CROW BUTTE OPERATION

First Half 2019 Semiannual Radiological Effluent and Environmental Monitoring Report

1 WATER QUALITY MONITORING DATA

1.1 Excursion Monitoring

Biweekly excursion monitoring in the shallow aquifer and perimeter monitor wells was continued in Mine Units 2 through 11 during the first and second quarters of 2019.

The first half of 2019 was marked with above normal precipitation coupled with cooler than normal temperatures. The cool temperatures began with an extended cold snap in February that lasted well into March. On March 14 and 15, 2019, the region was subjected to a major winter storm that included an estimated 18" snowfall combined with intense winds, gusting up to 90 mph. A second major winter storm impacted the region on April 10 and 11, 2019. Additionally, the spring weather continued to be unusually wet and cool during May and June. As a result of these conditions, seven shallow monitor wells were placed on excursion status during this period.

On March 26, 2019, SM10-28A was placed on excursion status when the multiple concentration limits (MCL) for chloride and conductivity were exceeded. While the parameters in this well have been affected during high precipitation events in the past, it appears that it was impacted by snowmelt runoff from the March 14 and 15, 2019 event. Due to the well's location (downhill from an east facing slope) and the prevailing wind patterns during the storm (west/northwest), it is likely that a large amount of snow accumulated on the slopes above the well, and the runoff from these drifts impacted the well. Upon investigation of the wellhead area, a hole was observed within 5' of the wellhead that may have provided a conduit for accelerated infiltration of these fluids to the screened interval of the well. This hole was filled with plug gel to help prevent a similar event. The excursion parameters in the well quickly corrected, and the samples collected on April 9, 16, and 23, 2019, were below the excursion parameters, removing the well from excursion status.

On March 28, 2019, SM8-25 was placed on excursion status when the single parameter upper control limit (SCL) for conductivity was exceeded. The conductivity has trended to near SCL exceedance levels during similar wet, cool conditions in the past, but has not exceeded the limit until this year. The well remained on excursion status at the end of the reporting period, but the parameters are trending down.

On April 10, 2019, SM10-17 was placed on excursion status when the MCL's for chloride and conductivity were exceeded. Similar to SM10-28A, it appears this well was directly impacted from snowmelt runoff resulting from the March 14 and 15, 2019, winter storm. It is similarly positioned in a location that would have been downslope from large drifts resulting from the storm. As was the

case with SM10-28A, the parameters quickly corrected, and the samples collected on April 16, 23, and 30, 2019, were below the excursion criteria, removing the well from excursion status.

On April 18, 2019, SM8-28 was placed on excursion status when the MCL's for conductivity and alkalinity were exceeded. This well has been placed on excursion status five times during wet spring conditions in past years. It remained on excursion status at the end of the reporting period.

On May 3, 2019, SM6-23 was placed on excursion status when the MCL's for alkalinity and conductivity were exceeded. This well has been placed on excursion status three times during wet spring conditions in past years. It remained on excursion status at the end of the reporting period.

On May 3, 2019, SM6-28 was placed on excursion status when the MCL's for alkalinity and conductivity were exceeded. This well has been placed on excursion status six times during wet spring conditions in past years. It remained on excursion status at the end of the reporting period.

On June 6, 2019, SM8-21 was placed on excursion status when the MCL's for alkalinity and conductivity were exceeded. This well has been placed on excursion status twice during wet spring conditions in past years. The samples collected on June 12, 19, and 26, 2019, were below the excursion criteria, removing the well from excursion status.

As conditions warm and dry, the wells remaining on excursion status at the end of the reporting period for this report (June 30, 2019) are trending back toward baseline conditions. As of this writing, SM6-23 and SM8-28 have been removed from excursion status, and SM8-25 has tested below excursion criteria for two consecutive weeks. SM6-28 has not tested below excursion parameters, but is trending downward.

1.2 Water Supply Wells and Surface Water

Summary sheets of quarterly radiological analytical data for the reporting period from all surface waters and water supply wells within one kilometer of the active wellfield boundary are included in Appendix A.

The reported radiological data are within the expected ranges for each well and surface water sampling points with the following exception. The second quarter radium 226 results for Well #12, Well #26, Well #28, Well #38, Well #131, Drinking Water Well, Stream S-1, Stream S-2, Stream S-5, Impoundment I-4, and Impoundment I-5, were well above historical norms. As part of the site quality assurance program, double samples are collected from two water supply wells and two surface water locations each quarter and submitted to a second laboratory. As it happens, double samples were collected for three of the samples in question, Drinking Water Well, Stream S-1, and Well #38.

Figure 1 below compares radium 226 sampling results from the primary lab (IML), the secondary lab (ACZ), and the average result for the last 9 samples (2017, 2018, and Q1 2019). Because the results of the double samples are much more in line with historical averages, CBO believes that the IML results are erroneous and has requested reruns for all samples listed above. The results of the rerun will be provided under separate cover. Samples were obtained from all sample locations with the exceptions noted in Appendix A.

Sample ID	IML Result	ACZ Result	Average of previous 9 samples
Drinking Water	9.6	.16	.2
Well 38	5.9	.26	.5
Stream S-1	15.4	.22	.2

Fig. 1: Radium 226 results comparison

2 OPERATIONAL

2.1 Production Data Summary

Mining operations continued through the first and second quarters of 2019. The average operating production flow rate was 150 gpm for the first quarter and 98 gpm for the second quarter. Injection and production totals from the totalizers and the calculated bleed totals for the reporting period are included in Appendix B. Production injection pressures are included in Appendix C.

2.2 Restoration

Restoration activities continued in Mine Units 2, 3, 4, 5, 6, and 7 during the first half of 2019. Permeate continued to be injected into Mine Units 6 and 7. On June 19, 2013, Mine Unit 2 was placed into stabilization, and stability monitoring continued in mine unit 2 during the first half of 2019. Stability monitoring was initiated in Mine Units 3, 4, and 5 during the third quarter of 2018. Stability monitoring continued in these mine units during the reporting period. Restoration injection and production totals are included in Appendix B. Restoration injection pressures are included in Appendix C.

2.3 Wastewater Summary

The total volume of wastewater discharged to the ponds was 200,270 gallons during the first quarter and 5,597,340 gallons during the second quarter. Currently, all five evaporation ponds contain wastewater.

On May 29, 2019, routine weekly monitoring results from Commercial Evaporation Pond #1 northwest and north middle underdrains indicated a potential liner leak. Transfer of the pond contents to Commercial Evaporation Pond #3 was initiated, and the upper liner was inspected for a breach. No breach was identified during the initial inspection, so transfer of the contents continued, and the site performed periodic inspections of the liner until a failed patch was identified and repaired on June 28, 2019. During the leak period, and for two weeks following the liner repair, contents samples were collected from the impacted underdrains on a weekly basis.

Wastewater that is not disposed of in the evaporation ponds is injected into the two Deep Disposal Wells (DDWs).

On February 19, 2019, CBO reported annulus pressure and annulus fluid loss in DDW #1 over the preceding weekend that exceeded the permit parameters. The pressure/fluid loss was gradual in nature, not a marked spike as had been observed in previous pressure/fluid loss events. This issue was discussed with Mr. David Meisbach who conferred with NDEQ staff. The staff determined that CBO could continue to operate the well until a rig and materials were available to investigate the situation, provided the pressure/fluid loss did not increase precipitously.

On the afternoon of February 26, 2019, the pressure/fluid loss declined, and the well began operating within the permit parameters. CBO discussed this development with Mr. David Meisbach, Ms. Amanda Jones, and Mr. Kory Winters in a conference call on March 7, 2019. At that time it was determined that the best path forward would be to wait to take corrective actions until the upcoming MIT in May, as long as the well continued to operate below the permit limitations.

On May 8, DDW #1 failed the bi-annual MIT. This was not unexpected, as the MIT tests both the integrity of the casing and the injection string and packer by pressuring up the annulus and monitoring for pressure loss. CBO was later able to pressure test the well casing, which passed the pressure test, isolating the annulus pressure loss issue to the injection string or the packer. These results also indicate that no injection fluids were released to the environment.

Following the MIT failure on May 8, 2019, CBO suspended injection in DDW 1 until the cause of the MIT failure could be diagnosed and repaired. The well remained off for the remainder of the month. Injection in DDW #1 remained off for most of the month of June while the well was awaiting replacement of the injection string and packer. This equipment was replaced and the well successfully passed an MIT

under the observation of Kory Winters, the onsite NDEQ representative, on June 23, 2019. Injection of waste fluid was resumed on June 25, 2019.

A summary of the total volume of wastewater injected and the average radionuclide content is contained in Appendix D.

2.4 Effluent Release

10 CFR §40.65 requires licensees to report quantities of radionuclides in liquid and gaseous effluent releases to the environment. In the Application for Renewal of Source Materials License SUA-1534, submitted December 1995, Table 7.3(A) presented calculations of the annual radon emissions for the Crow Butte Plant. These calculations assumed a 7.04×10^{-4} Curies/m^3 radon release from leaching operations and the radon release calculations for the first half of 2019 use this release rate estimate.

During the first quarter, production occurred at an average flow rate of 150 gpm (568 lpm). Production was maintained continuously for 90 days during the first quarter with an operating factor of 94%. The production flow for the first quarter results in a calculated radon release of 35 Curies. During the second quarter, production occurred at an average flow rate of 98 gpm (371 lpm). Production was maintained continuously for 91 days during the second quarter with an operating factor of 100%. The production flow for the second quarter results in a calculated radon release of 25 Curies. Calculations for radon release from production operations are shown in Appendix E.

There were no additional wells brought on line during the first half of 2019.

The total radon emission due to leaching operations from the Crow Butte plant for the first half of 2019 was 25 Curies. This calculated release rate is comparable with the releases estimated in CBO's License Renewal Application.

Radon gas is also released from restoration activities. For restoration water that is treated by ion exchange only, the radon concentration is 0.697 µCi/l. Of the total restoration production flow it is assumed that 25% of the radon is released through wellfield loss and 10% of the remaining radon is released during pressurized ion exchange treatment. For water that is treated by reverse osmosis, it is assumed that 100% of the remaining radon is released. For water treated by reverse osmosis the radon concentration is 0.470 µCi/l after adjusting for wellfield loss and ion exchange loss.

During the first half of 2019 a total of 105,889,552 gallons (400,835,558 l) of restoration water was produced from Mine Units 2, 3, 4, 5, 6, and 7. Based upon an estimated radon concentration of 0.697 µCi/l, the total amount of radon in the restoration solution was calculated to be 234 Curies as shown in Appendix E. The estimated release of radon through wellfield loss at 25% of this total was 70

Curies. The plant loss for ion exchange treatment of the restoration water is estimated at 10% of the remaining radon, or 21 Curies. For water that is treated by reverse osmosis, it is assumed that 100% of the remaining radon is released. For water treated by reverse osmosis the radon concentration is 0.470 µCi/l after adjusting for wellfield loss and ion exchange loss.

Of the total amount of restoration water produced in the first half of 2019, 53,340,149 gallons (201,914,429 l) of the water was treated by reverse osmosis. The total estimated radon release from reverse osmosis treatment was 95 Curies.

No additional acres of wellfields were placed into restoration during the first half of 2019. The calculated radon released from start-up of 0 acres is 0 Curies. Calculations for the start-up of 0 acres of a wellfield placed in restoration are shown in Appendix E.

Based upon the calculations shown in Appendix E, the total estimated semiannual radon emission for the first half of 2019 from restoration activities was 186 Curies. This resulted in a total estimated radon release from the leaching operation during the first half of 2019 of 245 Curies.

This information is included for historical purposes as a comparison for the requirements in License Condition 11.11.

2.5 License Condition 11.11

By letter dated January 6, 2016, the NRC staff indicated that it had completed the technical review of the licensee's January 2, 2015 submittal describing the site's operational airborne effluent and environmental monitoring program.

The licensee identified three primary sources of airborne effluents at the Crow Butte Project. These sources included the main plant, wellfield, and the wellhouses.
Main Plant

Radon and radon progeny

The licensee will measure ambient radon gas concentrations using track etch detectors and working level measurements at six different locations.

The licensee will use scintillation cell measurements quarterly at each tank vent for radon gas measurements.

Particulates

The licensee shall conduct isotopic analyses for alpha- and beta-emitting radionuclides on airborne samples at each in-plant air particulate sampling location at a frequency on once every six months for the first two years after the license renewal (November 2014) and annually thereafter to ensure compliance with 10 CFR 20.1204(g). For any changes to operations, the licensee shall conduct an evaluation to determine if more frequent isotopic analyses are required for compliance with 10 CFR 20.1204(g).

There were no changes made to the operation during the first half of 2019. Samples were collected from each of the in-plant air particulate sampling locations.

The summary of the Main Plant samples are shown in Appendix F.

Wellfield

The licensee identified two potential sources of radon in the wellfield. The first potential source of radon is when wellheads are opened to the atmosphere to depressurize a wellhead that has become pressurized. When these wellheads are depressurized, the licensee will obtain a grab sample using a scintillation cell. Wellhead pressurization occurs as a result of adding oxygen to the injection stream. Since CBO did not add oxygen to the injection stream during the reporting period, no wells became pressurized during the first half of 2019, so no scintillation cell grab samples were collected from pressurized wellheads during the period.

The other potential sources of radon in the wellfield include unplanned releases of process fluids from spills. The amount of radon released will be estimated based on the amount of fluid released and an estimate of the concentration of radon in the process fluid. The licensee will assume that all radon in the fluid is released to the atmosphere.

The summary of the Wellfield samples are shown in Appendix G.

Wellhouses

Radon and radon progeny

The licensee will measure radon in the wellhouses using track etch detectors with a six-month exposure time. The licensee will use the average radon concentration (collected quarterly) along with the flow rate of the wellhouse exhaust fans to determine the total radon released from the

wellhouses. Four production and four restoration wellhouses will be monitored annually in this manner.

Radon daughters will be measured semi-annually in the wellhouses where radon gas is being measured. The licensee will determine the total radon daughters released in the same manner as the radon gas using the flow rate of the wellhouse exhaust fan.

Particulates

The licensee will estimate the emission of particulate releases based on isotopic analyses of semiannual air particulate samples performed in each of the wellhouses that are monitored for radon. The exhaust rate of the wellhouses will be the same as described above for the radon emissions.

The summary of the Wellhouse samples are shown in Appendix H.

Estimated emissions for the first half of the year are summarized in the following table. The estimated emissions is 479.25 curies.

First Half of Year

Emissions in Ci for First 6 Months by Source

Source	Radon Progeny (Ci)	Radon Gas (Ci)	Particulate (Ci)	Total by Source	% by Source
Plant Floor Vents	0.12	2.05	5.74E-05	**2.17**	**0.5%**
Wellhouses (64)	0.14	3.95	2.43E-05	**4.09**	**0.9%**
Plant Tanks/vents	39.8	433.2	N/A	**473.0**	**98.7%**
Spills	N/A	0.00E+00	N/A	**0.00E+00**	**0.0%**
Deepwells	N/A	N/A	7.06E-07	**7.06E-07**	**0.0%**
Total by Type	**40.03**	**439.22**	**8.25E-05**		

Estimated Emissions for First Half of the Year = 479.25 Curies (Ci)

3 ENVIRONMENTAL MONITORING

3.1 Air Monitor Stations

Eight air monitoring stations are used to monitor the Crow Butte Plant. Ambient radon-222 concentrations and radionuclide concentrations in air for each monitoring site are listed in Appendix I. Six track etch cups were deployed at the background monitoring station and the nearest residence

to check for potential variability in data using only one track etch cup. All air monitoring results were within expected historical ranges.

3.2 TLD Monitors

Environmental TLD monitors are located at each air monitoring station. The results of the area TLD monitors fall within the expected ranges and are listed in Appendix J.

The site is provided with both a deployment and a transient dosimeter by the provider. The process used by the dosimeter provider, Landauer, is to subtract the deployment badge result from the badges used for environmental monitoring. If the deployment badge is lost, damaged, etc. the transient badge result is subtracted instead. If neither is available to be read, the average of a set number of previous quarter's background results is subtracted. Only one of the badge results is subtracted, not multiple. The purpose of these deployment and transient badges is to subtract off any radiation that was accumulated on the environmental badges during times when they were not deployed to ensure that only dose accumulated while in the prescribed monitoring location is returned to the site as a final result.

3.3 Mechanical Integrity Testing (MIT)

Mechanical integrity tests shall be performed on each injection and production well before the wells are utilized and on wells that have been serviced with equipment or procedures that could damage the well casing. Additionally, each well shall be retested at least once each five (5) years it is in use. The following table summarizes the MIT's performed during the first half of 2019.

Five (5) Year Retesting			
Required Testing	**Number Tested**	**Number Passed**	**Number Failed**
358	358	357	1

Wells Serviced			
Required Testing	**Number Tested**	**Number Passed**	**Number Failed**
0	0	0	0

Appendix A

Private Well and Surface Water Radiological Monitoring Results

First and Second Quarter, 2019

CROW BUTTE RESOURCES, INC.

PRIVATE WELL AND SURFACE WATER RADIOLOGICAL MONITORING RESULTS

First Quarter, 2019

SAMPLE ID	DATE SAMPLED	URANIUM mg/l	URANIUM µCi/ml	RADIUM-226 pCi/l	RADIUM-226 precision ±
Well #8	03/26/19	0.0133	9.00E-09	0.4	0.1
Well #11	Well Inoperable				
Well #12	03/21/19	0.0031	2.10E-09	0.2	0.1
Well #26	03/21/19	0.0050	3.40E-09	0.3	0.1
Well #28	03/26/19	0.0073	4.90E-09	0.4	0.1
Well #38	03/21/19	0.0031	2.10E-09	0.3	0.1
Well #41	03/21/19	0.0072	4.90E-09	0.2	0.1
Well #61	Well Inoperable				
Well #63	03/21/19	0.0159	1.08E-08	0.4	0.1
Well #66	03/21/19	0.0170	1.15E-08	0.2	0.1
Well #125	03/26/19	0.0049	3.30E-09	<.2	0.1
Well #129	03/27/19	0.0054	3.70E-09	0.3	0.1
Well #131	03/21/19	0.0053	3.60E-09	<.2	0.05
Well #133	03/21/19	0.0091	6.20E-09	0.3	0.1
Well #134	03/21/19	0.0074	5.00E-09	0.3	0.1
Well #135	03/21/19	0.0155	1.05E-08	0.4	0.1
Well #138	03/21/19	0.0111	7.50E-09	0.4	0.1
Well #140	03/26/19	0.0089	6.00E-09	0.3	0.1
Well #435	03/21/19	0.0062	4.20E-09	0.2	0.1
Well #445	03/21/19	0.0099	6.70E-09	<.2	0.04
Drinking Water Well	03/26/19	0.0066	4.50E-09	<.2	0.04
Stream S-1	03/21/19	0.0037	2.00E-09	0.2	0.1
Stream S-2	03/21/19	0.0031	2.10E-09	0.3	0.1
Stream S-5	03/21/19	0.0032	2.20E-09	<.2	0.1
Stream E-1 & 2 Composite	03/26/19	0.0204	1.38E-08	0.5	0.1
Stream E-5	03/21/19	0.0091	6.20E-09	<.2	0.04
Impoundment I-3	03/26/19	0.0274	1.85E-08	0.3	0.1
Impoundment I-4	03/21/19	0.0086	5.80E-09	<.2	0.04
Impoundment I-5	03/26/19	0.0090	6.10E-09	<.2	0.05
Reporting Limit		**0.0003**	**2.00E-10**	0.2	-

ND-Not detected at the reporting limit

CROW BUTTE RESOURCES, INC.

PRIVATE WELL AND SURFACE WATER RADIOLOGICAL MONITORING RESULTS

Second Quarter, 2019

SAMPLE ID	DATE SAMPLED	URANIUM mg/l	URANIUM µCi/ml	RADIUM-226 pCi/l	RADIUM-226 precision ±
Well #8	06/18/19	0.0149	1.01E-08	0.4	0.1
Well #11	Well Inoperable				
Well #12	06/18/19	0.0038	2.60E-09	11.9	0.4
Well #26	06/18/19	0.0059	4.00E-09	1.6	0.2
Well #28	06/18/19	0.0061	4.10E-09	2.3	0.2
Well #38	06/18/19	0.0034	2.30E-09	5.9	0.4
Well #41	06/19/19	0.0119	8.10E-09	0.6	0.1
Well #61	06/19/19	<.0003	<2.0E-10	3.2	0.2
Well #63	06/18/19	0.0167	1.13E-08	0.7	0.1
Well #66	06/19/19	0.0218	1.48E-08	0.4	0.1
Well #125	06/19/19	0.0063	4.30E-09	0.3	0.1
Well #129	06/19/19	0.0059	4.00E-09	0.2	0.05
Well #131	06/18/19	0.0052	3.50E-09	1.0	0.1
Well #133	06/18/19	0.0096	6.50E-09	0.5	0.1
Well #134	06/18/19	0.0070	4.70E-09	0.4	0.1
Well #135	06/18/19	0.0171	1.16E-08	0.4	0.1
Well #138	06/19/19	0.0154	1.04E-08	1.0	0.1
Well #140	06/18/19	0.0087	5.90E-09	0.3	0.1
Well #435	06/19/19	0.0075	5.10E-09	0.4	0.1
Well #445	06/18/19	0.0118	8.00E-09	0.5	0.1
Drinking Water Well	06/18/19	0.0067	4.50E-09	9.6	0.5
Stream S-1	06/18/19	0.0048	3.30E-09	15.4	0.7
Stream S-2	06/18/19	0.0041	2.80E-09	2.4	0.2
Stream S-5	06/18/19	0.0032	3.00E-09	1.6	0.2
Stream E-1 & 2 Composite	06/18/19	0.0185	1.85E-08	0.7	0.1
Stream E-5	06/18/19	0.0041	2.80E-09	0.3	0.2
Impoundment I-3	06/18/19	0.0141	9.60E-09	0.7	0.1
Impoundment I-4	06/18/19	0.0084	5.70E-09	1.2	0.1
Impoundment I-5	06/18/19	0.0046	3.10E-09	1.9	0.2
Reporting Limit		**0.0003**	**2.00E-10**	0.2	-

ND-Not detected at the reporting limit

Appendix B

Plant Production and Waste Totals

First and Second Quarter, 2019

WASTE VOLUME
First Quarter 2019

TOTALIZER	PLANT TO PONDS	PLANT TO DDW 1 & 2	RESTORATION TO DDW	CLEAN WATER INTO PLANT	DDW TOTAL INJECTED	TRUCKS TO POND	POND WATER TREATMENT
January	108,020	7,097,133	5,354,359	6,046	12,451,492	0	0
February	8,140	6,769,905	4,215,028	743	10,984,933	0	0
March	84,110	5,766,059	4,035,572	7,427	9,801,631	0	0
TOTAL GAL. EOQ	200,270	19,633,097	13,604,959	14,216	33,238,056	0	0

TOTAL 4th QTR VOLUME

DISCHARGED TO WASTE PONDS LESS POND WATER TREATMENT GALLONS =	200,270 GALLONS
DISCHARGED TO DEEP WELL=	33,238,056 GALLONS
DISCHARGED TO WASTE PONDS + DPWELL =	33,438,326 GALLONS
WF BLEED FROM WELLFIELDS=	33,424,110 GALLONS

COMMERCIAL WELLFIELD BLEED
First Quarter 2019

MONTH	January	February	March
BLEED	100.0%	100.0%	100.0%

RESTORATION WELLFIELD BLEED
First Quarter 2019

MONTH	January	February	March
BLEED	20.9%	19.8%	21.7%

PLANT FLOW
First Quarter 2019

AVERAGE OPERATING FLOW RATE=	150 GPM EOQ
TOTAL GALLONS PRODUCED=	19,485,179 GALLONS EOQ
TOTAL GALLONS INJECTED=	0 GALLONS EOQ

	TOTAL GALS. PRODUCED	TOTAL GALS. INJECTED	HOURS IN MONTH	HOURS IN PRODUCTION	AVERAGE PROD. GPM	AVERAGE COM INJ GPM	AVERAGE REST INJ GPM	HRS. DOWN TIME
Prev. YTD	0	0	0	0	0	0	0	0
January	7,283,403	0	744	744	163	0	433	0
February	6,507,107	0	672	672	161	0	411	0
March	5,694,669	0	744	612	128	0	423	132
EOQ TOTAL	19,485,179	0	2,160	2,028	150	0	423	132
YTD TOTAL	19,485,179	0	2,160	2,028	150	0	100	132

	TOTAL MUII GALS PRODUCED	TOTAL MUIII GALS PRODUCED	TOTAL MUIV GALS PRODUCED	TOTAL MUV GALS PRODUCED	TOTAL MUVI GALS PRODUCED	TOTAL MUVII GALS PRODUCED	MUII BLEED TO WASTE	MUIII BLEED TO WASTE	MUIV BLEED TO WASTE	MUV BLEED TO WASTE	MUVI BLEED TO WASTE	MUVII BLEED TO WASTE
Prev. YTD	0	0	0	0	0	0	0	0	0	0	0	0
January	0	24,887	48,525	997,194	8,212,212	16,338,358	0	18,023	35,142	722,174	2,126,165	1,649,335
February	0	0	2	588,041	4,926,764	15,758,512	0	0	2	460,934	1,416,087	1,793,686
March	0	0	2,366	173,211	4,774,437	13,618,166	0	0	3,070	224,782	1,229,782	2,500,178
EOQ TOTAL	0	24,887	50,893	1,758,446	17,913,413	45,715,036	0	18,023	38,214	1,407,889	4,772,033	5,943,199
YTD TOTAL	0	24,887	50,893	1,758,446	17,913,413	45,715,036	0	18,023	38,214	1,407,889	4,772,033	5,943,199

	TOTAL BRINE GALS PRODUCED	TOTAL PERM GALS PRODUCED	COMM BLEED TO RO FEED
Prev. YTD	0	0	0
January	5,354,359	15,509,780	803,520
February	4,215,028	12,765,798	544,320
March	4,035,572	11,459,612	77,760
EOQ TOTAL	13,604,959	39,735,190	1,425,600
YTD TOTAL	13,604,959	39,735,190	1,425,600

WASTE VOLUME Second Quarter 2019							
TOTALIZER	PLANT TO PONDS	PLANT TO DDW 1 & 2	RESTORATION TO DDW	CLEAN WATER INTO PLANT	DDW TOTAL INJECTED	TRUCKS TO POND	POND WATER TREATMENT
April	154,680	4,881,050	4,270,678	12,377	9,151,728	1,822	0
May	2,953,670	971,318	2,702,897	5,665	3,674,215	5,382	0
June	2,476,260	214,675	2,332,459	1,821	2,547,134	5,526	0
TOTAL GAL. EOQ	5,584,610	6,067,043	9,306,034	19,863	15,373,077	12,730	0

TOTAL 2nd QTR VOLUME	
DISCHARGED TO WASTE PONDS LESS POND WATER TREATMENT GALLONS =	5,597,340 GALLONS
DISCHARGED TO DEEP WELL=	15,373,077 GALLONS
DISCHARGED TO WASTE PONDS + DPWELL =	20,970,417 GALLONS
WF BLEED FROM WELLFIELDS=	20,950,554 GALLONS

COMMERCIAL WELLFIELD BLEED Second Quarter 2019			
MONTH	April	May	June
BLEED	100.0%	100.0%	100.0%

RESTORATION WELLFIELD BLEED Second Quarter 2019			
MONTH	April	May	June
BLEED	22.9%	23.6%	22.7%

PLANT FLOW Second Quarter 2019	
AVERAGE OPERATING FLOW RATE=	98 GPM EOQ
TOTAL GALLONS PRODUCED=	12,897,650 GALLONS EOQ
TOTAL GALLONS INJECTED=	0 GALLONS EOQ

	TOTAL GALS. PRODUCED	TOTAL GALS. INJECTED	HOURS IN MONTH	HOURS IN PRODUCTION	AVERAGE PROD. GPM	AVERAGE COM INJ GPM	AVERAGE REST INJ GPM	HRS. DOWN TIME
Prev. YTD	19,485,179	0	2,160	2,028	150	0	423	132
April	4,902,263	0	720	720	113	0	364	0
May	4,542,485	0	744	744	102	0	214	0
June	3,452,902	0	720	720	80	0	207	0
EOQ TOTAL	12,897,650	0	2,184	2,184	98	0	261	0
YTD TOTAL	32,382,829	0	4,344	4,212	124	0	339	132

	TOTAL MUII GALS PRODUCED	TOTAL MUIII GALS PRODUCED	TOTAL MUIV GALS PRODUCED	TOTAL MUV GALS PRODUCED	TOTAL MUVI GALS PRODUCED	TOTAL MUVII GALS PRODUCED	MUII BLEED TO WASTE	MUIII BLEED TO WASTE	MUIV BLEED TO WASTE	MUV BLEED TO WASTE	MUVI BLEED TO WASTE	MUVII BLEED TO WASTE
Prev. YTD	0	24,887	50,893	1,758,446	17,913,413	45,715,036	0	18,023	38,214	1,407,889	4,772,033	5,943,199
April	0	0	0	267,621	5,086,881	13,308,966	0	0	0	267,621	723,108	2,502,349
May	0	0	0	524,962	6,556,138	4,362,979	0	0	0	524,962	834,402	540,013
June	0	27,160	74,642	976,544	5,954,278	3,286,706	0	27,160	74,642	976,544	-99,079	627,432
EOQ TOTAL	0	27,160	74,642	1,769,127	17,597,297	20,958,651	0	27,160	74,642	1,769,127	1,458,431	3,669,794
YTD TOTAL	0	52,047	125,535	3,527,573	35,510,710	66,673,687	0	45,183	112,856	3,177,016	6,230,465	9,612,993

	TOTAL BRINE GALS PRODUCED	TOTAL PERM GALS PRODUCED	COMM BLEED TO RO FEED
Prev. YTD	13,604,959	39,735,190	1,425,600
April	4,270,678	11,993,201	777,600
May	2,702,897	7,647,058	803,520
June	2,332,459	5,937,504	725,760
EOQ TOTAL	9,306,034	25,577,763	2,306,880
YTD TOTAL	22,910,993	65,312,953	3,732,480

Appendix C

Wellfield Injection Pressures

First and Second Quarter, 2019

WELLFIELD INJECTION PRESSURE - PSI

First Quarter 2019

	WF HOUSE #3		WF HOUSE #4		WF HOUSE #5		WF HOUSE #6		WF HOUSE #7	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	0	0	0	8	11	27	28	37	7	28
February	0	7	3	14	16	46	31	42	9	44
March	0	0	3	18	23	46	25	46	3	35
AVERAGE	0	7	2	18	17	46	28	46	6	44
	WF HOUSE #8		WF HOUSE #9		WF HOUSE #10		WF HOUSE #11		WF HOUSE #12	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	0	0	6	11	0	0	0	4	4	14
February	0	0	2	8	0	0	1	10	11	35
March	0	0	4	20	0	0	0	0	20	59
AVERAGE	0	0	4	20	0	0	0	10	12	59
	WF HOUSE #13		WF HOUSE #14		WF HOUSE #15		WF HOUSE #16		WF HOUSE #17	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	3	8	35	42	0	0	1	22	20	40
February	3	8	35	43	0	0	0	4	13	20
March	2	34	33	46	0	0	0	0	11	45
AVERAGE	2	34	34	46	0	0	0	22	15	45
	WF HOUSE #18		WF HOUSE #19		WF HOUSE #20		WF HOUSE #21		WF HOUSE #22	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	19	30	0	0	32	57	45	72	59	77
February	21	54	0	0	30	33	33	48	41	58
March	5	28	0	0	29	52	32	68	45	70
AVERAGE	15	54	0	0	30	57	37	72	49	77
	WF HOUSE #23		WF HOUSE #24		WF HOUSE #25		WF HOUSE #26		WF HOUSE #27	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	50	75	74	83	70	84	63	80	70	87
February	35	50	56	77	49	79	45	63	52	72
March	40	64	58	88	52	82	49	76	56	84
AVERAGE	42	75	63	88	57	84	53	80	59	87
	WF HOUSE #28		WF HOUSE #29		WF HOUSE #30		WF HOUSE #31		WF HOUSE #32	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	48	56	52	58	46	53	22	32	27	36
February	44	49	44	85	42	88	21	88	23	60
March	30	48	24	40	25	42	13	72	9	16
AVERAGE	41	56	40	85	38	88	19	88	19	60
	WF HOUSE #33		WF HOUSE #34		WF HOUSE #35		WF HOUSE #36		WF HOUSE #37	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	34	41	0	0	0	0	0	0	0	0
February	32	68	3	72	3	82	3	84	3	88
March	15	38	0	0	0	0	0	0	0	0
AVERAGE	27	68	1	72	1	82	1	84	1	88
	WF HOUSE #38		WF HOUSE #39		WF HOUSE #40		WF HOUSE #41		WF HOUSE #42	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	0	0	0	0	2	76	0	0	0	0
February	3	82	0	0	2	65	3	75	1	38
March	0	0	0	0	0	0	0	0	0	0
AVERAGE	1	82	0	0	2	76	1	75	0	38
	WF HOUSE #43		WF HOUSE #44		WF HOUSE #45		WF HOUSE #46		WF HOUSE #46A	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	0	0	0	0	0	0	0	0	0	0
February	1	30	1	35	1	30	1	22	3	84
March	0	0	0	0	0	0	0	0	0	0
AVERAGE	0	30	0	35	0	30	0	22	1	84
	WF HOUSE #47		WF HOUSE #47A/65		WF HOUSE #48		WF HOUSE #49		WF HOUSE #50	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	0	0	0	0	0	0	0	0	0	0
February	3	84	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0
AVERAGE	1	84	0	0	0	0	0	0	0	0
	WF HOUSE #51		WF HOUSE #52		WF HOUSE #53		WF HOUSE #54		WF HOUSE #55	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	2	60	0	0
AVERAGE	0	0	0	0	0	0	1	60	0	0

	WF HOUSE #56			WF HOUSE #57	
	AVERAGE	MAXIMUM		AVERAGE	MAXIMUM
January	0	0	January	0	0
February	0	0	February	0	0
March	0	0	March	0	0
AVERAGE	0	0	AVERAGE	0	0

	WF HOUSE #60		WF HOUSE #61		WF HOUSE #62		WF HOUSE #63		WF HOUSE #64	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	1	5	1	5	0	0	0	0	0	0
February	1	5	0	5	0	0	0	0	0	0
March	1	6	1	38	0	0	0	10	0	8
AVERAGE	1	6	1	38	0	0	0	10	0	8

WELLFIELD INJECTION PRESSURE - PSI
Second Quarter 2019

	WF HOUSE #3		WF HOUSE #4		WF HOUSE #5		WF HOUSE #6		WF HOUSE #7	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	0	0	0	0	36	48	36	41	0	0
May	0	0	0	0	29	46	39	51	3	10
June	0	0	0	0	29	56	32	46	4	10
AVERAGE	0	0	0	0	31	56	36	51	2	10
	WF HOUSE #8		WF HOUSE #9		WF HOUSE #10		WF HOUSE #11		WF HOUSE #12	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	0	0	0	0	0	0	0	0	12	34
May	0	0	0	0	0	0	0	0	9	14
June	0	0	0	0	0	0	0	0	10	14
AVERAGE	0	0	0	0	0	0	0	0	10	34
	WF HOUSE #13		WF HOUSE #14		WF HOUSE #15		WF HOUSE #16		WF HOUSE #17	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	0	5	36	49	0	0	0	0	23	86
May	0	0	48	56	0	0	0	0	31	42
June	0	6	46	54	0	0	0	0	33	46
AVERAGE	0	6	43	56	0	0	0	0	29	86
	WF HOUSE #18		WF HOUSE #19		WF HOUSE #20		WF HOUSE #21		WF HOUSE #22	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	0	0	0	0	30	44	41	59	50	71
May	0	0	0	0	43	53	59	68	71	80
June	2	61	0	0	43	51	57	74	65	76
AVERAGE	1	61	0	0	39	53	52	74	62	80
	WF HOUSE #23		WF HOUSE #24		WF HOUSE #25		WF HOUSE #26		WF HOUSE #27	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	45	64	65	92	59	82	54	75	61	85
May	63	72	89	96	83	90	75	83	83	88
June	60	68	85	96	81	88	72	80	73	84
AVERAGE	56	72	80	96	75	90	67	83	72	88
	WF HOUSE #28		WF HOUSE #29		WF HOUSE #30		WF HOUSE #31		WF HOUSE #32	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	33	64	29	50	23	42	12	25	13	25
May	10	44	9	40	8	38	3	15	4	17
June	7	40	7	44	6	38	2	15	3	18
AVERAGE	16	64	15	50	12	42	6	25	6	25
	WF HOUSE #33		WF HOUSE #34		WF HOUSE #35		WF HOUSE #36		WF HOUSE #37	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	18	35	0	0	0	0	0	0	0	0
May	6	27	0	0	0	0	0	0	0	0
June	4	26	0	0	0	0	0	0	0	0
AVERAGE	9	35	0	0	0	0	0	0	0	0
	WF HOUSE #38		WF HOUSE #39		WF HOUSE #40		WF HOUSE #41		WF HOUSE #42	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	2	74	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0
AVERAGE	1	74	0	0	0	0	0	0	0	0
	WF HOUSE #43		WF HOUSE #44		WF HOUSE #45		WF HOUSE #46		WF HOUSE #46A	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	0	0	1	20	0	0	0	0	0	0
May	0	0	0	0	1	23	3	86	1	20
June	0	0	0	0	0	0	0	0	0	10
AVERAGE	0	0	0	20	0	23	1	86	0	20
	WF HOUSE #47		WF HOUSE #47A/65		WF HOUSE #48		WF HOUSE #49		WF HOUSE #50	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	0	0	0	0	0	0	0	0	0	0
May	0	14	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0
AVERAGE	0	14	0	0	0	0	0	0	0	0
	WF HOUSE #51		WF HOUSE #52		WF HOUSE #53		WF HOUSE #54		WF HOUSE #55	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	0	0	0	0	0	0	0	0	0	4
May	0	0	0	0	0	0	0	0	0	0
June	0	0	3	87	0	0	0	0	0	0
AVERAGE	0	0	1	87	0	0	0	0	0	4

	WF HOUSE #56			WF HOUSE #57	
	AVERAGE	MAXIMUM		AVERAGE	MAXIMUM
April	0	0	April	0	0
May	0	0	May	0	0
June	0	0	June	0	0
AVERAGE	0	0	AVERAGE	0	0

	WF HOUSE #60		WF HOUSE #61		WF HOUSE #62		WF HOUSE #63		WF HOUSE #64	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	1	6	0	0	0	0	0	0	0	0
May	1	8	0	5	0	0	0	0	0	0
June	1	6	0	0	0	0	0	0	0	0
AVERAGE	1	8	0	5	0	0	0	0	0	0

Appendix D

Deep Disposal Wells Injection Radiological Data

First and Second Quarter, 2019

Crow Butte Uranium Mine
Deep Disposal Well #1 Injection Radiological Data

Month	Total Gallons Injected	Average Natural Uranium (mg/l)	Total Natural Uranium Injected (mg)	Total Natural Uranium Injected (uCi)	Average Radium-226 (pCi/l)	Total Radium-226 Injected (uCi)
January-19	11,380,288	1.12	4.82E+07	3.27E+04	517	2.23E+04
February-19	10,150,848	1.63	6.26E+07	4.24E+04	383	1.47E+04
March-19	9,018,688	2.9	9.90E+07	6.70E+04	524	1.79E+04
April-19	8,335,232	1.49	4.70E+07	3.18E+04	442	1.39E+04
May-19	2,790,400	1.18	1.25E+07	8.44E+03	528	5.58E+03
June-19	1,855,616	2.09	1.47E+07	9.94E+03	509	3.58E+03
Totals	43,531,072		2.84E+08	1.92E+05		7.80E+04

Crow Butte Uranium Mine
Deep Disposal Well #2 Injection Radiological Data

Month	Total Gallons Injected	Average Natural Uranium (mg/l)	Total Natural Uranium Injected (mg)	Total Natural Uranium Injected (uCi)	Average Radium-226 (pCi/l)	Total Radium-226 Injected (uCi)
January-19	1,071,204	1.12	4.54E+06	3.07E+03	517	2.10E+03
February-19	834,085	1.63	5.15E+06	3.48E+03	383	1.21E+03
March-19	782,943	2.9	8.59E+06	5.82E+03	524	1.55E+03
April-19	816,496	1.49	4.61E+06	3.12E+03	442	1.37E+03
May-19	883,815	0.44	1.47E+06	9.97E+02	392	1.31E+03
June-19	691,518	0.666	1.74E+06	1.18E+03	391	1.02E+03
Totals	5,080,061		2.61E+07	1.77E+04		8.56E+03

Appendix E

Radon Release Calculations

First and Second Quarter, 2019

Radon Effluent Release Calculation (Production and Startup)

First Quarter 2019 Radon Release from Leaching Operations:

Curies/M3	*Production Flow (liters)*	*Radon-222 Decay Constant*	*Operating Days*	*Operating Factor*	*M3/liter conversion*	*Hours/Day Conversion*	*Minutes/Hour Conversion*	*Total Radon Release from Leaching*
7.04E-04	568	0.72	90	94.0%	0.001	24	60	35

Second Quarter 2019 Radon Release from Leaching Operations:

Curies/M3	*Production Flow (liters)*	*Radon-222 Decay Constant*	*Operating Days*	*Operating Factor*	*M3/liter conversion*	*Hours/Day Conversion*	*Minutes/Hour Conversion*	*Total Radon Release from Leaching*
7.04E-04	371	0.72	91	100.0%	0.001	24	60	25

First Half 2019 Radon Release From Startup:

Curies/M3	*Total Acres of New Wellfield*	*Meter2/Acre Conversion*	*Orebody Thickness (meters)*	*Porosity*	*Total Radon Release from Startup*
7.04E-04	0.0	4,074	1.52	0.29	0

Total Estimated Radon Release from Production: **60**

Radon Effluent Release Calculation (Restoration)

First Half 2019 Radon Release From Restoration:

Total Restoration Flow (liters)	*Microcuries/liter*	*Curies/Microcurie*	*Production Potential*
400,835,558	0.697	1.00E-06	279

Wellfield Loss (25% of Production Potential):	70
Ion Exchange Loss (10% of Production Potential minus Wellfield Loss):	21
Reverse Osmosis Loss (100% of remaining activity at 0.470 microcuries/liter)	95

Total Reverse Osmosis Flow (liters)	*Microcuries/liter*	*Curies/Microcurie*
201,914,429	0.470	1.00E-06

First Half 2019 Radon Release From Startup of New Restoration:

Curies/M3	*Total Acres of New Wellfield*	*Meter2/Acre Conversion*	*Orebody Thickness (meters)*	*Porosity*	*Total Radon Release from Startup*
7.04E-04	0.00	4074	1.52	0.29	0

Total Estimated Radon Release from Restoration: **186**

Total Estimated Radon Release, First Half 2019: **245**

Appendix F

Main Plant

Track Etch Detectors

Working Level Measurements

Scintillation Cell Measurements

Isotopic Analyses

First Half, 2019

Calculation of Radon Gas Emissions from the Main Plant

First Half of Year

Locations	RnG Concentration (x 10-9 µCi/ml)
01 Blower Pipe (Injection Filters)	4
02 Blower Pipe (Between Injection Tanks)	3.2
03 Boxed Fan (PWT West)	4.5
04 Boxed Fan (PWT East)	11.4
05 Pipe Duct (PWT)	6.2
09 Boxed Fan (Behind Acid Scrubber)	1
12 Shaker Room Blower/Exhaust	8.4

	Average RnG Concentration (µCi/ml)	Plant Vent Rate (CFM)	Plant Vent Rate (ml/6 months)	RnG Emissions (Ci/6 Months)
Plant Average	**5.5E-09**	**49748**	**3.7E+14**	**2.05**

Formula Ci/yr = average (µCi/ml) * ventilation (ml/yr) / (1e6 µCi/Ci)

Calculation of Radon Progeny Emissions from the Plant

First Half of 2019

Exhaust Rate for Building (CFM)	49748
Total Flow from Building (ml/ 6 months)	3.7E+14

Total In Plant Radon Progeny Emissions (Ci/yr] 0.12

Formula Ci/yr = WL * (3e-8 µCi/ml/0.33 WL) * ventilation (ml/6 months) / (1e6 µCi/Ci)

Start Date	1/1/2019	Average	0.0037
End Date	6/30/2019		

SITE_CODE	LOCATION_NAME	START_DATE	RNP_VALUE	AREA_SAMPLE_CLASS_COD	AREA_SAMPLE_TYPE_CODE
CB	R8 Motor Control Room	1/16/2019	0.00073487	Dosimetry	R
CB	R7 Between Precip Cells and Raw Water Tank	1/16/2019	0.00349511	Dosimetry	R
CB	R1 Between IX Columns and Precip Cells	1/16/2019	0.0030707	Dosimetry	R
CB	R2 Between Precip Cells and Eluent Tanks	1/16/2019	0.00296482	Dosimetry	R
CB	R12 Down Flow Column Area	1/16/2019	0.00318443	Dosimetry	R
CB	R13-E Pond Water Treatment Room East	1/16/2019	0.00792721	Dosimetry	R
CB	R13-M Pond Water Treatment Room Middle	1/16/2019	0.01023568	Dosimetry	R
CB	R13-W Pond WaterTreatment Room West	1/16/2019	0.00393371	Dosimetry	R
CB	R3 Between IX Columns and Injection Tanks	1/16/2019	0.00189264	Dosimetry	R
CB	R4 Between IX Columns and Resin Transfer Tanks	1/16/2019	0.00663424	Dosimetry	R
CB	R5 Between IX Columns and Column Drain Tank	1/16/2019	0.00677416	Dosimetry	R
CB	R6 Between IX Column Trains	1/16/2019	0.00578226	Dosimetry	R
CB	R8 Motor Control Room	2/20/2019	0.00152321	Dosimetry	R
CB	R7 Between Precip Cells and Raw Water Tank	2/20/2019	0.00181113	Dosimetry	R
CB	R1 Between IX Columns and Precip Cells	2/20/2019	0.00341408	Dosimetry	R
CB	R2 Between Precip Cells and Eluent Tanks	2/20/2019	0.00266989	Dosimetry	R
CB	R12 Down Flow Column Area	2/20/2019	0.00161427	Dosimetry	R

CB	R13-W Pond WaterTreatment Room West	2/20/2019	0.00711622	Dosimetry	R
CB	R13-M Pond Water Treatment Room Middle	2/20/2019	0.00980182	Dosimetry	R
CB	R13-E Pond Water Treatment Room East	2/20/2019	0.00714002	Dosimetry	R
CB	R3 Between IX Columns and Injection Tanks	2/20/2019	0.00275023	Dosimetry	R
CB	R4 Between IX Columns and Resin Transfer Tanks	2/20/2019	0.00503882	Dosimetry	R
CB	R5 Between IX Columns and Column Drain Tank	2/20/2019	0.0059405	Dosimetry	R
CB	R6 Between IX Column Trains	2/20/2019	0.00431165	Dosimetry	R
CB	R8 Motor Control Room	3/20/2019	0.00035209	Dosimetry	R
CB	R7 Between Precip Cells and Raw Water Tank	3/20/2019	0.00137481	Dosimetry	R
CB	R1 Between IX Columns and Precip Cells	3/20/2019	0.00165925	Dosimetry	R
CB	R2 Between Precip Cells and Eluent Tanks	3/20/2019	0.00259515	Dosimetry	R
CB	R12 Down Flow Column Area	3/20/2019	0.00031382	Dosimetry	R
CB	R13-E Pond Water Treatment Room East	3/20/2019	0.00270666	Dosimetry	R
CB	R13-M Pond Water Treatment Room Middle	3/20/2019	0.0054855	Dosimetry	R
CB	R13-W Pond WaterTreatment Room West	3/20/2019	0.0047193	Dosimetry	R
CB	R3 Between IX Columns and Injection Tanks	3/20/2019	0.00217895	Dosimetry	R
CB	R4 Between IX Columns and Resin Transfer Tanks	3/20/2019	0.00761145	Dosimetry	R
CB	R5 Between IX Columns and Column Drain Tank	3/20/2019	0.00506509	Dosimetry	R
CB	R6 Between IX Column Trains	3/20/2019	0.00318071	Dosimetry	R
CB	R8 Motor Control Room	4/17/2019	0.00070157	Dosimetry	R
CB	R7 Between Precip Cells and Raw Water Tank	4/17/2019	0.00342433	Dosimetry	R
CB	R1 Between IX Columns and Precip Cells	4/17/2019	0.002645	Dosimetry	R
CB	R2 Between Precip Cells and Eluent Tanks	4/17/2019	0.00191763	Dosimetry	R
CB	R12 Down Flow Column Area	4/17/2019	0.00244803	Dosimetry	R
CB	R13-E Pond Water Treatment Room East	4/17/2019	0.01496923	Dosimetry	R
CB	R13-M Pond Water Treatment Room Middle	4/17/2019	0.01128016	Dosimetry	R
CB	R13-W Pond WaterTreatment Room West	4/17/2019	0.00515588	Dosimetry	R
CB	R3 Between IX Columns and Injection Tanks	4/17/2019	0.00339943	Dosimetry	R
CB	R4 Between IX Columns and Resin Transfer Tanks	4/17/2019	0.0052987	Dosimetry	R
CB	R5 Between IX Columns and Column Drain Tank	4/17/2019	0.00570329	Dosimetry	R
CB	R6 Between IX Column Trains	4/17/2019	0.00335585	Dosimetry	R
CB	R8 Motor Control Room	5/22/2019	0.00135312	Dosimetry	R
CB	R7 Between Precip Cells and Raw Water Tank	5/22/2019	0.00033032	Dosimetry	R
CB	R1 Between IX Columns and Precip Cells	5/22/2019	0	Dosimetry	R
CB	R2 Between Precip Cells and Eluent Tanks	5/22/2019	0.00298694	Dosimetry	R
CB	R12 Down Flow Column Area	5/22/2019	0.00171902	Dosimetry	R
CB	R13-E Pond Water Treatment Room East	5/22/2019	0.00242976	Dosimetry	R

CB	R13-M Pond Water Treatment Room Middle	5/22/2019	0.00363965	Dosimetry	R
CB	R13-W Pond WaterTreatment Room West	5/22/2019	0.00433921	Dosimetry	R
CB	R3 Between IX Columns and Injection Tanks	5/22/2019	0.00073888	Dosimetry	R
CB	R4 Between IX Columns and Resin Transfer Tanks	5/22/2019	0.0033312	Dosimetry	R
CB	R5 Between IX Columns and Column Drain Tank	5/22/2019	0.00257375	Dosimetry	R
CB	R6 Between IX Column Trains	5/22/2019	0.00317001	Dosimetry	R
CB	R8 Motor Control Room	6/19/2019	0.00332253	Dosimetry	R
CB	R7 Between Precip Cells and Raw Water Tank	6/19/2019	0	Dosimetry	R
CB	R1 Between IX Columns and Precip Cells	6/19/2019	0	Dosimetry	R
CB	R2 Between Precip Cells and Eluent Tanks	6/19/2019	0.00167993	Dosimetry	R
CB	R12 Down Flow Column Area	6/19/2019	0.00065006	Dosimetry	R
CB	R13-E Pond Water Treatment Room East	6/19/2019	0.0071642	Dosimetry	R
CB	R13-M Pond Water Treatment Room Middle	6/19/2019	0.00508347	Dosimetry	R
CB	R13-W Pond WaterTreatment Room West	6/19/2019	0.00316279	Dosimetry	R
CB	R3 Between IX Columns and Injection Tanks	6/19/2019	0.00193814	Dosimetry	R
CB	R4 Between IX Columns and Resin Transfer Tanks	6/19/2019	0.00453881	Dosimetry	R
CB	R5 Between IX Columns and Column Drain Tank	6/19/2019	0.00257782	Dosimetry	R
CB	R6 Between IX Column Trains	6/19/2019	0.00253413	Dosimetry	R

Tank Vent Effluent (RnP and RnG Emissions from Tank Vents)

First Half Data

				First Quarter Results						Second Quarter Results					
Location	Ventalation Blower Flow Rates (cfm)	Ventalation Blower Flow Rates (m^3/min)	Ventalation Blower Flow Rates (L/min)	RnG Filling pCi/l	RnP Filling WL	RnG Draining pCi/l	RnP Draining WL	RnG Steady pCi/l	RnP Steady WL	RnG Filling pCi/l	RnP Filling WL	RnG Draining pCi/l	RnP Draining WL	RnG Steady pCi/l	RnP Steady WL
6 - Pond Water Treat. Fan	4700	133.1	133089.0					19.55	0.071					16.37	0.033
8 - Waste Tank Blower	1500	42.5	42475.2					92.7	0.021					1011.02	0.048
10 - Precip Demister Fan	1500	42.5	42475.2	191.022	0.022			6.05	0.003					0.09	0.005
11 - Shaker Deck Blower	800	22.7	22653.4	6226.66	0.587	14.03	0.043	2.37	0.005					0	0.000
13 - Eluent Tank Blower	1500	42.5	42475.2	518.67	0.337	426.98	0.016	2.53	0.003					299.13	0.004
14 - Precip A Blower	185	5.2	5238.6					1.15	0.011					2.34	0.003
15 - East Train/West Train/Backwash Tank Blower	6000	169.9	169900.8					9717.7	9.95					7368.31	9.205

Footnote: Locations numbered per HPC Air Ventilation Study - August 2013 (LRA SUA 1534 November 2014 Appendix C) ML15310A373

First Half Results

				Average for First Half of Year													
Location	Ventalation Blower Flow Rates (cfm)	Ventalation Blower Flow Rates (m^3/min)	Ventalation Blower Flow Rates (L/min)	RnG Filling pCi/l	RnP Filling WL	RnG Draining pCi/l	RnP Draining WL	RnG Steady pCi/l	RnP Steady WL	Average RnG (pCi/l)	Average RnG (pCi/min)	Average RnG Emissions (Ci/6months)	Average RnP Emissions (Ci/6 months)	Max RnG (pCi/l)	Max RnG (pCi/min)	Maximum RnG Emissions (Ci/6 months)	Maximum RnP Emissions (Ci/6 months)
6 - Pond Water Treat. Fan	4700	133.1	133089.0					18.0	0.1	18.0	2.39E+06	0.63	0.2	18.0	2.39E+06	0.63	0.17
8 - Waste Tank Blower	1500	42.5	42475.2					551.9	0.0	551.9	2.34E+07	6.16	0.0	551.9	2.34E+07	6.16	0.04
10 - Precip Demister Fan	1500	42.5	42475.2	191.0	0.0			3.1	0.0	97.0	4.12E+06	1.08	0.0	191.0	8.11E+06	2.13	0.02
11 - Shaker Deck Blower	800	22.7	22653.4	6226.7	0.6	14.0	0.0	1.2	0.0	2080.6	4.71E+07	12.39	0.1	6226.7	1.41E+08	37.07	0.32
13 - Eluent Tank Blower	1500	42.5	42475.2	518.7	0.3	427.0	0.0	150.8	0.0	365.5	1.55E+07	4.1	0.1	518.7	2.20E+07	5.79	0.34
14 - Precip A Blower	185	5.2	5238.6					1.7	0.0	1.7	9.14E+03	0.0	0.0	1.7	9.14E+03	0.00	0.00
15 - East Train/West Train/Backwash Tank Blower	6000	169.9	169900.8					8543.0	9.6	8543.0	1.45E+09	381.4	38.9	8543.0	1.45E+09	381.44	38.88

Footnote: Locations numbered per HPC Air Ventilation Study - August 2013 (LRA SUA 1534 November 2014 Appendix C) ML15310A373

Sum	405.8	39.3
First Half 2019 Tank RnP and RnG		

433.23	39.76
472.99	

Calculation of Particulate Emissions from the Plant

2019

	Run Time (min)	Flow Rate (LPM)	Total Volume (L)	Lab Result (µCi/ml) Lead 210	Radium 226	Thorium 230	Uranium	Calculated Result (µCi/ml) Th234	Po-210
Between IX Train	11151	49.61	553161.0	1.10E-13	3.30E-16	5.30E-16	2.90E-15	1.42E-15	1.10E-13
Below Thickener Tank	11151	49.80	555330.0	1.00E-13	5.50E-16	5.00E-17	1.40E-14	6.86E-15	1.00E-13
Top of Precip B	11150	49.66	553708.0	3.50E-14	3.40E-16	1.40E-15	9.50E-15	4.66E-15	3.50E-14
Belt Filter Room	11152	49.59	553058.0	2.90E-14	7.40E-16	6.90E-16	7.60E-14	3.72E-14	2.90E-14
Top of Tall White Tanks	11158	49.61	553569.0	3.50E-14	4.70E-16	9.80E-16	5.60E-14	2.74E-14	3.50E-14
Dryer Change Room	11151	47.50	529672.5	5.20E-14	7.20E-16	4.70E-15	1.20E-15	5.88E-16	5.20E-14
R.O. Building	11451	49.56	567460.0	5.60E-14	1.20E-15	8.10E-16	4.40E-16	2.16E-16	5.60E-14
10 CFR 20 Effluent Limit				**1.00E-10**	**3.00E-10**	**6.00E-12**	**2.00E-11**	**3.00E-10**	**9.00E-13**
RL				**2.00E-15**	**1.00E-16**	**1.00E-16**	**1.00E-16**		

Note: if result was non-detect, 1/2 RL was used

Exhaust Rate for Building (CFM)	49748
Total Flow from Building (ml/ 6 months)	3.70E+14

Total Emissions of Each Radionuclide for First Half of 2019

	Emission (Ci/yr)
Lead 210	2.21E-05
Radium 226	2.30E-07
Thorium 230	4.84E-07
Uranium	8.46E-06
Th234	4.15E-06
Po-210	2.21E-05
Sum	**5.74E-05**

Appendix G

Wellfield

Scintillation Cell Measurements

First and Second Quarter, 2019

Calculation of Radon Gas Emissions from Venting Wellheads

First Half of Year

	RnG (pCi/L)
Average RnG vented from Wellheads - Q1	N/A
Average RnG vented from Wellheads - Q2	N/A

Total Emissions for First Half

Average RnG (pCi/L)	0	
Casing volume (L)	1563.75	(4.5 in diameter, 500 ft depth)
Wellheads bled/Month	0	
Wellheads bled/6 Months	0	
Ci/6 Months	**0.00E+00**	

Appendix H

Wellhouses

Track Etch Detectors

Working Level Measurements

Isotopic Analyses

First and Second Quarter, 2019

Calculation of Radon Gas Emissions from Wellhouses

First Half of Year

Wellhouses	RnG Concentration (x 10-9 µCi/ml)
Wellhouse 9 (Restoration)	63.8
Wellhouse 13 (Restoration)	2.1
Wellhouse 20 (Restoration)	8.6
Wellhouse 25 (Production)	0.16
Wellhouse 31 (Production)	6.2
Wellhouse 37 (Production)	44.2
Wellhouse 44 (Production)	1.3
Wellhouse 51 (Production)	0.86
Wellhouse 9 (Restoration)*	63.8

Total Emissions for First Half of 2017

	Average RnG Concentration (µCi/ml)	WH Vent Rate (CFM)	WH Vent Rate (ml/6 months)	# WH	RnG Emissions (Ci/6 Months)
WH Avg Concentration (Restoration)	3.62E-09	800	6.0E+12	24	0.52
WH Avg Concentration (Production)	1.31E-08	800	6.0E+12	39	3.05
*WH Not part of Average	6.38E-08	800	6.0E+12	1	0.38
			Total Radon Gas Emissions from WH's		**3.95**

Formula Ci/yr = average (µCi/ml) * ventilation (ml/yr) * # WH / (1e6 µCi/Ci)

Calculation of Radon Progeny Emissions from Wellhouses

First Half of Year

Wellhouses	WL Q1	Q2	Average
Wellhouse 9 (Restoration)	0.009	0.011	0.010
Wellhouse 13 (Restoration)	0.003	0.002	0.003
Wellhouse 20 (Restoration)	0.004	0.003	0.004
Wellhouse 25 (Production)	0.004	0.01	0.007
Wellhouse 31 (Production)	0.007	0.001	0.004
Wellhouse 37 (Production)	0.011	0.005	0.008
Wellhouse 44 (Production)	0.001	0.002	0.002
Wellhouse 51 (Production)	0.002	0.002	0.002
Wellhouse 9 (Restoration)*	0.009	0.011	0.010

Total Emissions for First Half of 2019

	Average WL	WH Vent Rate (CFM)	WH Vent Rate (ml/ 6months)	# of WH	Ci/6 Months (RnP)
WH Avg Concentration (Restoration)	0.004	800	6.0E+12	24	0.06
WH Avg Concentration (Production)	0.004	800	6.0E+12	39	0.08
*WH Not part of Average	0.010	800	6.0E+12	1	0.01
			First Half Radon Progeny Emmissions from WH		**0.14**

Formula Ci/yr = WL * (3e-8 µCi/ml/0.33 WL) * ventilation (ml/6 months) * # of WH / (1e6 µCi/Ci)

Calculation of Particulate Emissions from the Wellhouses

First Half of Year

	Run Time (min)	Flow Rate (LPM)	Total Volume (L)	Lab Result (µCi/ml) Lead 210	Radium 226	Thorium 230	Uranium	Calculated Result (µCi/ml) Th234	Po-210
Wellhouse 9 (Restoration)	20363	49.5998	1010000.0	3.50E-14	3.50E-16	3.00E-16	4.60E-16	2.25E-16	3.50E-14
Wellhouse 13 (Restoration)	20363	49.5998	1010000.0	1.90E-14	1.90E-16	2.40E-16	1.60E-15	7.84E-16	1.90E-14
Wellhouse 20 (Restoration)	20380	49.5584	1010000.0	2.20E-14	2.20E-16	2.20E-16	5.00E-16	2.45E-16	2.20E-14
Wellhouse 25 (Production)	20379	49.5608	1010000.0	1.80E-14	1.80E-16	4.30E-16	6.40E-16	3.14E-16	1.80E-14
Wellhouse 31 (Production)	18715	49.6686	929547.0	5.30E-14	7.10E-16	5.90E-16	1.50E-15	7.35E-16	5.30E-14
Wellhouse 37 (Production)	18667	49.6623	927046.0	3.90E-14	5.00E-17	7.80E-16	8.30E-16	4.07E-16	3.90E-14
Wellhouse 44 (Production)	18733	49.7295	931582.0	4.50E-14	1.20E-16	3.50E-15	1.30E-15	6.37E-16	4.50E-14
Wellhouse 51 (Production)	18668	49.7423	928590.0	1.50E-14	1.40E-16	2.80E-16	3.90E-16	1.91E-16	1.50E-14
10 CFR 20 Effluent Limit				**1.00E-10**	**3.00E-10**	**6.00E-12**	**2.00E-11**	**3.00E-10**	**9.00E-13**
RL				**2.00E-15**	**1.00E-16**	**1.00E-16**	**1.00E-16**		

Note: if result was non-detect, 1/2 RL was used

Exhaust Rate for Wellhouse (CFM)	800	
Total Flow from Building (ml/ 6 months)	6.0E+12	(1 ft3 = 28316.84659 ml)
# Wellhouses	64	

Total Emissions of Each Radionuclide for First Half of Year

	Emission (Ci/6 Months)
Lead 210	1.17E-05
Radium 226	9.33E-08
Thorium 230	3.02E-07
Uranium	3.44E-07
Th234	1.68E-07
Po-210	1.17E-05
Sum	**2.43E-05**

Calculation of Particulate Emissions from DeepWell Buildings

First Half of Year

	Run Time (min)	Flow Rate (LPM)	Total Volume (L)	Lab Result (µCi/ml) Lead 210	Radium 226	Thorium 230	Uranium	Calculated Result (µCi/ml) Th234	Po-210
DeepWell Building #1	15623	49.72188	776805.0	3.20E-14	3.20E-16	5.00E-17	1.70E-15	8.33E-16	3.20E-14
DeepWell Building #2	15647	49.61641	776348.0	2.50E-14	5.00E-17	8.70E-16	4.90E-16	2.40E-16	2.50E-14
10 CFR 20 Effluent Limit				**1.00E-10**	**3.00E-10**	**6.00E-12**	**2.00E-11**	**3.00E-10**	**9.00E-13**
RL				**2.00E-15**	**1.00E-16**	**1.00E-16**	**1.00E-16**		

Note: if result was non-detect, 1/2 RL was used

	Building 1	Building 2
Exhaust Rate for Wellhouse (CFM)	800	800
Total Flow from Building (ml/ 6 months)	6.0E+12	6.0E+12

(1 ft3 = 28316.84659 ml)

Total Emissions of Each Radionuclide for First Half of Year

	Emission (Ci/6 Months) Building 1	Building 2
Lead 210	1.91E-07	1.49E-07
Radium 226	1.91E-09	2.98E-10
Thorium 230	2.98E-10	5.18E-09
Uranium	1.01E-08	2.92E-09
Th234	4.96E-09	1.43E-09
Po-210	1.91E-07	1.49E-07
By Building	**3.98E-07**	**3.07E-07**
Total	**7.06E-07**	

Crow Butte Resources

Wellhouse Radon Daughters Summary **C.Yada**

WH#	2019 2nd Qtr. Working Level Concentration	Date	2019 1st Qtr. Working Level Concentration	Date
3	0.002	4/9/2019	0.003	1/15/2019
4	0.003	4/9/2019	0.003	1/15/2019
5	0.002	4/9/2019	0.003	1/15/2019
6	0.005	4/9/2019	0.003	1/15/2019
7	0.006	4/9/2019	0.001	1/15/2019
8	0.004	4/9/2019	0.002	1/15/2019
9	0.011	4/9/2019	0.009	1/15/2019
10	0.020	4/9/2019	0.009	1/15/2019
11	0.001	4/9/2019	0.003	1/15/2019
12	0.001	4/9/2019	0.003	1/15/2019
13	0.002	4/9/2019	0.003	1/16/2019
14	0.003	4/9/2019	0.004	1/16/2019
15	0.001	4/9/2019	0.003	1/16/2019
16	0.003	4/9/2019	0.004	1/16/2019
17	0.002	4/9/2019	0.002	1/16/2019
18	0.003	4/9/2019	0.005	1/16/2019
19	0.002	4/9/2019	0.003	1/16/2019
20	0.003	4/9/2019	0.004	1/16/2019
21	0.005	4/9/2019	0.002	1/16/2019
22	0.008	4/9/2019	0.005	1/16/2019
23	0.001	4/9/2019	0.002	1/16/2019
24	0.027	4/9/2019	0.004	1/16/2019
25	0.010	4/9/2019	0.004	1/16/2019
26	0.021	4/9/2019	0.003	1/16/2019
27	0.001	4/9/2019	0.002	1/16/2019
28	0.002	5/20/2019	0.015	2/12/2019
29	0.001	5/20/2019	0.018	2/12/2019
30	0.001	5/20/2019	0.002	2/12/2019
31	0.001	5/20/2019	0.007	2/12/2019
32	0.000	5/20/2019	0.009	2/12/2019
33	0.000	5/20/2019	0.009	2/12/2019
34	0.003	5/20/2019	0.003	2/12/2019
35	0.000	5/20/2019	0.002	2/12/2019
36	0.003	5/20/2019	0.003	2/12/2019
37	0.005	5/21/2019	0.011	2/12/2019

Crow Butte Resources

Wellhouse Radon Daughters Summary **C.Yada**

WH#	2019 2nd Qtr. Working Level Concentration	Date	2019 1st Qtr. Working Level Concentration	Date
38	0.005	5/20/2019	0.006	2/12/2019
39	0.005	5/21/2019	0.003	2/12/2019
40	0.001	5/20/2019	0.003	2/12/2019
41	0.000	5/21/2019	0.001	2/13/2019
42	0.002	5/21/2019	0.001	2/13/2019
43	0.002	5/21/2019	0.001	2/13/2019
44	0.002	5/21/2019	0.001	2/13/2019
45	0.001	5/21/2019	0.001	2/13/2019
46	0.000	5/20/2019	0.001	2/13/2019
46A	0.000	5/20/2019	0.002	2/13/2019
47	0.000	5/21/2019	0.001	2/13/2019
47A	0.001	5/21/2019	0.000	2/13/2019
48	0.001	5/20/2019	0.003	2/13/2019
49	0.019	5/20/2019	0.018	2/13/2019
50	0.000	5/20/2019	0.001	2/13/2019
51	0.002	6/25/2019	0.002	3/20/2019
52	0.000	6/25/2019	0.001	3/20/2019
53	0.002	6/25/2019	0.002	3/20/2019
54	0.002	6/25/2019	0.003	3/20/2019
55	0.000	6/25/2019	0.004	3/20/2019
56	0.000	6/25/2019	0.002	3/20/2019
57	0.002	6/25/2019	0.004	3/20/2019
60	0.001	6/25/2019	0.003	3/20/2019
61	0.002	6/25/2019	0.001	3/20/2019
62	0.001	6/25/2019	0.005	3/20/2019
63	0.000	6/25/2019	0.004	3/20/2019
64	0.002	6/25/2019	0.005	3/20/2019
DDW-1	0.002	6/26/2019	0.001	3/20/2019
DDW-2	0.002	6/26/2019	0.001	3/20/2019

Appendix I

Environmental Air Monitoring Results

First and Second Quarter, 2019

Crow Butte Resources, Inc.
Crow Butte Uranium Project

Track Etch Cup Ambient Radon Concentrations

Air Monitoring Station No.

Period: January 3,2019 to July 1,2019

	Gross Count	Average Radon Concentration ($\times 10^{-9}$ µCi/ml)	Accuracy ($\times 10^{-9}$ µCi/ml)	Percent Effluent Concentration
AM-1	18.0	0.11	0.03	1.1%
AM-2	14.0	0.08	0.02	0.8%
AM-3	16.0	0.08	0.02	0.8%
AM-4	15.0	0.08	0.02	0.8%
AM-5	17.0	0.08	0.02	0.8%
AM-6A	21.0	0.11	0.02	1.1%
AM-6B	32.0	0.19	0.03	1.9%
AM-6C	23.0	0.14	0.03	1.4%
AM-6D	20.0	0.11	0.02	1.1%
AM-6E	25.0	0.14	0.03	1.4%
AM-6F	24.0	0.14	0.03	1.4%
AM-8	26.0	0.14	0.03	1.4%
AM-9A	16.0	0.08	0.02	0.8%
AM-9B	18.0	0.11	0.03	1.1%
AM-9C	12.0	0.08	0.02	0.8%
AM-9D	16.0	0.08	0.02	0.8%
AM-9E	18.0	0.11	0.03	1.1%
AM-9F	17.0	0.08	0.02	0.8%

LLD ($\times 10^{-9}$ µCi/ml)	0.2
Effluent Concentration Limit, 10 CFR 20 App B Column 2:	10

Inter-Mountain Labs
Your Environmental Monitoring Partner
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Air Filter Summary Report

Client: Cameco Resources, Crow Butte Operation

Client Sampler ID: AM-1

Lab ID S1904114-001 — **Sample Air Volume: 6296603 Liters**
Samples1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	114	7.4	1.8E-14	1.2E-15	2E-15	6 E-13	Day	3.0
Radium 226	0.3	0.1	4.9E-17	1.6E-17	1E-16	9 E-13	Week	0.0054
Thorium 230	0.3	0.2	4.5E-17	3.2E-17	1E-16	3 E-14	Year	0.15
Uranium	0.2		2.8E-17		1E-16	9 E-14	Year	0.031

Client Sampler ID: AM-1

Lab ID S1907088-001 — **Sample Air Volume: 6463078 Liters**
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	62.5	4.3	9.7E-15	6.7E-16	2E-15	1 E-10	Day	0.0097
Radium 226	0.3	0.2	5.0E-17	3.1E-17	1E-16	3 E-10	Week	0.000017
Thorium 230	0.11	0.1	0.0E+0	1.5E-17	1E-16	6 E-12	Year	0
Uranium	0.2		2.5E-17		1E-16	2 E-11	Year	0.00012

Client Sampler ID: AM-2

Lab ID S1904114-002 — **Sample Air Volume: 6302678 Liters**
Samples1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	131	6.7	2.1E-14	1.1E-15	2E-15	6 E-13	Day	3.5
Radium 226	0.28	0.1	4.5E-17	1.6E-17	1E-16	9 E-13	Week	0.0050
Thorium 230	0.5	0.2	7.2E-17	3.2E-17	1E-16	3 E-14	Year	0.24
Uranium	0.2		2.9E-17		1E-16	9 E-14	Year	0.032

Client Sampler ID: AM-2

Lab ID S1907088-002 — **Sample Air Volume: 6473542 Liters**
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	56.3	4.2	8.7E-15	6.5E-16	2E-15	1 E-10	Day	0.0087
Radium 226	0.20	0.1	3.2E-17	1.5E-17	1E-16	3 E-10	Week	0.000011
Thorium 230	0.16	0.1	0.0E+0	1.5E-17	1E-16	6 E-12	Year	0
Uranium	0.2		2.8E-17		1E-16	2 E-11	Year	0.00014

Client Sampler ID: AM-3

Lab ID S1904114-003 — **Sample Air Volume: 6321942 Liters**
Samples1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	680	13.7	1.1E-13	2.2E-15	2E-15	6 E-13	Day	18
Radium 226	0.18	0.1	2.8E-17	1.6E-17	1E-16	9 E-13	Week	0.0031
Thorium 230	0.3	0.2	4.9E-17	3.2E-17	1E-16	3 E-14	Year	0.16
Uranium	1.2		1.9E-16		1E-16	9 E-14	Year	0.21

Client Sampler ID: AM-3

Lab ID S1907088-003 — **Sample Air Volume:** 6501510 Liters
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	47.4	3.9	7.3E-15	6.0E-16	2E-15	1 E-10	Day	0.0073
Radium 226	0.15	0.1	2.3E-17	1.5E-17	1E-16	3 E-10	Week	0.0000077
Thorium 230	0.14	0.1	0.0E+0	1.5E-17	1E-16	6 E-12	Year	0
Uranium	0.2		2.4E-17		1E-16	2 E-11	Year	0.00012

Client Sampler ID: AM-4

Lab ID S1904114-004 — **Sample Air Volume:** 6309056 Liters
Samples1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	142	8.1	2.3E-14	1.3E-15	2E-15	6 E-13	Day	3.8
Radium 226	0.18	0.1	2.9E-17	1.6E-17	1E-16	9 E-13	Week	0.0032
Thorium 230	0.1	0.1	0.0E+0	1.6E-17	1E-16	3 E-14	Year	0
Uranium	0.4		6.4E-17		1E-16	9 E-14	Year	0.071

Client Sampler ID: AM-4

Lab ID S1907088-004 — **Sample Air Volume:** 6442350 Liters
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	61.1	4.3	9.5E-15	6.7E-16	2E-15	1 E-10	Day	0.0095
Radium 226	0.24	0.2	3.9E-17	3.1E-17	1E-16	3 E-10	Week	0.000013
Thorium 230	0.12	0.1	0.0E+0	1.6E-17	1E-16	6 E-12	Year	0
Uranium	0.2		3.1E-17		1E-16	2 E-11	Year	0.00016

Client Sampler ID: AM-5

Lab ID S1904114-005 — **Sample Air Volume:** 6305654 Liters
Samples1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	125	7.4	2.0E-14	1.2E-15	2E-15	6 E-13	Day	3.3
Radium 226	0.20	0.1	3.2E-17	1.6E-17	1E-16	9 E-13	Week	0.0036
Thorium 230	0.1	0.1	0.0E+0	1.6E-17	1E-16	3 E-14	Year	0
Uranium	0.2		3.3E-17		1E-16	9 E-14	Year	0.037

Client Sampler ID: AM-5

Lab ID S1907088-005 — **Sample Air Volume:** 6496218 Liters
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	42.3	4.0	6.5E-15	6.2E-16	2E-15	1 E-10	Day	0.0065
Radium 226	0.28	0.1	4.5E-17	1.5E-17	1E-16	3 E-10	Week	0.000015
Thorium 230	0.13	0.1	0.0E+0	1.5E-17	1E-16	6 E-12	Year	0
Uranium	0.3		4.6E-17		1E-16	2 E-11	Year	0.00023

Client Sampler ID: AM-6

Lab ID S1904114-006 — **Sample Air Volume:** 6282149 Liters
Samples1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	110	7.9	1.7E-14	1.3E-15	2E-15	6 E-13	Day	2.8
Radium 226	0.20	0.1	3.3E-17	1.6E-17	1E-16	9 E-13	Week	0.0037
Thorium 230	1.9	0.5	3.0E-16	8.0E-17	1E-16	3 E-14	Year	1.0
Uranium	0.3		5.3E-17		1E-16	9 E-14	Year	0.059

Client Sampler ID: AM-6

Lab ID S1907088-006 — **Sample Air Volume:** 6001550 Liters
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	41.6	4.0	6.9E-15	6.7E-16	2E-15	1 E-10	Day	0.0069
Radium 226	0.15	0.1	2.6E-17	1.7E-17	1E-16	3 E-10	Week	0.0000087
Thorium 230	0.7	0.3	1.1E-16	5.0E-17	1E-16	6 E-12	Year	0.0018
Uranium	0.2		3.6E-17		1E-16	2 E-11	Year	0.00018

Client Sampler ID: AM-8

Lab ID S1904114-007 — **Sample Air Volume:** 6294572 Liters
Samples 1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	171	10.1	2.7E-14	1.6E-15	2E-15	6 E-13	Day	4.5
Radium 226	0.09	0.1	0.0E+0	1.6E-17	1E-16	9 E-13	Week	0
Thorium 230	0.4	0.2	6.3E-17	3.2E-17	1E-16	3 E-14	Year	0.21
Uranium	0.2		3.5E-17		1E-16	9 E-14	Year	0.039

Client Sampler ID: AM-8

Lab ID S1907088-007 — **Sample Air Volume:** 6505088 Liters
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	71.0	4.8	1.1E-14	7.4E-16	2E-15	1 E-10	Day	0.011
Radium 226	0.13	0.1	2.0E-17	1.5E-17	1E-16	3 E-10	Week	0.0000067
Thorium 230	0.09	0.1	0.0E+0	1.5E-17	1E-16	6 E-12	Year	0
Uranium	0.2		2.9E-17		1E-16	2 E-11	Year	0.00014

Client Sampler ID: AM-9

Lab ID S1904114-008 — **Sample Air Volume:** 6271862 Liters
Samples 1/3/19-4/1/19 (2019 1st Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	120	6.6	1.9E-14	1.1E-15	2E-15	6 E-13	Day	3.2
Radium 226	0.17	0.1	2.8E-17	1.6E-17	1E-16	9 E-13	Week	0.0031
Thorium 230	0.4	0.2	7.1E-17	3.2E-17	1E-16	3 E-14	Year	0.24
Uranium	0.2		3.5E-17		1E-16	9 E-14	Year	0.039

Client Sampler ID: AM-9

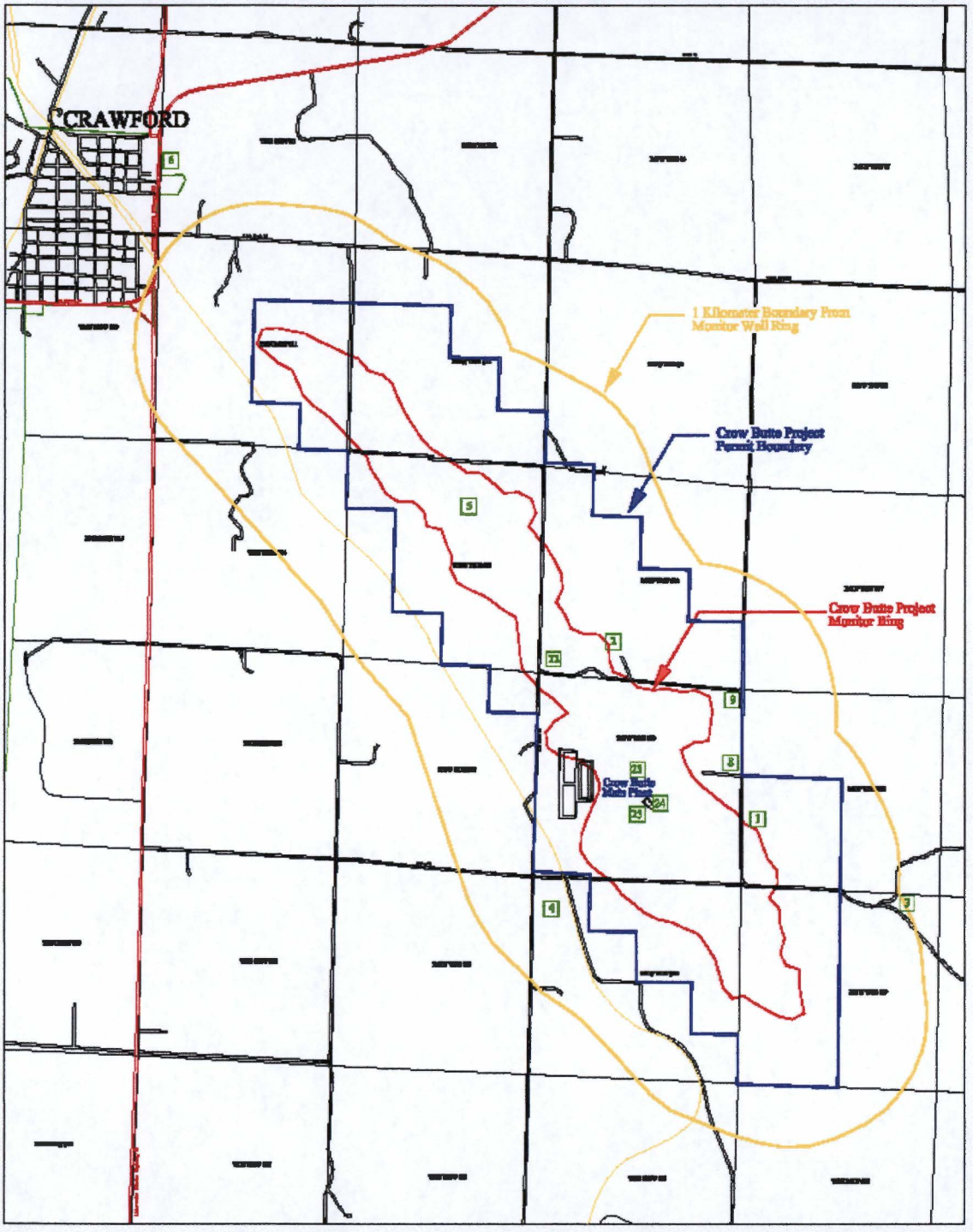
Lab ID S1907088-009 — **Sample Air Volume:** 6516653 Liters
Sampled 4/1/19-7/1/19 (Q2 2019)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Occupational Limit	Effluent Class	% DAC Conc.
Lead 210	130	6.1	2.0E-14	9.4E-16	2E-15	1 E-10	Day	0.020
Radium 226	0.19	0.1	2.9E-17	1.5E-17	1E-16	3 E-10	Week	0.0000097
Thorium 230	0.7	0.3	1.1E-16	4.6E-17	1E-16	6 E-12	Year	0.0018
Uranium	<0.3		2.3E-17		1E-16	2 E-11	Year	0.00012

Effluent Limits are from 10 CFR Part 20 Appendix B Table 2

ND - Not Detected at the Reporting Limit

Regional Sampling Locations



CROW BUTTE RESOURCES

8 Air Monitoring Station, Radon, Soil, Direct Radiation

0 500 1000 2000 meters

0 1000 3000 5000 feet

Appendix J

Environmental OSL Monitoring Results

First and Second Quarter, 2019

Crow Butte Resources

Crow Butte Uranium Project

Perimeter Air Monitoring Stations

Gamma Exposure Results

Location	Exposure of Dosimeter (mrems ambient dose equivalent)		Net Cumulative Totals		
	Gross	Net	Calendar Quarter	Year to Date	Permanent
1/1/2019 -3/31/2019					
Transient Control	--	0.0	Q1	2019	--
Deploy Control	22.2	0.0	--	--	--
AM-1	32.0	9.8	9.8	9.8	361.2
AM-2	30.3	8.1	8.1	8.1	392.9
AM-3	33.6	11.4	11.4	11.4	426.9
AM-4	32.5	10.3	10.3	10.3	327.0
AM-5	33.7	11.5	11.5	11.5	426.2
AM-6	33.4	11.1	11.1	11.1	380.0
AM-8	34.0	11.8	11.8	11.8	498.5
AM-9	33.6	11.4	-	-	--

mrem – millirems

AM-1 air sampling locations

Minimum Detectable Dose = 0.1 mrems ambient dose equivalent

Crow Butte Resources

Crow Butte Uranium Project

Perimeter Air Monitoring Stations

Gamma Exposure Results

Location	Exposure of Dosimeter (mrems ambient dose equivalent)		Net Cumulative Totals		
	Gross	Net	Calendar Quarter	Year to Date	Permanent
4/1/2019 - 6/30/2019					
Transient Control	--	0.0	Q2	2019	--
Deploy Control	26.9	0.0	--	--	--
AM-1	28.7	8.8	8.8	18.6	369.9
AM-2	37.7	10.9	10.9	19.0	403.7
AM-3	40.3	13.4	13.4	24.8	440.3
AM-4	37.2	10.4	10.4	20.7	337.3
AM-5	40.4	13.5	13.5	25.0	439.7
AM-6	39.7	12.8	12.8	24.0	392.9
AM-8	38.8	12.0	12.0	23.8	510.5
AM-9	37.3	10.4	-	--	--

mrem – millirems

AM-1 air sampling locations

Minimum Detectable Dose = 0.1 mrems ambient dose equivalent