Linton, Ron

From: Scott Schierman (USA - Casper) <Scott.Schierman@uranium1.com>
Sent: Wednesday, September 19, 2018 10:45 AM
To: Linton, Ron
Subject: [External_Sender] 1st Half 2018 Semi-Annual Effluent Report Willow Creek
Attachments: Semi Annual Report August 2018 Final.pdf

Ron

For some reason not able to send FedEx to the NRC address must be related to storm activities along the east coast. As discussed please fin an electronic copy of the 1st Half 2018 Semi-effluent Report for the Willow Creek facility.

This will be an electronic submittal only for this document.

If you have any questions regarding this matter please contact at (307) 233-6330 or email at scott.schierman@uranium1.com.

Regards,

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Willow Creek ISR Project
License Number SUA-1341
Docket No.040-08502

First Half 2018
Semi-Annual Report

January 01, 2018 through June 30, 2018

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1.0 INTRODUCTION

In accordance with Sections 12.1 and 12.3 of the Nuclear Regulatory Commission (NRC) Source License No. SUA-1341, Uranium One USA, Inc. hereby submits the 1st half of 2018 Semi-Annual Effluent and Monitoring Report. This document summarizes the required operational and environmental monitoring activities conducted at the Irigaray (IR) and Christensen Ranch (CR) projects from January 1, 2018 through June 30, 2018.

2.0 OPERATIONAL MONITORING

2.1 Activities Summary

During the report period, limited production operations occurred within Mine Units 7, 8, and 10. Uranium One notified NRC on May 16, 2018 that Willow Creek operations would be transitioning from a low production mode of operations to Care and Maintenance (C&M) over the next 8.5 months. Full C&M is scheduled to begin in February 2019 and is planned to continue for a 5-year period unless market conditions substantially change. Flow from currently operating wellfields (MU7, 8, 10 and Module 5-2) will continue at a rate sufficient to maintain a hydraulic gradient inwards toward the center of the wellfield. During this C&M period, wellfield maintenance work will proceed. Maintenance planned includes the 5-year mechanical integrity testing (MIT) of well casings in Mine Units 7, 8 and 10 as per regulatory requirements.

2.2 Excursion Well Status

Uranium One had one (1) monitor well from a previously restored wellfield that went on excursion status during the report period. Monitor well 4MW-15 was confirmed to be on excursion June 30, 2018. Emails, written notifications and summary reports were submitted to the WDEQ and NRC regarding this event and will not be duplicated in this report.

2.3 Groundwater Volumes Injected and Recovered

During this reporting period an overall wellfield bleed was maintained at 5.3%. A total of 403,407,042 gallons were injected and 426,174,488 gallons were recovered during this period. During the reporting period all mine units averaged at least at 1.0% bleed. The data is summarized by wellfield in Table 1 and is located in Appendix A of this report.

2.4 Injection Manifold Pressures

Injection manifold pressures at the CR project are limited to 140 psi during wellfield operations and 168 psi during maintenance tasks, as per License Condition 11.1. Injection manifold pressures are continuously logged by pressure chart recorders located in every wellfield module building. The data from these logs are summarized in Table 2 of Appendix A. During the reporting period, forty-four occurrences were observed that the manifold pressure exceeded the 140 psi limit. All occurrences were a quick pressure spike, the exceedances were not sustained, and normal pressures below

140 psi were obtained within seconds. Through our self-auditing system, Uranium One recognized an increase number of pressure spike instances and began corrective actions to address the issue. Review of the occurrences of manifold pressure exceedance were attributed to power interruptions and wellfield auto valves not responding quick enough to operational changes. Corrective actions have included calibration of wellfield auto values to respond quicker and conducted additional training for wellfield operational personnel. Corrective actions implemented were effective in reducing the number of occurrences by approximately forty percent from the first to second quarter.

2.5 Summary of Mechanical Integrity Testing (MIT)

During the report period, Mechanical Integrity Tests (MIT's) were completed on a total of 325 wells. The MIT's were completed using the "Two Packer Pressurized Test Method" approved in Permit No. 478. Of the total of 325 MIT's that were performed, there were five (5) failures. Since the reporting period, two (2) of the wells that initially failed MIT have been repaired, retested and put back into production.

The MIT's were completed in the following area:

Location	Number MIT's	Number Failures
Mine Unit 7	6	1
Mine Unit 8	23	0
Mine Unit 10	296	4

There were four (4) wells in Mine Unit 10 that were grouted during the period of January 1, 2018 through June 30, 2018. The four (4) wells that were grouted have not been (surface) abandoned as of June 30, 2018 as agreed to by Wyoming Department of Environmental Quality/ Land Quality Division (WDEQ/LQD). The well abandonment records are maintained on site.

3.0 Restoration

3.1 Christensen Ranch:

All groundwater restoration activities, including stabilization monitoring, ended at Christensen Ranch Mine Units 2 through 6 on May 30, 2005. The results of all wellfield restoration were compiled into a report and submitted to the WDEQ and NRC on April 8, 2008. On October 23, 2012 in NRC's technical Evaluation Report (TER) listed their basis for denying restoration completeness. Uranium One submitted responses to NRC's TER concerns regarding groundwater restoration at Christensen Mine Units 2-6 were submitted for NRC review on September 11, 2015. WDEQ was provided a copy of Uranium One responses to NRC TER for review and comment on May 26, 2016. WDEQ provided comments to the September 11, 2015 Christensen Mine Unit 2-6 Groundwater Restoration submittal on October 13, 2017. Uranium One provided WDEQ response to comments on June 2, 2018. NRC provided comments to the September 11, 2015 Christensen Mine Unit 2-6 Groundwater Restoration report on February 15, 2018.

Uranium One is currently working on response to NRC comments and anticipates a response will be ready by mid-August 2018.

3.2 Irigaray:

Irigaray groundwater restoration activities and stabilization monitoring were conducted from 1990 to 2002. The "Wellfield Restoration Report Irigaray Mine" was submitted to the WDEQ in July of 2004. The WDEQ-LQD approved restoration of Irigaray Mine Units 1-9 via correspondence dated November 1, 2005. After an independent review, Irigaray restoration approval was received from the NRC in correspondence dated September 20, 2006. The Final Decommissioning Report for Irigaray Mine Units 1-9 was submitted to NRC for review and approval on August 7, 2015. Confirmation monitoring and sampling was conducted by NRC and Oak Ridge Associate University (ORAU) on July 26-28, 2016 and additional confirmation sampling conducted by NRC on October 17-19, 2017 and again on May 16, 2018. The site is awaiting results of the NRC May 2018 confirmation sampling event.

4.0 ENVIRONMENTAL MONITORING

4.1 Regional Ranch Wells

Six (6) stock watering and domestic water wells are located within two kilometers of Christensen Ranch mining area, and one (1) is located near Irigaray. Routine quarterly groundwater samples were collected from these six regional ranch wells. The samples were analyzed for Uranium, Thorium-230, Radium-226, Lead-210 and Polonium-210 for both suspended and dissolved parameters. All parameters are in line with historical data presented in Table 5.23 of the SUA-1341 License Renewal Application. Sampling was consistent with the requirements of License Condition 11.3 and Section 5.8 of the License Renewal Application. This data is summarized in Table 3 of Appendix A.

4.2 Surface Water Monitoring

During the reporting period Surface Water samples were collected across the Willow Creek Project. Willow Creek is the only source of surface water present within and adjacent to the permit boundaries of both the IR and CR projects. Willow Creek is an ephemeral stream which was sampled on a quarterly basis. Three sample locations are designated at both project sites; upstream, downstream and within the permit boundary. The Powder River is also sampled annually at the Brubaker Ranch, which is approximately 4.5 miles downstream from its confluence with Willow Creek. Sample location IR-9 is located where Willow Creek meets up with the Powder River.

During the sampling period all regional wells that are sampled quarterly were below the 10 CFR Appendix B Table 2 Effluent Concentrations. Radionuclide levels for the 1st half of 2018 are consistent with historical values presented in Table 5.25 of the SUA-1341 License Renewal Application. Comparison of suspended radionuclide results is limited to data that has been collected since 2012 so historical data for these parameters are limited.

The surface water sampling for the first half 2018 is summarized in Table 4 of Appendix A.

4.3 Summary of Spills

There were no (0) reportable spill during the reporting period from January 1, 2018 to June 30, 2018.

4.4 Soil Sampling

Annual soil sampling at the Willow Creek environmental locations occurred during the previous reporting period. The samples were taken from 5 locations at the Irigaray Project and 4 locations from the Christensen Project. Sampling locations coincide with air particulate stations and radon stations. The soil was analyzed for uranium, radium-226, lead-210, and thorium. This data is summarized in Table 5 located in Appendix A of this report.

4.5 Vegetation Sampling

Annual vegetation sampling at the Willow Creek environmental locations occurred during June 7, 2018. Analytical results for the uranium values at sample location IR-3 are higher than historic values and are currently being evaluated and potentially re-sampled. Revised analytical results will be reported as part of the next semi-annual effluent report. Vegetation analytical results received to date are shown in Table 5A of Appendix A. The samples were taken from 5 locations at the Irigaray project and 4 locations at the Christensen Project. Comparing the vegetation results to historical averages as are presented in Table 5.15 of the SUA 1341 License Renewal Application indicate no upward trends were noted and all samples were within natural variances of the historical averages.

5.0 AIR MONITORING

5.1 Dryer Stack Emissions

The semi-annual Dryer Stack Emission testing was performed on January 5, 2018 by Western Environmental Services and Testing Services The sample collected on January 5, 2018 during drying of Willow Creek materials shows a release rate of 0.014 lb/hr, which is in compliance with the WDEQ Air Quality Permit OP254 limit of. A summary of the total emissions is summarized in Table 7 of Appendix A.

Uranium One has included the quantities from stack emissions released for the reporting period for Th-230, Pb-210, Ra-226, and U-nat. These values are based on the operating times of the dryer and the stack testing performed by an outside entity.

5.2 Environmental Airborne Radionuclides

During dryer operations, continuous airborne radionuclide sampling is required at the five specified environmental air sampling locations at the IR project. The yellowcake dryer was in operation for approximately 1440 hours during the of First half of 2018. The stations used to monitor airborne radionuclides and are located as follows:

- IR-1 Downwind of Restricted Area
- IR-3 Upwind of Restricted Area
- IR-5 is located at Brubaker Ranch
- IR-6 is the background location
- IR-13 is the employee house trailer and is considered the maximally exposed individual.

Air Particulate samples are collected weekly and then composited quarterly for analysis by an outside laboratory. The data for the first half 2018 are summarized in Table 8 of Appendix A.

5.3 Environmental Radon Monitoring

Radon gas is monitored continuously at the eight environmental air locations surrounding the Irigaray Project, and twelve locations surrounding the Christensen Ranch Project. Passive outdoor radon detectors are exchanged quarterly and sent to Landauer for analysis. The data is shown in Table 6 of Appendix A. Data is given as raw data without subtracting the background location. Comparing the data to historical data presented in 5.11 and 5.12 of the SUA 1341 License Renewal Application the data is all below or within historical values.

Uranium One has received NRC approval of methodologies for quantifying radon release before implementation as per license condition 11.3 and these values will be reported for the semi-annual effluent report.

5.4 Environmental Gamma Radiation Monitoring

Passive gamma radiation is monitored continuously at six environmental air locations surrounding the Irigaray Project and at locations surrounding the Christensen Ranch Project. Dosimeters are exchanged and analyzed quarterly by the Landauer Dosimetry Services, a NVLP accredited company. The gamma data is summarized in Appendix A Table 9. The data is consistent with the values presented in Tables 5.19 and 5.20 of the SUA 1341.

5.5 Effluent Released from Willow Creek Activities

As part of the 10 CFR 40.65 effluent monitoring requirements the licensee must specify the quantity of each of the principle radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months. Additionally, Uranium One is required under License Condition 11.3 to quantify the principal radionuclides from all point and diffuse sources. Under this license condition the method for estimating the quantity of radionuclides emitted from a facility needs to be verified by NRC before implementation. Uranium One received verification by the NRC for these estimations in

June 2018 and will include this information for the second half 2018 semi-annual effluent report under this section.

6.0 PUBLIC DOSE

10 CFR 20.1301 requires that each NRC licensee conduct their operations in a manner that the total effective dose equivalent (TEDE) to members of the public does not exceed 100 mrem in a year, and that the dose from external sources in any unrestricted area does not exceed 2 mrem in any hour.

Additionally, 10CFR 20.1302 require licensees to show compliance to these dose limits by:

1. Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit or;

2. Demonstrate
   A. The annual average concentration of radioactive material released in gaseous and liquid effluent at the boundary of the unrestricted area do not exceed the values specified in table 2 of appendix B
   B. If an individual were continuously present in an unrestricted area, the dose from the external sources would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year.

Uranium One will demonstrate compliance to the public dose requirements by performing a dose assessment for the individual predicted to be the maximally exposed individual on an annual basis. Uranium One anticipates that the highest exposed individual would be operators staying in the man camps off shift. Operators working at Uranium One typically work four shifts of 12 hours and on four shifts off. This equates to a conservative three nights per week spent in workforce housing. For the year this equates to a total of 1872 hours spent in workforce housing.

Dose to individuals at the workforce housing are monitored through the use of Radtrak Track-Etch detectors, OSL environmental dosimeters, and airborne particulate sampling. The concentration is equated to dose using the following equation.

$$D = DCF \sum_{i} C_i F_i T_i$$

Where

D = annual dose (mrem/yr);
DCF =dose conversion factor
C_i = annual average concentration at the receptor location i;
F_i = equilibrium factors for receptor location I used for radon; and
Ti = occupancy time factor (fraction of year) for receptor location i

Dose conversion factors are established by taking effluent concentration limits in 10 CFR 20 Appendix B, Table 2, and using the annual dose limit of 100mrem/yr. Taking the annual dose limit and dividing by the effluent concentration limit will provide the dose conversion factor. Dose conversion factors for radon will be calculated using the daughters present with the 100% equilibrium.

External gamma radiation will be determined through the use of Landauer environmental dosimeters. A dosimeter will be placed at each maximally exposed individual location. Dose will be assigned to each receptor.

Public Dose is calculated on an annual basis and will be included in the semi-annual effluent report submitted in February 2019.

7.0 SAFETY AND ENVIRONMENTAL EVAULATIONS

Per License Condition 9.4E Uranium One shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the evaluations made by the safety and environmental evaluation panel (SERP). Uranium One completed one (1) SERP during the reporting period from January through June 2018. A summary of the SERPs findings for each evaluation can be found in Table 10 of Appendix A.

8.0 Other

8.1 ALARA REVIEW

As required by License condition 12.3 the licensee shall submit the results of the annual review of the radiation protection program content and implementation performed in accordance with 10CFR20.1101(c). A copy of the 2017 ALARA audit is included in Appendix B of this semi-annual effluent.

8.2 Land Use Survey

The primary use of surrounding lands at both IR and CR project continues to be rural sheep and cattle ranching. Livestock actively graze these lands, but fencing prevents access to the evaporation ponds, plant sites, and wellfields.

The secondary use of surrounding lands continues to be petroleum production from wells dispersed throughout the region. The closest oil well at the CR project is located approximately one third of a mile west of the CR plant. The closest oil wells at the IR site are located approximately one half mile east of proposed MU 9 wellfield. Oil activities at and around the Willow Creek project for the first half of 2018 have been significantly reduced due to continued depressed oil prices.

Over the past several years (2001-2018) some additional interest has developed in the immediate areas of the IR and CR projects in the development of coal bed methane (CBM) gas. Several CBM wells are located within a half mile of Uranium facilities.

The nearest residence to the IR site is 4 miles to the north (the Brubaker Ranch) and the nearest residence to CR is the John Christensen Ranch located 3 miles southeast of the CR plant site. Both are ranch housing with a population of six or less.

Land use surveys are conducted on an annual basis to verify the use of surrounding lands is consistent with previous assessments. These assessments are used in determining survey locations and which individuals may be potentially affected by Uranium One's activities. The Land Use Report will be included as part of the semi-annual report submitted to NRC in February 2019.

APPENDIX A

Tables 1-10

MU 5-2 Monthly Totals Date	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2018	255,400	0	255,400	100.0 %
February 2018	67,080	0	67,080	100.0 %
March 2018	249,440	0	249,440	100.0 %
April 2018	223,320	0	223,320	100.0 %
May 2018	161,280	0	161,280	100.0 %
June 2018	161,280	0	161,280	100.0 %
Totals	**1,117,800**	**0**	**1,117,800**	**100.0 %**

MU 7 Monthly Totals Date	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2018	20,761,245	19,329,362	1,431,883	6.9 %
February 2018	15,177,695	13,988,851	1,188,844	7.8 %
March 2018	13,775,849	12,632,073	1,143,776	8.3 %
April 2018	12,237,197	11,016,960	1,220,237	10.0 %
May 2018	4,840,395	4,074,953	765,442	15.8 %
June 2018	561,127	0	561,127	100.0 %
Totals	**67,353,508**	**61,042,199**	**6,311,309**	**9.4 %**

MU 8 Monthly Totals Date	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2018	36,368,119	34,999,673	1,368,446	3.8 %
February 2018	26,112,665	25,144,830	967,835	3.7 %
March 2018	25,347,055	24,408,795	938,260	3.7 %
April 2018	30,440,349	29,123,938	1,316,411	4.3 %
May 2018	23,137,000	22,152,381	984,619	4.3 %
June 2018	1,074,378	0	1,074,378	100.0 %
Totals	**142,479,566**	**135,829,617**	**6,649,949**	**4.7 %**

MU 10 Monthly Totals				
Date	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2018	56,764,946	55,155,784	1,609,162	2.8 %
February 2018	41,534,476	39,994,256	1,540,220	3.7 %
March 2018	38,114,472	36,814,643	1,299,829	3.4 %
April 2018	44,848,204	43,434,163	1,414,041	3.2 %
May 2018	32,634,452	31,136,380	1,498,072	4.6 %
June 2018	1,327,064	0	1,327,064	100.0 %
Totals	**215,223,614**	**206,535,226**	**8,688,388**	**4.0 %**

Overall Monthly Totals				
Date	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2018	114,149,710	109,484,819	4,664,891	4.1 %
February 2018	82,891,916	79,127,937	3,763,979	4.5 %
March 2018	77,486,816	73,855,511	3,631,305	4.7 %
April 2018	87,749,070	83,575,061	4,174,009	4.8 %
May 2018	60,773,127	57,363,714	3,409,413	5.6 %
June 2018	3,123,849	0	3,123,849	100.0 %
Overall Totals	**426,174,488**	**403,407,042**	**22,767,446**	**5.3 %**

Table 2 - Christensen Ranch Weekly Maximum Injection Pressures per Module Building

Mine Unit 7

	Weekly Maximum injection Pressure (Maximum Permissible 140 psi)					
Week Ending	Module 7-1	Module 7-2	Module 7-3	Module 7-4	Module 7-5	Module 7-6
January 6, 2018	No Injection	No Injection	136	105	133	No Injection
January 13, 2018	No Injection	No Injection	135	110	140	No Injection
January 20, 2018	No Injection	No Injection	129	160	128	No Injection
January 27, 2018	No Injection	No Injection	129	90	123	No Injection
February 3, 2018	No Injection	No Injection	127	96	128	No Injection
February 10, 2018	No Injection	No Injection	151	101	137	No Injection
February 17, 2018	No Injection	No Injection	140	115	130	No Injection
February 24, 2018	No Injection	No Injection	137	122	133	No Injection
March 3, 2018	No Injection	No Injection	155	117	132	No Injection
March 10, 2018	No Injection	No Injection	135	125	130	No Injection
March 17, 2018	No Injection	No Injection	139	125	134	No Injection
March 24, 2018	No Injection	No Injection	132	130	130	No Injection
March 31, 2018	No Injection	No Injection	135	125	130	No Injection
April 7, 2018	No Injection	No Injection	165	132	135	No Injection
April 14, 2018	No Injection	No Injection	No Injection	134	134	No Injection
April 21, 2018	No Injection	No Injection	No Injection	130	139	No Injection
April 28, 2018	No Injection	No Injection	No Injection	135	138	No Injection
May 5, 2018	138	No Injection	No Injection	123	133	No Injection
May 12. 2018	142	No Injection	No Injection	125	127	No Injection
May 19, 2018	130	No Injection	No Injection	115	129	No Injection
May 26, 2018	122	No Injection	No Injection	No Injection	No Injection	No Injection
June 2, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 9, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 16, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 23, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 30, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection

Table 2 - Christensen Ranch Weekly Maximum Injection Pressures per Module Building

Mine Unit 8

	Weekly Maximum injection Pressure (Maximum Permissible 140 psi)					
Week Ending	Module 8-1	Module 8-2	Module 8-3	Module 8-4/5	Module 8-6	Module 8-7
January 6, 2018	136	144	134	124	136	142
January 13, 2018	132	135	127	120	135	130
January 20, 2018	149	132	134	130	135	130
January 27, 2018	140	135	121	132	136	130
February 3, 2018	135	133	131	131	129	130
February 10, 2018	139	130	132	171	144	157
February 17, 2018	143	135	142	136	129	142
February 24, 2018	139	137	142	150	149	144
March 3, 2018	145	139	80	138	131	153
March 10, 2018	149	163	184	135	135	160
March 17, 2018	138	140	143	137	138	142
March 24, 2018	147	135	131	134	135	143
March 31, 2018	139	135	130	140	130	133
April 7, 2018	136	135	148	134	132	136
April 14, 2018	138	135	168	135	133	150
April 21, 2018	136	159	153	134	136	136
April 28, 2018	136	139	129	136	138	138
May 5, 2018	131	148	90	128	125	140
May 12. 2018	131	131	114	127	128	142
May 19, 2018	130	130	91	127	127	165
May 26, 2018	130	134	92	131	132	114
June 2, 2018	130	130	89	128	128	111
June 9, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 16, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 23, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 30, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection

Table 2 - Christensen Ranch Weekly Maximum Injection Pressures per Module Building

Mine Unit 8 (Cont.) and Mine Unit 5-2

	Weekly Maximum injection Pressure (Maximum Permissible 140 psi)					
Week Ending	Module 8-8	Module 8-9		Module 5-2		
January 6, 2018	No Injection	115		No Injection		
January 13, 2018	No Injection	105		No Injection		
January 20, 2018	No Injection	105		No Injection		
January 27, 2018	No Injection	122		No Injection		
February 3, 2018	No Injection	108		No Injection		
February 10, 2018	No Injection	130		No Injection		
February 17, 2018	No Injection	95		No Injection		
February 24, 2018	No Injection	105		No Injection		
March 3, 2018	No Injection	109		No Injection		
March 10, 2018	No Injection	108		No Injection		
March 17, 2018	No Injection	110		No Injection		
March 24, 2018	No Injection	112		No Injection		
March 31, 2018	No Injection	95		No Injection		
April 7, 2018	No Injection	137		No Injection		
April 14, 2018	No Injection	121		No Injection		
April 21, 2018	No Injection	136		No Injection		
April 28, 2018	No Injection	135		No Injection		
May 5, 2018	No Injection	135		No Injection		
May 12. 2018	No Injection	134		No Injection		
May 19, 2018	No Injection	128		No Injection		
May 26, 2018	No Injection	130		No Injection		
June 2, 2018	No Injection	130		No Injection		
June 9, 2018	No Injection	No Injection		No Injection		
June 16, 2018	No Injection	No Injection		No Injection		
June 23, 2018	No Injection	No Injection		No Injection		
June 30, 2018	No Injection	No Injection		No Injection		

Table 2 - Christensen Ranch Weekly Maximum Injection Pressures per Module Building

Mine Unit 10

	Weekly Maximum injection Pressure (Maximum Permissible 140 psi)					
Week Ending	Module 10-1	Module 10-2	Module 10-3	Module 10-4	Module 10-5	Module 10-6
January 6, 2018	131	125	130	130	133	135
January 13, 2018	133	127	130	127	126	149
January 20, 2018	135	127	125	143	124	137
January 27, 2018	139	135	126	136	125	134
February 3, 2018	130	130	129	125	134	130
February 10, 2018	140	131	134	130	135	149
February 17, 2018	135	126	127	132	132	137
February 24, 2018	137	126	131	134	134	140
March 3, 2018	134	126	130	149	133	135
March 10, 2018	132	130	133	128	126	142
March 17, 2018	135	135	134	132	130	142
March 24, 2018	132	126	135	128	126	135
March 31, 2018	140	125	130	130	126	136
April 7, 2018	132	135	136	133	133	146
April 14, 2018	132	132	133	139	132	138
April 21, 2018	132	134	135	140	131	143
April 28, 2018	130	130	134	135	130	121
May 5, 2018	128	129	130	135	122	131
May 12. 2018	128	132	130	135	127	137
May 19, 2018	127	132	118	132	128	133
May 26, 2018	127	132	120	128	131	138
June 2, 2018	127	134	118	130	129	136
June 9, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 16, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 23, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection
June 30, 2018	No Injection	No Injection	No Injection	No Injection	No Injection	No Injection

Sample Location	Christensen Ranch House #3					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	1.2E-08	NA	3.9	1.3E-08	NA	4.4
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	2.0E-10	1.0E-10	0.2
Thorium-230 (Suspended)	ND	NA	NA	4.0E-10	2.0E-10	0.4
Radium-226 (Disolved)	9.0E-09	4.0E-10	15.0	9.0E-10	1.0E-10	1.5
Radium-226 (Suspended)	2.0E-10	1.0E-10	0.3	3.0E-10	1.0E-10	0.5
Lead-210 (Disolved)	1.6E-09	3.0E-10	16.0	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	1.8E-09	3.0E-10	18.0
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch Ellendale #4					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	5.0E-10	NA	0.2	5.0E-10	NA	0.2
Uranium (Suspended)	ND	NA	NA	2.9E-09	NA	1.0
Thorium-230 (Disolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	1.0E-09	2.0E-10	1.0
Radium-226 (Disolved)	3.6E-09	2.0E-10	6.0	2.0E-10	1.0E-10	0.3
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch Willow Corral #32					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	ND	NA	NA	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	4.0E-10	3.0E-10	0.4
Radium-226 (Disolved)	5.0E-10	1.0E-10	0.8	3.0E-10	1.0E-10	0.5
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch First Artesian #1					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	1.0E-08	NA	3.4	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	3.0E-10	1.0E-10	0.3
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Disolved)	7.0E-10	1.0E-10	1.2	ND	NA	NA
Radium-226 (Suspended)	ND	NA	NA	2.0E-10	1.0E-10	0.3
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	1.1E-09	3.0E-10	11.0	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch Middle Artesian					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	ND	NA	NA	4.5E-09	NA	1.5
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Disolved)	4.8E-09	3.0E-10	8.0	8.0E-10	1.0E-10	1.3
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	2.3E-08	2.2E-09	56.8
Polonium-210 (Suspended)	ND	NA	NA	1.8E-09	7.0E-10	4.5

Sample Location	Christensen Ranch Del Gulch Lower #13					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	3.0E-10	NA	0.1	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	3.0E-10	1.0E-10	0.3
Radium-226 (Disolved)	3.0E-10	1.0E-10	0.5	3.0E-10	1.0E-10	0.5
Radium-226 (Suspended)	ND	NA	NA	2.0E-10	1.0E-10	0.3
Lead-210 (Disolved)	ND	NA	NA	1.1E-09	3.0E-10	11.0
Lead-210 (Suspended)	1.1E-09	3.0E-10	11.0	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Irigaray Willow #2					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	ND	NA	NA	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	3.0E-10	1.0E-10	0.3
Radium-226 (Disolved)	4.2E-09	2.0E-10	7.0	ND	NA	NA
Radium-226 (Suspended)	ND	NA	NA	2.0E-10	1.0E-10	0.3
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

LLD's

Uranium	2.0E-10 µCi/ml
Thorium-230	2.0E-10 µCi/ml
Radium-226	2.0E-10 µCi/ml
Lead-210	1.0E-9 µCi/ml
Polonium-210	1.0E-9 µCi/ml

ND = NON DETECTABLE
NA= NOT APPLICABLE

***10 CFR 20 Appendix B Table 2 values**

Uranium	3.0E-7 µCi/ml
Thorium-230	1.0E-7 µCi/ml
Radium-226	6.0E-8 µCi/ml
Lead-210	1.0E-8 µCi/ml
Polonium-210	4.0E-8 µCi/ml

Sample Location	Irigaray-9					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	1.1E-08	NA	3.7	2.1E-08	NA	7.1
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	6.0E-10	2.0E-10	0.2
Thorium-230 (Suspended)	ND	NA	NA	9.0E-10	2.0E-10	0.3
Radium-226 (Disolved)	4.0E-10	1.0E-10	0.1	1.1E-09	1.0E-10	0.4
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	1.0E-09	3.0E-10	0.3	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	2.3E-09	8.0E-10	5.8

Sample Location	Irigaray-14					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	4.7E-09	NA	1.6	2.6E-09	NA	0.9
Uranium (Suspended)	ND	NA	NA	3.0E-10	NA	0.1
Thorium-230 (Disolved)	8.0E-10	2.0E-10	0.8	4.0E-10	1.0E-10	0.4
Thorium-230 (Suspended)	ND	NA	NA	8.0E-10	2.0E-10	0.8
Radium-226 (Disolved)	6.0E-10	1.0E-10	1.0	1.7E-09	1.0E-10	2.8
Radium-226 (Suspended)	ND	NA	NA	3.0E-10	1.0E-10	0.5
Lead-210 (Disolved)	ND	NA	NA	1.4E-09	3.0E-10	14.0
Lead-210 (Suspended)	1.0E-09	3.0E-10	10.0	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	1.3E-09	6.0E-10	3.3

Sample Location	Irigaray-17					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	1.8E-08	NA	6.0	9.5E-09	NA	3.2
Uranium (Suspended)	ND	NA	NA	4.0E-10	NA	0.1
Thorium-230 (Disolved)	ND	NA	NA	4.0E-10	2.0E-10	0.4
Thorium-230 (Suspended)	ND	NA	NA	4.0E-10	1.0E-10	0.4
Radium-226 (Disolved)	1.8E-09	2.0E-10	3.0	1.8E-09	1.0E-10	3.0
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch GS-01					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	6.0E-09	NA	2.0	4.0E-09	NA	1.3
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	1.4E-09	4.0E-10	1.4
Thorium-230 (Suspended)	ND	NA	NA	4.1E-09	8.0E-10	4.1
Radium-226 (Disolved)	ND	NA	NA	3.0E-10	1.0E-10	0.5
Radium-226 (Suspended)	9.0E-10	1.0E-10	1.5	3.0E-10	1.0E-10	0.5
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	5.1E-09	1.2E-09	12.8

Sample Location	Christensen Ranch GS-03					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	8.9E-09	NA	3.0	3.2E-08	NA	10.8
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	6.0E-10	2.0E-10	0.6
Radium-226 (Disolved)	3.8E-09	2.0E-10	6.3	8.7E-09	3.0E-10	14.5
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch CG-05					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	2.2E-08	NA	7.2	4.9E-09	NA	1.6
Uranium (Suspended)	ND	NA	NA	5.0E-10	NA	0.2
Thorium-230 (Disolved)	ND	NA	NA	1.1E-09	4.0E-10	1.1
Thorium-230 (Suspended)	ND	NA	NA	3.0E-10	1.0E-10	0.3
Radium-226 (Disolved)	1.1E-09	1.0E-10	1.8	9.0E-10	1.0E-10	1.5
Radium-226 (Suspended)	ND	NA	NA	3.0E-10	1.0E-10	0.5
Lead-210 (Disolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Powder River (Annual)					
Radionuclide	1st Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*	2nd Q (µCi/ml)	Uncertainty (±µCi/ml)	% of EFF Conc*
Uranium (Disolved)	ANNUAL	NA	NA	2.4E-09	NA	0.8
Uranium (Suspended)	ANNUAL	NA	NA	ND	NA	NA
Thorium-230 (Disolved)	ANNUAL	NA	NA	4.0E-10	2.0E-10	0.4
Thorium-230 (Suspended)	ANNUAL	NA	NA	2.0E-10	1.0E-10	0.2
Radium-226 (Disolved)	ANNUAL	NA	NA	3.0E-10	1.0E-10	0.5
Radium-226 (Suspended)	ANNUAL	NA	NA	2.0E-10	1.0E-10	0.3
Lead-210 (Disolved)	ANNUAL	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ANNUAL	NA	NA	ND	NA	NA
Polonium-210 (Disolved)	ANNUAL	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ANNUAL	NA	NA	ND	NA	NA

LLD's

Uranium	2.0E-10 µCi/ml
Thorium-230	2.0E-10 µCi/ml
Radium-226	2.0E-10 µCi/ml
Lead-210	1.0E-9 µCi/ml
Polonium-210	1.0E-9 µCi/ml

ND = NON DETECTABLE
NA= NOT APPLICABLE

***10 CFR 20 Appendix B Table 2 values**

Uranium	3.0E-7 µCi/ml
Thorium-230	1.0E-7 µCi/ml
Radium-226	6.0E-8 µCi/ml
Lead-210	1.0E-8 µCi/ml
Polonium-210	4.0E-8 µCi/ml

IRIGARAY PROJECT

IR-1 (Downwind of Restricted Area)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	5.00E-06	*NA
Thorium-230	9.00E-07	2.00E-10
Radium-226	1.60E-06	2.00E-10
Lead-210	1.30E-06	3.00E-10

IR-3 (Upwind of Restricted Area)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	3.40E-09	*NA
Thorium-230	7.00E-10	2.00E-10
Radium-226	9.00E-10	3.00E-10
Lead-210	ND	NA

IR-4 (North Road - Background)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	4.00E-10	*NA
Thorium-230	6.00E-10	2.00E-10
Radium-226	1.10E-09	3.00E-10
Lead-210	ND	NA

IR-5 (Irigaray Ranch - Nearest Resident)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	4.00E-10	*NA
Thorium-230	7.00E-10	2.00E-10
Radium-226	8.00E-10	2.00E-10
Lead-210	ND	NA

IR-6 (Ridge Road S.E.)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	8.00E-10	*NA
Thorium-230	7.00E-10	2.00E-10
Radium-226	1.20E-09	3.00E-10
Lead-210	ND	NA

CHRISTENSEN PROJECT

AS-1 (Table Mountain - Background)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	3.00E-10	*NA
Thorium-230	6.00E-10	2.00E-10
Radium-226	1.10E-09	3.00E-10
Lead-210	1.50E-09	3.00E-10

AS-5A (CR Plant Upwind S.E.)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	1.50E-09	*NA
Thorium-230	1.70E-09	3.00E-10
Radium-226	1.20E-09	3.00E-10
Lead-210	2.90E-09	3.00E-10

AS-5B (CR Plant Downwind N.W.)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	1.10E-09	*NA
Thorium-230	8.00E-10	2.00E-10
Radium-226	1.40E-09	3.00E-10
Lead-210	2.20E-09	3.00E-10

AS-6 (Christensen Ranch - Nearest Resident)		
	(µCi/g)	Uncertainty (±µCi/g)
Uranium	9.00E-10	*NA
Thorium-230	2.30E-09	4.00E-10
Radium-226	1.10E-09	3.00E-10
Lead-210	1.50E-09	3.00E-10

RL's (µCi/g): Uranium = 2.0E-7
Thorium-230 = 2.0E-7
Radium-226 = 2.0E-7
Lead-210 = 2.0E-7

Analyses performed by Inter-Mountian Labs (IML), Sheridan, Wyoming
*The activity for uranium is a mathematical calculation based on a chemical analysis, therefore, no precision estimate (error) is given.
The Inter-Mountain Lab reporting limit (RL) are based on the weight of the samples.

IRIGARAY PROJECT

IR-1 (Downwind of Restricted Area)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	1.7E-07	*NA
Thorium-230	4.7E-09	1.8E-09
Radium-226	2.7E-08	2.2E-09
Lead-210	1.4E-07	8.4E-09

IR-3 (Upwind of Restricted Area)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	4.2E-07	*NA
Thorium-230	1.3E-08	2.8E-09
Radium-226	9.4E-09	1.2E-09
Lead-210	5.1E-08	4.8E-09

IR-4 (North Road - Background)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	1.0E-08	*NA
Thorium-230	9.6E-09	2.2E-08
Radium-226	1.2E-08	2.3E-09
Lead-210	2.7E-07	1.7E-08

IR-5 (Irigaray Ranch - Nearest Resident)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	7.1E-09	*NA
Thorium-230	6.8E-08	1.9E-08
Radium-226	4.5E-09	2.0E-09
Lead-210	1.5E-07	1.2E-08

IR-6 (Ridge Road S.E.)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	1.2E-08	*NA
Thorium-230	9.8E-09	2.6E-09
Radium-226	1.2E-08	1.4E-09
Lead-210	3.2E-07	1.1E-08

CHRISTENSEN PROJECT

AS-1 (Table Mountain - Background)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	1.4E-08	*NA
Thorium-230	9.1E-09	3.5E-09
Radium-226	4.1E-09	3.3E-09
Lead-210	5.0E-07	1.4E-08

AS-5A (CR Plant Upwind S.E.)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	2.0E-08	*NA
Thorium-230	2.4E-08	8.8E-09
Radium-226	1.7E-08	2.0E-09
Lead-210	1.7E-07	1.1E-08

AS-5B (CR Plant Downwind N.W.)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	1.1E-08	*NA
Thorium-230	2.0E-08	9.4E-09
Radium-226	2.4E-08	2.5E-09
Lead-210	1.9E-07	1.1E-08

AS-6 (Christensen Ranch - Nearest Resident)		
	(µCi/kg)	Uncertainty (±µCi/kg)
Uranium	1.5E-08	*NA
Thorium-230	6.9E-09	2.0E-09
Radium-226	2.6E-09	7.0E-10
Lead-210	5.4E-07	1.4E-08

LLD's (µCi/kg) **Uranium = 2.0E-7**
Thorium-230 = 2.0E-7
Radium-226 = 5.0E-8
Lead-210 = 1.0E-6

Analyses performed by Inter-Mountian Labs (IML), Sheridan, Wyoming
*The activity for uranium is a mathematical calculation based on a chemical analysis, therefore, no precision estimate (error) is given.
The Inter-Mountain Lab reporting (LLD's) are based on the weight of the samples.

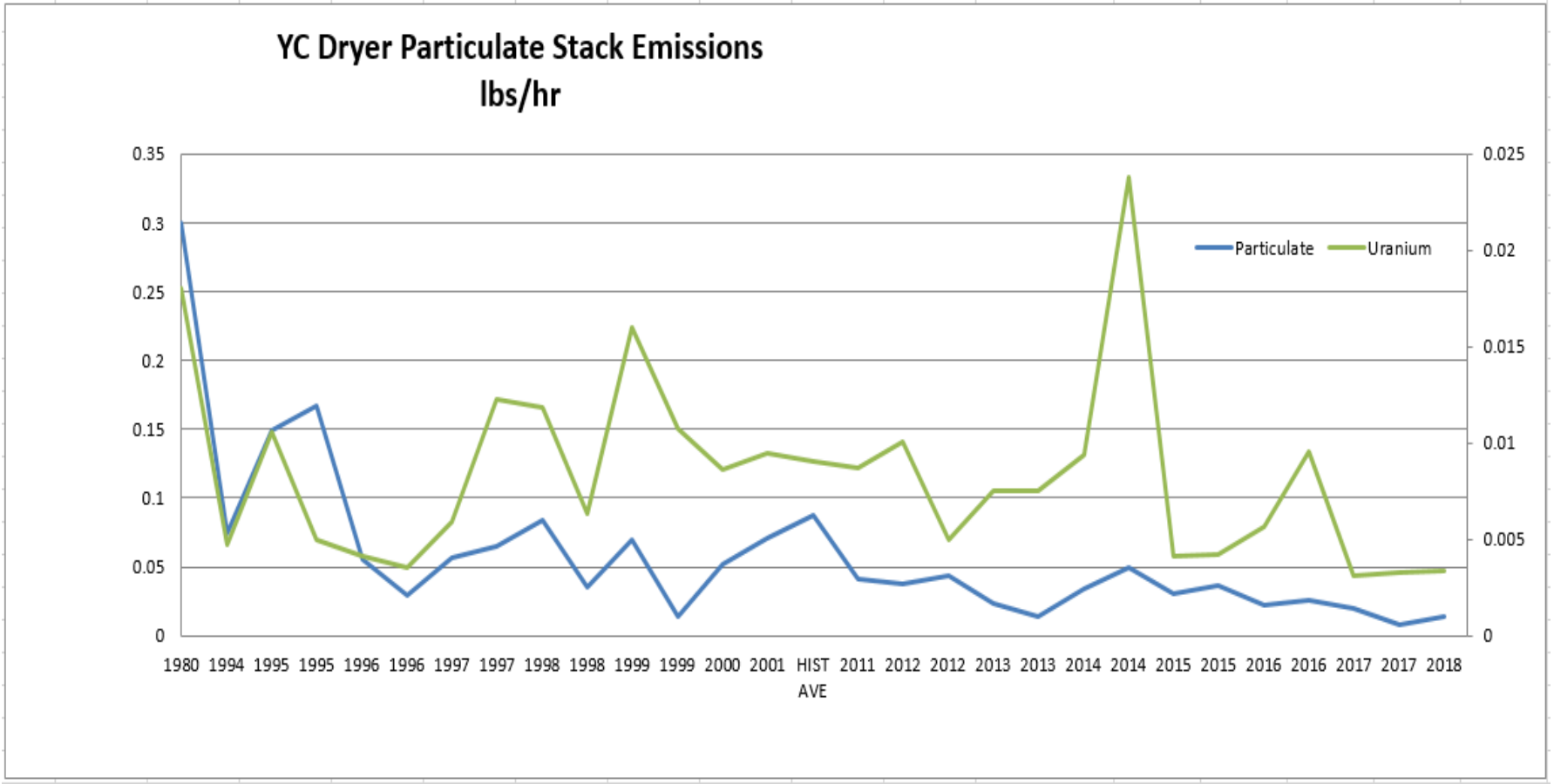
Location	1st Quarter µCi/ml (2018)	Uncertainty ± µCi/ml	2nd Quarter µCi/ml 2018	Uncertainty ± µCi/ml	Location Average 2018	10 CFR APP B Table 2
IRIGARAY PROJECT						
IR-1 (Downwind of Restricted Area)	1.90E-10	1.70E-10	3.50E-10	1.10E-10	2.70E-10	1.00E-10
IR-3 (Upwind of Restricted Area)**	2.40E-10	1.70E-10	4.60E-10	1.40E-10	3.50E-10	1.00E-10
IR-4 (North Road)	1.60E-10	1.10E-10	2.70E-10	1.10E-10	2.15E-10	1.00E-10
IR-5 (Irigaray Ranch)	1.50E-09	2.80E-10	1.20E-09	2.50E-10	1.35E-09	1.00E-10
IR-6 (Ridge Road - S.E. - Background)	1.40E-10	9.00E-11	1.90E-10	1.10E-10	1.65E-10	1.00E-10
IR-13 (IR Employee House Trailer)	2.20E-10	1.70E-10	3.50E-10	1.70E-10	2.85E-10	1.00E-10
IR-14 (IR Employee House Trailer inside)	4.90E-10	1.70E-10	3.80E-10	1.10E-10	8.50E-01	1.00E-10
CHRISTENSEN PROJECT						
AS-1 (Table Mountain - Background)	2.20E-10	1.70E-10	1.60E-10	1.10E-10	1.90E-10	1.00E-10
AS-5A (CR Plant Upwind S.E.)	1.90E-10	1.70E-10	2.70E-10	1.10E-10	2.30E-10	1.00E-10
AS-5B (CR Plant Downwind N.W)	4.10E-10	4.00E-11	2.40E-10	1.10E-10	3.25E-10	1.00E-10
AS-6 (Christensen Ranch)	3.20E-10	1.10E-10	3.00E-10	1.10E-10	3.10E-10	1.00E-10
AS-7 (CR Employee House Trailer)*	1.90E-10	1.10E-10	4.90E-10	1.40E-10	3.40E-10	1.00E-10
AS-8 (CR Employee House Trailer inside)*	2.40E-10	4.00E-11	3.20E-10	1.10E-10	2.80E-10	1.00E-10
AS-9 (Mine Unit 7)	1.90E-10	1.70E-10	2.70E-10	1.10E-10	2.30E-10	1.00E-10
AS-10 (CR Wellfield Module 8-6)	2.20E-10	1.10E-10	3.00E-10	1.10E-10	2.60E-10	1.00E-10
AS-11 (Water Tank)	3.20E-10	1.10E-10	2.20E-10	1.10E-10	2.70E-10	1.00E-10
AS-12 (Mine Unit 10)	1.60E-10	1.70E-10	1.90E-10	1.10E-10	1.75E-10	1.00E-10
AS-13 (Substation)	2.70E-10	1.70E-10	3.50E-10	1.70E-10	3.10E-10	1.00E-10

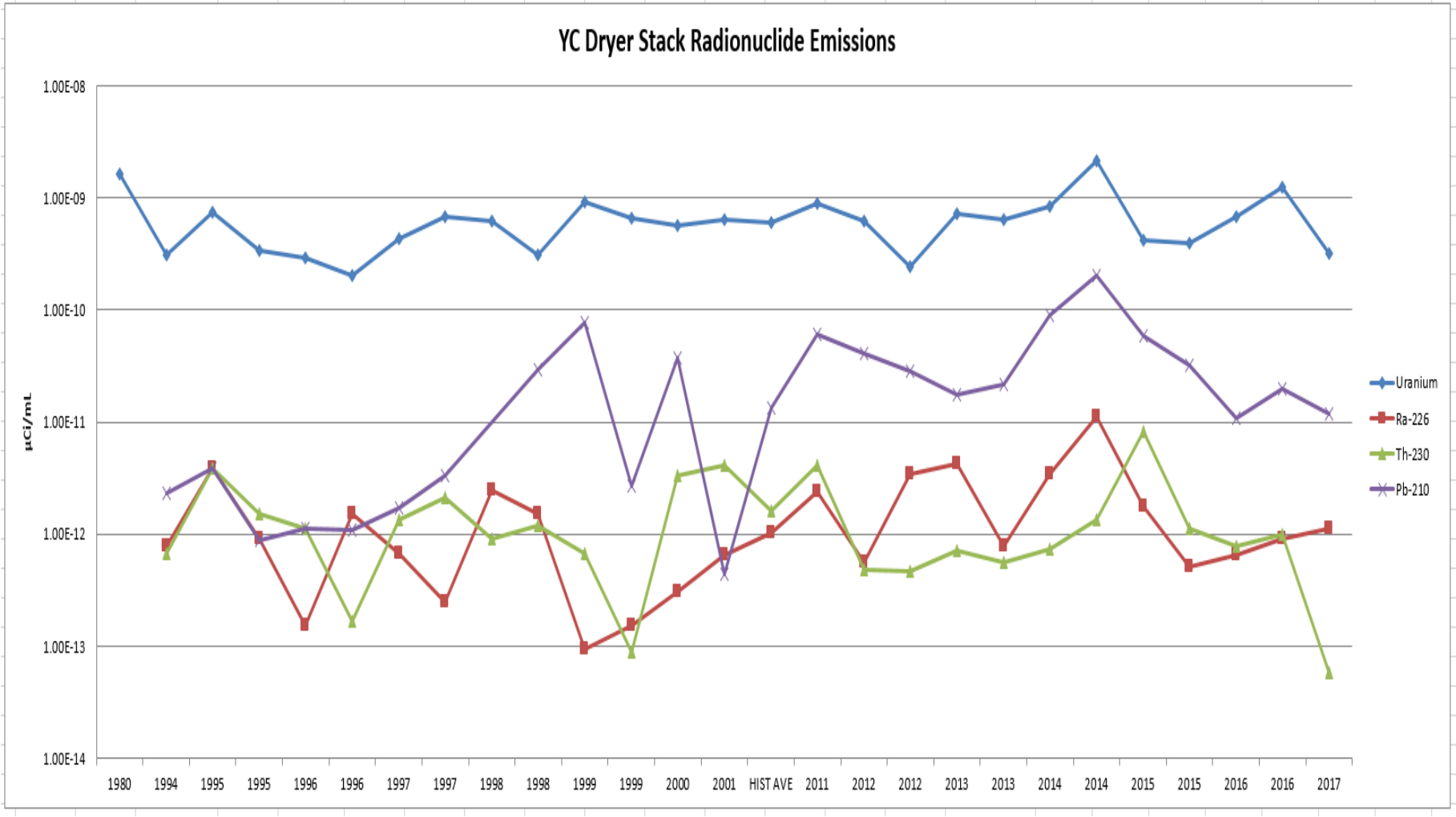
LLD = 0.06 pCi/l

SUMMARY OF STACK EMISSIONS SURVEY RESULTS
Irigaray Dryer and Packaging Circuit

Time	Total Particulates	U3O8 Emissions	Unat. Released	Unat. Uncertainty	Th-230 Released	Th-230 Uncertainty	Ra-226 Released	Ra-226 Uncertainty	Pb-210 Released	Pb-210 Uncertainty
	lbs/hour (% limit)	lbs	Ci	Ci	Ci	Ci	Ci	Ci	Ci	Ci
Jan-June, 2018	0.0033	4.8	1.16E-03	NA	4.94E-06	9.94E-07	4.16E-06	4.28E-07	4.43E-05	5.64E-06
	0	0.0	0.00E+00	NA		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		4.8	1.16E-03		4.94E-06		4.16E-06		4.43E-05	
	Permit Limit 0.30									

COMMENTS: YC Dryer ran for 1440 hours for the first half of 2018. These numbers are utilized to determine the relase from the Irigaray YC drying and packaging operations for the above radionuclides.


YC Dryer Particulate Stack Emissions
lbs/hr
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.025
0.02
0.015
0.01
0.005
0
Particulate
Uranium
1980 1994 1995 1995 1996 1996 1997 1997 1998 1998 1999 1999 2000 2001 HIST AVE 2011 2012 2012 2013 2013 2014 2014 2015 2015 2016 2016 2017 2017 2018


YC Dryer Stack Radionuclide Emissions
µCi/mL
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12
1.00E-13
1.00E-14
1980
1994
1995
1995
1996
1996
1997
1997
1998
1998
1999
1999
2000
2001
HIST AVE
2011
2012
2012
2013
2013
2014
2014
2015
2015
2016
2016
2017
Uranium
Ra-226
Th-230
Pb-210

1st Quarter 2018 Data				
	Uranium µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
IR-1 Downwind	3.2E-15	1.5E-16	2.0E-16	1.4E-14
Uncertainty	NA	7.9E-17	7.9E-17	1.3E-15
%of Pt, App. B Effluent Limit	3.6%	0.5%	0.0%	2.3%
IR-3 Upwind	6.6E-15	4.2E-15	0.0E+00	1.2E-14
Uncertainty	NA	5.9E-16	NA	1.3E-15
%of Pt, App. B Effluent Limit	7.3%	14.0%	0.0%	2.0%
IR-5 Brubaker Ranch	5.6E-16	4.6E-16	1.5E-16	6.5E-15
Uncertainty	NA	1.1E-16	5.3E-17	1.2E-15
%of Pt, App. B Effluent Limit	0.6%	1.5%	0.0%	1.1%
IR-6 Background	5.5E-15	5.3E-15	3.5E-16	2.1E-14
Uncertainty	NA	9.7E-16	7.4E-17	2.2E-15
%of Pt, App. B Effluent Limit	6.1%	17.7%	0.0%	3.5%
IR-13 Employee House Trailer	0.0E+00	1.0E-15	0.0E+00	0.0E+00
Uncertainty	NA	1.7E-16	5.7E-17	0.0E+00
%of Pt, App. B Effluent Limit	0.0%	3.3%	0.0%	0.0%

2nd Quarter 2018 Data				
	Uranium µCi/ml	Th-230 µCi/ml	Ra-226 µCi/ml	Pb-210 µCi/ml
IR-1 Downwind	4.0E-16	3.8E-16	2.3E-16	1.2E-14
Uncertainty	NA	3.6E-16	8.9E-17	2.5E-15
%of Pt, App. B Effluent Limit	0.4%	0.1%	0.0%	2.0%
IR-3 Upwind	4.8E-16	1.4E-15	0.0E+00	1.2E-14
Uncertainty	NA	6.2E-16	NA	2.5E-15
%of Pt, App. B Effluent Limit	0.5%	0.2%	0.0%	2.0%
IR-5 Brubaker Ranch	3.6E-16	5.4E-15	6.1E-16	1.2E-14
Uncertainty	NA	1.3E-15	1.8E-16	2.6E-15
%of Pt, App. B Effluent Limit	0.4%	0.9%	0.1%	2.0%
IR-6 Background	4.6E-15	2.9E-15	0.0E+00	7.9E-15
Uncertainty	NA	1.2E-15	NA	2.9E-15
%of Pt, App. B Effluent Limit	5.1%	9.7%	0.0%	1.3%
IR-13 Employee House Trailer	1.8E-16	1.2E-15	0.0E+00	7.4E-15
Uncertainty	NA	5.3E-16	N/A	2.3E-15
%of Pt, App. B Effluent Limit	0.2%	0.2%	0.0%	1.2%

2018 Summary (Averages)				
	U (µCi/ml)	Th-230 (µCi/ml)	Ra-226 (µCi/ml)	PB-210 (µCi/ml)
IR-1	1.8E-15	2.7E-16	2.2E-16	1.3E-14
IR-3	6.0E-14	2.8E-15	0.0E+00	1.2E-14
IR-5	4.6E-16	2.9E-15	3.8E-16	9.3E-15
IR-6	5.1E-15	2.8E-15	1.8E-16	1.4E-14
IR-13	9.0E-17	1.1E-15	0.0E+00	3.7E-15

10 CFR Pt. 20, App. B, Effluent Limits (uCi/ml)
Uranium = 9E-14 (Y)
Th-230 = 3.0E-14 (Y)
Ra-226 = 9.0E-13 (W)
Pb- 210 = 6.0E-13 (D)

Lab LLD's
Uranium = 1.0E-16
Th-230 = 1.0E-16
Ra-226 = 1.0E-16
Pb-210 = 2.0E-15

0 or N/D =Non Detectable

Location	1st Quarter 2018 mrem/quarter	2nd Quarter 2018 mrem/quarter	Location Average 2018 mrem/quarter	Year to Date Total 2018 mrem/quarter
IRIGARAY PROJECT				
Control	52.9	38.4	NA	NA
IR-1 (Downwind of Restricted Area)	4.1	4.4	4.3	8.5
IR-3 (Upwind of Restricted Area)	28.1	43.6	35.9	71.7
IR-4 (North Road)	-4.3	8.9	2.3	4.6
IR-5 (Irigaray Ranch)	-13.5	2.5	-5.5	-11.0
IR-6 (Ridge Road S.E. - Background)	-9.2	2.2	-3.5	-7.0
IR-13 (I.R. Employee House Trailer)	-2.8	4.6	0.9	1.8
IR-14 (I.R. Employee House Trailer inside)	-5.9	3	-1.5	-2.9
Quarterly Average	-0.5	9.9	4.7	4.7
CHRISTENSEN PROJECT				
AS-1 (Table Mountain - Background)	-6.6	4.4	-1.1	-2.2
AS-5A(CR Plant Upwind S.E.)	-1.0	11.3	5.2	10.3
AS-5B (CR Plant Downwind N.W.)	1.8	10.4	6.1	12.2
AS-6 (Christensen Ranch)	-1.6	11.3	4.9	9.7
AS-7 (C.R. Employee House Trailer)	-12.4	2	-5.2	-10.4
AS-8 (C.R. Employee House Trailer inside	-23.3	-0.9	-12.1	-24.2
AS-9 (Mine Unit 7)	-6.0	4.9	-0.6	-1.1
AS-10 (C.R. Wellfield Module 8-6)	-1.2	10.4	4.6	9.2
AS-11 (Water Tank)	-8.5	5.5	-1.5	-3.0
AS-12 (Mine Unit 10)	-5.4	6.7	-1.1	-4.5
AS-13 (Substation)*	-8	2.2	-2.9	-5.8
Quarterly Average	-4.0	7.9	2.0	2.0

Table 10
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Uranium One USA, Inc-Willow Creek Project
2018 Semi-Annual Effluent and Monitoring Report
SERP Summary

SERP No.	Date	SERP Topic	Evaluation Summary
SERP 18-01	2/28/18	Effects of Accidents (LC9.17)	None identified no actions

APPENDIX B

ALARA Audit

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2017 ANNUAL ALARA AUDIT REPORT

AS LOW AS IS REASONABLY ACHIEVABLE

PREPARED FOR:
URANIUM ONE AMERICAS, INC.
907 N. POPLAR STREET, SUITE 260
CASPER, WYOMING 82601

USNRC LICENSE NUMBER: SUA-1341
WILLOW CREEK PROJECT

PREPARED BY:
SHERYL AND ROGER A. GARLING
R AND D ENTERPRISES, INC.
P.O. BOX 3321
CASPER, WY 82602
307 277 3861

April 24, 2017

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1.0 EXECUTIVE SUMMARY

The annual 2017 ALARA audit was performed on April 3, 2018 for Uranium One USA, Inc. (U1) Willow Creek ISR Project (WC), located in Johnson and Campbell counties, Wyoming. Per Regulatory Guide (RG) 8.31, Section 2.3.3 Radiation Protection and ALARA Program Audit the review should address *trends in personnel exposures for identifiable categories of workers and types of operational activities, whether equipment for exposure control is being properly used, maintained, and inspected, and provide recommendations on ways to further reduce personnel exposures from uranium and its daughters*.

The startup of the current WC ISR Project was on December 22, 2010 followed by dryer operations beginning September 30, 2011. Christensen Ranch (CR) satellite recovery and Irigaray (IR) Central Processing Plant (CPP) have been in continuous operation since. Currently, the Willow Creek Project operation has eliminated lixiviant chemical fortification and is maintaining the required recovery bleed.

The radiation safety staff continued to assess the operations and make recommendations for improvement using engineering techniques (process isolation, ventilation, controls, etc.) to reduce occupational exposures. Corporate and Site managers are committed to maintaining the ALARA principle and the radiation safety staff has the full cooperation of management regarding the protection of their employees to limit occupational exposure. Specific findings and recommendations are identified within the ALARA report.

The audit results indicate that U1 is operating in a manner consistent with the ALARA principle, represented by the overall operation's 2017 average TEDE of 0.095 rem compared to 2016 average TEDE of 0.139 rem.

2.0 2017 ALARA SUMMARY

The audit team was comprised of Sheryl Garling and Roger A. Garling of R and D Enterprises, Inc. (RDE). U1 WC Project's Senior Radiation Safety Technician (RST) Larry Arbogast, accompanied the audit team. Scott Schierman, Radiation Safety Officer, was available for telephonic communications. Additional information and data was requested and received after the site visit was completed. This audit serves as the annual review of the content and implementation of the radiation protection program for 2017 as required by 10 CFR Part 20.1101(c) and License Condition (LC) 12.3.

Prior to, during and post audit visit, the following documents were reviewed:

- ✓ ALARA audit reports from 2016
- ✓ USNRC License SUA-1341, Amendment No.4, Dated August 20, 2015
- ✓ USNRC Regulatory Guides and other relevant documents including, but not limited to 1.86, 8.10, 8.22, 8.30, 8.31, 10 CFR Part 20, NUREG -1400, etc.,
- ✓ USNRC Inspection Reports 040-08502/2017-001, Dated September 14, 2017
- ✓ 2017 Monthly Radiation Safety Summary Reports, and

- ✓ Licensee documentation, site records and reports generated by the Radiation Safety Officer and Health Physics staff.

Regulatory Guide 8.31, Revision 1, May 2002: *Information Relevant To Ensuring That Occupational Radiation Exposure At Uranium Facilities Will Be As Low As Is Reasonably Achievable* (ALARA), Section 2.3.3, *Radiation Protection and ALARA Program Audit*, audit guidelines were followed.

2.1 ALARA PHILOSOPHY – REGULATORY GUIDE 8.31, SECTION 1

A major purpose of the occupational radiation protection program at a uranium recovery facility is to maintain radiation [occupational] *exposure ALARA for all employees, contractors and visitors. The implementation and effectiveness of a successful ALARA program is the responsibility of everyone involved in the processing of uranium ores. Responsibilities for conducting a radiation protection and ALARA program are shared by licensee management, the radiation safety officer and all workers in the uranium recovery facility.*

The ALARA program is predicated on timeliness of sampling, measurement and documentation of occupational exposure and effluent monitoring. RG 8.30 recommends…*Sample analysis should usually be completed within two working days after sample collection*…to determine employee occupational exposures. U1's radiation safety staff performs onsite measurements and analyses within time constraints in accordance with the sampling procedures and analytical methods required for the prescribed employee occupational exposure monitoring programs.

2.2 SAFETY AND ENVIRONMENTAL REVIEW PANEL (SERP)

The following table represents the Safety and Environmental Review Panel (SERP) proposed changes evaluated during 2017. LC 9.4(b) allows U1 to make changes in the facility, procedures and conduct tests or experiments that are not presented in the approved application if such changes follow the specified criteria identified in the LC.

SERP ID	Proposed Changes
Evaluation Report – SERP 17-01	Wellfield alarm upgrade Evaluated and canceled
Evaluation Report – SERP 17-02	Well Stimulation Test Utilizing Air Injection on MU10 to improve recovery Dated 06/20/2017

2.3 NRC LICENSING ACTIVITIES

2.3.1 July 11 - August 17, 2017 - The USNRC performed an onsite, announced annual inspection. U1 received one Notice of Violation (NOV); *During the wellfield tours, the inspectors observed the secured area of a wellfield 11.e(2) waste bin which did not*

preclude removal of licensed material or access into the area. This is a violation of 10 CFR 20.1801 and is detailed in Section 5.2.b of the Inspection Report. *On July 17, 2017, the licensee took corrective actions by moving the wellfield waste [11.e(2) material] bins into an 8 foot high fenced area located inside the licensee restricted area which will meet the requirements of 10 CFR 20.1801. By promptly moving the waste bins into the locked fenced area, the violation was brought promptly into compliance. There has been no intrusion into the 11.e(2) material area while it was located inside the fenced area at CR Satellite pond area.*

2.3.2 In 2017, U1 and NRC resolved LC 11.3 effluent monitoring matter; U1 is in the process of implementing approved increased monitoring program.

2.3.3 In 2017, U1 and NRC resolved LC 11.9 minimal detectable concentration (MDC) matter; U1 is in the process of implementing program.

2.3.4 In 2017, U1 and NRC resolved Mine Units 1-9 Final Status of Decommissioning matter; U1 and NRC scheduled additional sampling for 2018.

2.3.5 In 2017, U1 and NRC are in the process of resolving LC 9.8 and 9.12 regarding responsible personnel training and contamination control plan matters.

2.4 FACILITY AND 2017 PROGRAM IMPROVEMENTS

Improvements during 2017 include:

- The radiation safety staff completed the migration of forms, calculations and data archiving into electronic format (spreadsheet/database). The process of calculating occupational employee exposure and dose to the public are streamlined and efficient.
- The radiation safety staff reviews and periodically checks data (QAQC) for accuracy and completeness.
- The use of spreadsheet/database to perform calculations provides the link into creating charts. Uranium particulate and radon progeny are charted and incorporated into the RST/RSO monthly reports;
- The operations, occupational and radiation safety staff initiated weekly meetings to increase awareness regarding lines of communications and safety issues;
- The RST/RSO continues the practice of conducting investigations/evaluations of monitoring data anomalies or detections that could identify a compromise in operational or personnel procedures resulting in potential occupational exposures;
- The radiation safety staff initiated the task to revise, update and improve SOPs with the inclusion of detailed descriptions and photographs. This is a dynamic process and staff continues to migrate SOPs, update forms and calculations to electronic/digital format.

3.0 2017 ASSESSMENTS AND AUDITS

3.1 NRC INSPECTIONS AND RELATED ACTIONS DURING 2017

The following summarizes NRC inspections and related actions at Willow Creek during 2017:

3.1.1 July 11 – August 17, 2017 - The USNRC performed an onsite, announced annual inspection, to examine activities conducted under the license as they related to public health and safety and to confirm compliance with the Commission's rules and regulations and the conditions of the Willow Creek SUA-1341license. Additional technical review regarding the facility's ability to maintain an inward hydraulic gradient was performed in office (NRC). A final telephonic exit was conducted with U1 representatives on August 17, 2017. Additional information regarding this inspection is in Section 2.3.1, above.

3.1.1.1 One NOV was identified: failure to adequately secure or control access to 11.e(2) material in the wellfield. U1 provided a corrective action, approved by the NRC, which was completed on July 17, 2017. No written response was required due to the violation promptly being brought into compliance by U1.

3.1.1.2 One non-cited violation (NCV) was identified associated with an employee's failure to wear the required breathing zone monitor for work under a Radiation Work Permit (RWP). U1 self-identified the violation, which was promptly corrected. The violation was a non-repetitive and not willful. The NRC closed the NCV on July 11, 2017.

3.1.1.3 Discussed Unresolved Item, 040-08502/2013-01, SERP approval of monitoring wells located outside of permit boundary. *The URI remains open pending a NRC legal review of the licensee's approval and implementation of the above mentioned SERP evaluations.*

3.1.2 March 29, 2017 – An onsite ALARA audit was performed by a third-party contractor.

3.2 2016 ANNUAL ALARA AUDIT

Recommendations from the 2016 ALARA audit were implemented and incorporated into U1's Willow Creek Project Radiation Safety and Health Physics program and operating procedures. In 2017, U1 completed the transition of migrating the radiation safety monitoring program documentation, calculations and reporting into a spreadsheet/database. This process has streamlined the processing and reporting of monitoring data. Additional information is in Section 2.4, above.

In 2017, U1 and the NRC resolved most of matters regarding license conditions that have been under review and negotiations. Additional information is in Section 2.3, above.

3.3 SELF-IDENTIFIED VIOLATIONS (SIV)

There was one SIV reported in 2017, failure to wear a breathing zone air sampler during an RWP activity. The RSO identified the violation to the employee and immediately provided corrective action.

4.0 RADIATION PROTECTION AND ALARA PROGRAM

Radiation detection equipment used for monitoring occupational exposure is appropriate for the operation and application of use, is properly maintained and calibrated, and the radiation safety staff demonstrated accurate and correct information on the use and operation of instrumentation. Refer to item 2.3.3, above regarding LLD (MDC) documentation.

4.1 EMPLOYEE EXPOSURE RECORDS AND TRENDS IN PERSONNEL EXPOSURES

The Total Effective Dose Equivalent (TEDE) is defined as the sum of the Deep Dose Equivalent (DDE, for external exposures) and the Committed Dose Equivalent (CDE, for internal exposures). The dose limit for TEDE (TEDE = DDE + CDE (CEDE)) is 5 rem/year. [RG 8.30]

Historically, employee exposures have been very low due to stand-by operations, or limited operational mode. The following table summarizes the 2017 employee occupational exposures with 2016 data in parenthesis for comparison.

2017 EMPLOYEE OCCUPATIONAL EXPOSURE SUMMARIES –WILLOW CREEK SITE (2016 DATA PROVIDED IN PARENTHESES)

EXPOSURE CATEGORY	REM		% OF REGULATORY LIMIT LIMIT = 5 REM/YEAR	
	AVERAGE	MAXIMUM	AVERAGE %	MAXIMUM %
External (DDE)	0.016 (0.020-2016)	0.056 (0.088-2016)	0.32 (0.40)	1.12 (1.8)
Radon Progeny (CEDE)	0.065 (0.095-2016)	0.027 (0.141-2016)	1.3 (1.9)	0.54 (2.8)
Airborne Uranium (CEDE)	0.004 (0.007-2016)	0.002 (0.013-2016)	0.08 (0.14)	0.04 (0.26)
Dry Pack Airborne Uranium (CEDE)	0.0095 (0.017-2016)	0.04 (0.040-2016)	0.019 (0.34)	0.80 (0.80)
CEDE combined	0.014 (0.119-2016)	0.042 (0.194-2016)	0.28 (2.4)	0.84 (3.9)

2017 Employee Occupational Exposure Summaries –Willow Creek Site (2016 Data Provided in Parentheses)				
Exposure Category	rem		% of Regulatory Limit Limit = 5 rem/year	
	Average	Maximum	Average %	Maximum %
Total Equivalent Dose Equivalent (DDE+CEDE = TEDE)	0.095 (0.139-2016)	0.114 (0.266-2016)	1.90 (2.78)	2.28 (5.32)

Dose assessments from routine and non-routine operations are included in the table summaries. Routine operations generally include those covered by an SOP. Non-routine operations are those covered by a Radiation Work Permit (RWP).

The RST/RSO is timely in assessing employee occupational exposures, which complies with the ALARA principle.

In 2017 (2016 data in parentheses), the average TEDE for all employee categories was 0.095 (0.139) rem, with a maximum of 0.114 (0.266) rem. The 2017 average TEDE represents a 31.7% reduction from 2016.

The above data demonstrates U1's commitment to operating in a manner consistent with the ALARA principle.

4.1.1 EXTERNAL RADIATION AND DEEP DOSE EQUIVALENT (DDE)

Monitoring is provided for employees that may exceed 10% of the allowable limit as required in 10 CFR Part 20.1502, Conditions requiring individual monitoring of external and internal occupational dose.

The RST/RSO continues to evaluate gamma occupational exposure levels for wellfield personnel to determine if there are any engineering controls or SOPs that can be incorporated to further reduced gamma exposure. Gamma occupational exposure levels continue to be below 10% of the allowable limits.

Gamma surveys are conducted quarterly to verify operating conditions do not develop which could cause elevated external occupational exposures.

The addition of operational notes on gamma survey reports provides useful information to assess short-term trends (e.g., IX column status, operating status of modules, etc.). Throughout the year, the radiation safety staff refers to this information when making assessments to determine if trends are developing. All postings are current. This activity supports the ALARA principle.

4.1.2 EXTERNAL RADIATION

4.1.2.1 BETA

Beta dose measurements were conducted semiannually in 2017. Seventeen (17) locations were measured at the IR CPP, thirty (30) locations were measured at the CR Satellite and twenty-one (21) measurements were taken in the wellfield MOD buildings. In 2017, the maximum reading of 1.1 mrem/hr was observed in Mod Building 10-5.

4.1.2.2 GAMMA

In 2017, gamma readings were measured on a quarterly frequency (monthly at CR). Gamma measurement fluctuation is attributed to process flow, radon daughters, and precipitate in filter media. The maximum gamma measurement observed in 2017, for IR was 3.0 mrem/hr @ 30 cm in the Dry Pack Storage Area in the vicinity of full drums, and at CR, 4.4 mrem/hour in MOD Building 10-6 (next to canister filter).

U1 complies with Subpart J-Precautionary Postings, 10 CFR Part 20.1902. Due to the fluctuation of gamma measurements and the site action level of 2 mrem/hour, U1 continually maintains postings in areas where gamma measurements have been observed greater than site action levels. All postings are current.

4.1.3 AIRBORNE RADIATION

4.1.3.1 URANIUM PARTICULATES

Air sampling for airborne particulate uranium is performed on a continuous basis at eleven standard locations with filter changes performed on Monday, Wednesday, and Friday when the dryer is in operation. Breathing zone air sampling is also performed for non-routine operations such as tank entries that are not represented by the standard locations. After the drying campaign of the Honeymoon product, U1 instituted the use of the Y-class Unat DAC to assess occupational exposure. The Y-Class value, 2E-11 uCi/ml, is more conservative than the lung solubility value, 4.7E-10 uCi/ml, which was derived by the original operator of the facility, Wyoming Minerals, and has been historically used for occupational exposure assessment.

During drying and packaging operations, the dryer enclosure is posted as an Airborne Radioactivity Area and access is prohibited unless respiratory protection is worn.

Operational and data analysis, specific to the dryer room, identify that dryer atmosphere engineering controls are effective in maintaining uranium air particulate concentration ALARA. The average and maximum data documented for the

Control Area and Locker Room for 2017 is anomalous and was a result of one activity performed under an RWP. No persons were in the Control Room or Locker Room when the activity was performed. The RST/RSO documented the event and provided corrective action and additional training. Corrective actions initiated were successful at significantly lowering airborne concentrations for similar RWP activities.

Routine air particulate sampling results for 2017 from the dryer and packaging enclosure and areas outside the YC circuit are summarized in the following table. Sample locations identified as locker room, control area, drum loading room furnace room and drum storage area are equipped with continuous air sampling pumps and data collected is used to assess the employee occupational exposure.

Dryer and Packaging Enclosures and Areas Outside the YC Circuit used to assess Employee Occupation Exposures – 2017 (2016)		
Sampler Location	**Average Result % DAC (uCi/ml)**	**Maximum Result % DAC (uCi/ml)**
Locker Room	4.47E-12 (without RWP data) 22.4% of DAC 1.13E-11 (with RWP data) (3.46E-12 - 2016)	7.87E-12 (without RWP data) 39.4% of DAC 7.26E-11 (with RWP data) (1.26E-11 - 2016)
Control Area	1.73E-12 (without RWP data) 8.7% of DAC 3.79E-12 (with RWP data) (1.70E-12 - 2016)	9.56E-12 (without RWP data) 47.8% of DAC 8.75E-11 (with RWP data) (5.45E-12 - 2016)
Drum Loading Room	5.32E-11 266% (2.96E-11 - 2016)	1.77E-10 885% (1.38E-10 - 2016)
Furnace Room	3.67E-11 184% (2.19E-11 - 2016)	2.12E-10 1060% (9.98E-11 - 2016)
Drum Storage	2.88E-12 14.4% (2.29E-12 - 2016)	4.15E-11 208% 6.07E-12 - 2016)

Review of the continuous air sampling data indicates that airborne radioactivity levels demonstrates that the furnace and drum loading rooms are at negative pressure to the other areas of the facility, which confirms that the engineering controls maintain doses ALARA.

Airborne uranium sampling from the Christensen Satellite facility is collected monthly at three sampling locations. The DAC at the Christensen Satellite is based on a solubility classification of 100% Class D or a DAC of 5 E-10 µCi/ml. In 2017, the maximum airborne uranium recorded was 9.00E-13 uCi/ml (0.2% of DAC). In 2016, the maximum airborne uranium recorded was 7.7E-12 uCi/ml (1.5%of DAC).

In 2017, no employee exceeded 10 CFR Part 20.1201(e) limits, …*In addition to the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity (see footnote 3 of appendix B to part 20)*.

4.1.3.2 RADON PROGENY

In 2017, radon progeny sampling was conducted monthly and the concentration is being maintained ALARA. There were no occurrences at IR or CR where radon daughters exceeded 0.08 WL, which is 25% of the regulatory limit of 4WLM, or 0.33 WL in one month.

4.1.4 COMMITTED EFFECTIVE DOSE EQUIVALENT

The Committed Effective Dose Equivalent (CEDE) was calculated for employees for 2017, which is the combined internal dose due to inhalation of airborne uranium and radon progeny. Other routes of potential internal exposure such as ingestion or absorption in wounds are considered negligible as substantiated by surface and personnel contamination sampling, bioassay sampling, and implementation of good hygiene practices.

The average CEDE for all locations and employees that worked a full year for 2017 was 0.021 rem, compared to 2016, which was 0.12 rem (0.114-2015; 0.111-2014)) rem, which included data from the dry pack area.

4.1.5 TOTAL EFFECTIVE DOSE EQUIVALENT

The average Total Effective Dose Equivalent (TEDE) was calculated for employees for 2017 and reported at 0.098 rem (0.139-2016). The data is in Section 4.1 table, above. The TEDE is the sum of external (DDE) and internal (CEDE) doses. ALARA discussions are provided in the external and internal dose sections above.

4.1.6 RADIATION WORK PERMITS (RWPs)

In 2017, there were no incidents documented associated with RWPs. Seventy (70) RWPs were issued in 2017 and are primarily issued for maintenance related activities (not covered under an SOP) where a potential of an occupational exposure could occur. Depending on the task, data collected during an RWP may include air particulate for uranium or radon progeny, bioassay, and or surface contamination. The RWP is another method that supports the ALARA principle. The RST/RSO is migrating tasks that have become routine and performed under an RWP to tasks with written SOPs.

4.1.7 DOSE TO THE PUBLIC

The off-shift operations personnel that utilize the man-camps for Irigaray and Christensen are used to demonstrate compliance with public dose limits. These individuals have been identified as the member of the public likely to receive the highest dose from Willow Creek operations. Monitoring indicates that potential doses to the public are far below allowable limits and ALARA.

In 2017, the highest Dose to the Public, measured at the Irigaray Man Camp location, was 16.8 (13.4-2016) mrem, which represents 16.8% of the 100 mrem limit. A change in calculating radon contribution on a quarterly basis vs. annual, which is more conservative, was initiated in 2016.

At the Christensen Man Camp location, Dose to the Public was documented at 4.1 (5.04-2016) mrem, 4.1% of the 100 mrem limit.

2017 ANNUAL PUBLIC DOSE, MREM (2016 IN PARENTHESES)

COMPONENT	IRIGARAY SITE	CHRISTENSEN SATELLITE SITE
RADON	16.2 (11.9-2016)	3.5 (4.6-2016)
GAMMA	0.0 (1.5-2016)	0.0 (0.37-2016)
URANIUM AIRBORNE PARTICULATE	0.551 (0.0074-2016)	0.551* (0.074*-2016)
ANNUAL PUBLIC DOSE, MREM	16.8 (13.42-2016)	4.05 (5.04-2016)

*NOTE: There is no environmental airborne radioactive sampling performed at the Christensen Satellite Facility, data utilized from the Irigaray Site to provide for a conservative estimate.

4.2 BIOASSAY RESULTS

Bioassay analyses are performed by a third party outside laboratory. Routine samples are typically collected on a monthly schedule from plant operators, technician and electrician when dryer maintenance is required, and when an RWP is issued. Routine bioassay samples are collected prior to the start of the first day on shift and 36 hours after completion of their last shift. During yellowcake drying operation, samples are collected once per shift rotation or every 4 days.

In 2017, 387 bioassay samples were submitted for uranium analysis. All, but four samples, were reported at less than (<) 5 ug/L. Three samples were at or near the laboratory reporting limit and one was reported at 11.7 ug/L. The RSO initiated an investigation and determined that the elevated bioassay result was attributed to the employee not following the established bioassay sampling procedures. The detected bioassay result was determined to be an outcome of contamination from work clothes. The employee was reacquainted with the proper sampling procedure. The third-party laboratory provides phone/email confirmation (time and date identified on analytical report) of elevated bioassays as soon as practical, within the Regulatory Guide recommendation, upon analytical determination.

Spiked samples are prepared in accordance with RG 8.22, 1988 version, one at 10-20 ug/L and one 40-60 ug/L, are submitted monthly. Standard Operating Procedures (SOP HP-4) reflects that the monthly sampling delivery group reflects Section 8.1 requirements of a specimen batch for spiked sample submittal, analytical rechecks, and protocol when the spikes are reported outside the prescribed 30% QA limit.

Regulatory Guide 8.22, May 2014, Revision 2, was revised to achieve better alignment with other industry standards. The NRC goal was to harmonize its guidance with international standards, to the extent practical. The May 2014 RG 8.22 removed the specific QAQC requirements previously identified in the 1988 version while referencing several industry publications. U1's bioassay program is robust and compliant with ALARA to monitor employee occupational exposures due to ingestion.

The bioassay program is complaint with SUA-1341 license conditions, referenced regulatory guidance and the ALARA principle.

4.3 REPORTS OF DAILY, WEEKLY, AND MONTHLY INSPECTIONS

4.3.1 DAILY WALK-THROUGH INSPECTION REPORTS

Daily walk-through inspections (by RST/RSO and approved Plant Operators) are accomplished as required and items are resolved in a timely manner.

4.3.2 WEEKLY INSPECTION REPORTS

Weekly inspections are accomplished as required and items are resolved in a timely

manner. Reports are prepared by the Radiation Safety staff.

4.3.3 MONTHLY RSO REPORTS

The RST/RSO provide monthly reports to management to summarize employee exposure and other relevant radiation survey reports and items are resolved in a timely manner.

4.4 DOCUMENTED TRAINING PROGRAM ACTIVITIES

4.4.1 RADIATION PROTECTION

In 2017, employees and contractors (job specific training) were trained throughout the year, which included initial (new hire) and annual radiation safety refresher, DOT Hazmat, routine safety meetings (to include tailgate style meetings), and SOP training. In addition to standard site radiation safety, DOT and industrial safety training, Job Safety Analysis (JSA), industrial safety inspections and emergency drills are periodically performed. The radiation safety staff is compliant with their required training.

New employees at Willow Creek are trained in radiation protection prior to reporting to their workstation. Training is provided as described in NRC Regulatory Guide 8.31 and Willow Creek SOP S-2 1. Contractor training is tailored to the specific work task assigned to the contractor.

In 2017, annual radiation protection refresher training was completed in the first quarter; DOT HazMat, Respiratory Protection and First Aid training were completed in the third quarter; Defensive & winter driving training was completed in the fourth quarter.

In June of 2017, U1 performed an Emergency Response Drill. Staff was required to participate in the *hands on*, mock resin spill training event.

Larry Arbogast (Senior Radiation Safety Technician) and Scott Schierman (Radiation Safety Officer) attended a 40-hour training class on radiation safety and health physics in June 2017. The class was provided by Two Lines, Inc.

4.4.2 DOT

DOT Hazmat training, 49 CFR Part 172, Subpart H, requires the following areas to be included: General Awareness/Familiarization, Function Specific, Safety Training, and Security. Annual DOT Hazmat training is provided to the operators and drivers associated with Hazmat material transportation. This schedule is compliant with the US DOT training requirements.

4.5 RADIATION SAFETY MEETING REPORTS

Meetings are documented, and records are maintained on site.

4.6 RADIOLOGICAL SURVEY AND SAMPLING DATA

U1 survey programs are effectively used to maintain exposure ALARA.

4.6.1 PERSONAL AND EQUIPMENT CONTAMINATION SURVEYS

Personnel surveys are documented at scan stations and reviewed by radiation safety personnel. Spot checks (measurements) were performed on 25% of employees or vehicles per quarter and no contamination was found.

In 2017, no unusual monitoring incidences were identified.

4.6.2 SURFACE CONTAMINATION SURVEYS

Surface contamination surveys are conducted weekly in eating areas, change rooms, control rooms and offices as identified in RG 8.30. The RSO or designee will be notified if any samples exceed the action level 100 dpm/cm^2 so clean up can occur and the area can be resurveyed.

Shipping surveys, surveys in restricted and clean areas, and surveys for release of equipment for unrestricted use surveys are accomplished and documentation is maintained by radiation safety personnel.

In 2017, three 11.e(2) byproduct shipments were made to Energy Fuels, White Mesa, Blanding, UT operation; four Strata Energy and four U1 yellowcake product shipments were sent to the conversion facility located in Metropolis IL.

In 2017, U1 had 3 reportable spills.

4.7 REPORTS ON OVEREXPOSURES OF WORKERS

There were no employee overexposures during the 2017 report period.

4.8 OPERATING PROCEDURES

The RST/RSO reviews SOPs annually as required. The RSO tracks the status of updates and manages the review process. SOPs are a dynamic process and work continues to further add and improve SOPs to better provide guidance for staff to keep occupational exposures ALARA. In 2016, the radiation safety staff initiated the task of revising the SOPs to include more detail and photographs of the task description.

In 2017, the radiation safety staff reviewed the SOPs and documented the task.

4.9 EQUIPMENT FOR EXPOSURE CONTROL

Interviews with employees and radiation safety staff, and observation of equipment in use indicated

that equipment was properly being utilized.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The radiation safety staff continues to improve on engineering controls, monitoring and documentation to affect a more efficient transfer of information and data flow to the appropriate staff.

U1 has been in correspondence/negotiations with the NRC regarding a variety of LC matters. Most of the items have been rectified in 2017 and U1 has fully complied or is in the final stages of implementation.

5.1 SUMMARY OF RECOMMENDATIONS

The radiation safety staff should continue to review, revise and upgrade forms and site documentation to a digital format as required. The migration to an electronic data acquisition and documentation was evident with the electronic format production of occupational exposure data presented during this audit. This is a dynamic process and will improve efficiency of collection, compilation, calculations and archiving required data. Staff is continually reviewing forms, calculations, etc. to maintain consistency between programs. RST/RSO initiated a basic QAQC plan to confirm that data is calculated and documented (surveyor, date, efficiency, etc.) correctly.