



August 31, 2015

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

**Subject: License SUA-1314  
Docket No. 040-08502  
Willow Creek Project  
ALARA Report  
Semi-Annual Effluent and  
Environmental Monitoring Report**

Dear Mr. Persinko:

In accordance with 10 CFR 40.65 and per license conditions 12.1 and 12.3 of Source Materials License SUA-1341, please find enclosed the Semi-Annual Effluent and Environmental Monitoring Report for the period of January 1 through June 30, 2015. The annual land use survey report will be included in the 2<sup>nd</sup> half 2015 semi-annual effluent report which will be submitted in February 2016.

If you have any questions regarding this report please contact me at (307) 233-6330, or e-mail at [scott.schierman@uranium1.com](mailto:scott.schierman@uranium1.com).

Sincerely,

Scott Schierman  
HSE Manager/RSO

cc: G. Kruse  
R.Kukura

August 31, 2015

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NHSS01

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

**Semi-Annual Report**

**January 01, 2015 through June 30, 2015**

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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 2014 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, 2015 through June 30, 2015.

## **2.0 OPERATIONAL MONITORING**

### **2.1 Activities Summary**

During the report period, production operations occurred at Mine Unit 7, Mine Unit 8, Mine Unit 5-2, Mine Unit 10A, and Mine Unit 10B. The operational plan forward for 2015 involves the cessation of injection in the operating wellfields and sustaining a small recovery bleed sufficient to maintain a cone of depression towards the wellfields. During this downtime, wellfield maintenance work will proceed. Maintenance planned includes the 5-year mechanical integrity testing (MIT) of well casings in Mine Unit 7 (as per regulatory requirements), replacement of flow meters and electronics where necessary in all wellfield module building, conversion of pattern layouts, swabbing of wells and cleaning of air vents and injection wells. This work will prepare the wellfields for additional limited production in 2016.

### **2.2 Excursion Well Status**

No wells were on excursion status during the reporting period from January 1, 2015 to June 30, 2015.

### **2.3 Groundwater Volumes Injected and Recovered**

During this reporting period an overall wellfield bleed was maintained at 1.9%. A total of 778,959,314 gallons were injected and 764,163,039 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.

The 140 psi limit exceeded nine (9) times during the period from January 1, 2015 through June 30, 2015 due to shutting off too many injection wells at one time, mechanical malfunction of column sump, or mechanical failure of the recording device.

On January 1, 2015 and March 25, 2015 turning off too many injection wells at one time resulted in spike in injection pressure. In both cases the pressure was corrected immediately after the spike occurrence.

Pressure readings above 140 psi were recorded on April 5, 2015 in Module 8-8 and April 12, 2015 in Module 7-3 which were the result of a pen on the circular chart being out of adjustment. The pen was adjusted and normal pressures were recorded. On April 24, 2015 a sump column malfunction that occurred that caused pressure in Module 7-3 to exceed the 140 psi limit.

On April 30, 2015 and May 3, 2015 an operator shutting off too many injection wells at one time resulted in pressure reading above 140 psi in Module 10-2 and Module 8-1. Pressure readings were corrected immediately in both instances. The last instance which occurred on May 3, 2015 occurred when an operator changing a circular chart dropped the pen and it made a false reading on the chart.

## **2.5 Summary of Mechanical Integrity Testing (MIT)**

During the report period, Mechanical Integrity Tests (MIT's) were completed on a total of 46 wells. The MIT's were completed using the "Two Packer Pressurized Test Method" approved in Permit No. 478. The table of the MIT records is contained in Attachment A. Of the total of 46 MIT's that were performed, there were 2 failures.

The MIT's were completed in the following area:

<u>Location</u>	<u>Number MIT's</u>	<u>Number Failures</u>
Mine Unit 7	19	0
Mine Unit 8	2	2
Mine Unit 10	2	1

Uranium One is assessing whether failed MIT wells in Mine Unit 8 and Mine Unit 10 will need to be abandoned or further maintenance work will allow the wells to pass MIT testing.

There were three wells in Mine Unit 8 that were abandoned during the period of January 1, 2015 through June 30, 2015. 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 anticipates responses to NRC concerns regarding Christensen Mine Units 2-6 will be submitted in September 2015.

### **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 is scheduled for submittal to NRC in late July early August 2015.

## **4.0 ENVIRONMENTAL MONITORING**

### **4.1 Regional Ranch Wells**

Five stock watering and domestic water wells are located within two kilometers of Christensen Ranch mining area, and one 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. Before 2012 samples were only analyzed for dissolved radionuclides. Review of the data indicates the elevated suspended Pb-210 observed in the last semi-annual report across multiple wells were not observed for this reporting period. All other 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. The elevated suspended radionuclide levels observed during the last semi-annual reporting period were not observed in the follow-up samples collected from the Powder River during the 1<sup>st</sup> and 2<sup>nd</sup> quarter of 2015. Radionuclide levels for the 1<sup>st</sup> half of 2015 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 2015 is summarized in Table 4 of Appendix A.

#### **4.3 Summary of Spills**

There was one reportable spills during the reporting period. Emails, written notifications, and summary reports were submitted to the NRC and WDEQ regarding these events and will not be duplicated in this report.

#### **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 30, 2015. Analytical results for uranium at the sample locations for IR-1 and IR-3 are higher than historic values and are currently being re-sampled. Resample 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 location 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 with the exception resample's collected from IR-1 and IR-3.

### **5.0 AIR MONITORING**

#### **5.1 Dryer Stack Emissions**

The semi-annual Dryer Stack Emission testing was performed on January 14, 2015 and April 21, 2015 by Western Environmental Services and Testing Services. The test in January during the drying of the Honeymoon yellowcake showed a release rate of 0.030 lb/hr. The sample collected in April during drying of Willow Creek materials shows a release rate of 0.036 lb/hr, which shows compliance with the WDEQ Air Quality Permit OP254 of 0.30 lb/hr for both sampling events. A summary of the total emissions is summarized in Table 6 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. Additionally



Uranium One is awaiting approval of methodologies for quantifying radon release before implementation as per license condition 11.3.

## **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 during the first and most of the second quarter of 2015. 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 2015 are summarized in Table 8 of Appendix A. It is important to note that during the 3<sup>rd</sup> quarter of 2014 Uranium One began drying Honeymoon material and completed drying of the Honeymoon material March 18, 2015. Once Uranium One began drying the Honeymoon material the Y classification for the 10 CFR Appendix B Effluent Limits was used for uranium.

## **5.3 Environmental Radon Monitoring**

Radon gas is monitored continuously at the six environmental air locations surrounding the Irigaray Project, and five 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 8 of Appendix E. 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. For the damaged monitoring device at IR-3 and the monitoring device found on the ground during the 2<sup>nd</sup> quarter 2015 at AS-7 historic average data will be utilized for these locations and reported with the annual report due in February 2016.

## **5.4 Environmental Gamma Radiation Monitoring**

Passive gamma radiation is monitored continuously at six environmental air locations surrounding the Irigaray Project and at five locations surrounding the Christensen Ranch Project. Dosimeters are exchanged and analyzed quarterly by the Landauer Dosimetry Services, a NVLP accredited company. The first quarter shows an elevated control badge result which would indicate the badges may have received an exposure during transit as not only was the control badge elevated all the badges in the package were elevated over previous measured levels. Discussions with the badge supplier indicated this happens fairly often. It is unlikely that the exposure to the control badge occurred at the site as the environmental control badge is stored in a lead lined box when badges are deployed for monitoring quarter. The data seems to be consistent with recent data; however results are consistently lower than the values presented in Tables 5.19 and 5.20 of the SUA-1341 License Renewal Application. It appears that the control values

were not subtracted from the data presented in the License Renewal Application but will be investigated further.

### **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 we are required under License Condition 11.3 to quantify the principal radionuclides from all point and diffuse sources. Under this license condition methods for estimating quantity of radionuclides emitted from a facility need to be verified by NRC before implementation. Once verification is achieved by the NRC these estimations will be made and reported under this section of the report.

### **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<sub>i</sub> = annual average concentration at the receptor location i;
- F<sub>i</sub> = equilibrium factors for receptor location i used for radon; and
- T<sub>i</sub> = 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 2016.

## 7.0 SAFETY AND ENVIRONMENTAL EVALUATIONS

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 a total of one SERPs during the reporting period. 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 2014 ALARA audit is included located in Appendix B to 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 2015 have been significantly reduced due to continued depressed oil prices.

Over the past several years (2001-2014) 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 2016.

# APPENDIX A

## Tables 1-10

**Table 10**  
**Page of 1 of 1**  
**Uranium One USA, Inc-Willow Creek Project**  
**2015 Semi-Annual Effluent and Monitoring Report**  
**SERP Summary**

SERP No.	Date	SERP Topic	Evaluation Summary
SERP 15-01	1/15/2015	Review and Approval of RST Qualifications	The purpose of the SERP evaluation is to change the dryer temperature to allow the yellowcake product to reach temperatures that are sufficient to convert the uranium mineralogy for the Willow Creek to a more stable $UO_3$ or $U_3O_8$ product.

# APPENDIX B

## ALARA Audit

August 2015

2015 Semi-Annual Effluent  
And Monitoring Report  
Willow Creek Project  
SUA-1341

# APPENDIX A

## Tables 1-10



**Table 1****Page 1 of 2**

**Uranium One USA, Inc. - Willow Creek Project**  
**2015 Semi-Annual Effluent and Monitoring Report**  
**Groundwater Volumes Injected and Recovered**

Date	MU 5-2 Monthly Totals			
	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2015	1,177,632	1,088,160	89,472	7.6 %
February 2015	57,600	0	57,600	100.0 %
March 2015	45,555	0	45,555	100.0 %
April 2015	213,266	0	213,266	100.0 %
May 2015	111,600	0	111,600	100.0 %
June 2015	44,355	0	44,355	100.0 %
<b>Totals</b>	<b>1,650,008</b>	<b>1,088,160</b>	<b>561,848</b>	<b>34.1 %</b>

Date	MU 7 Monthly Totals			
	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2015	53,346,054	52,178,128	1,167,926	2.2 %
February 2015	45,118,453	43,695,050	1,423,403	3.2 %
March 2015	20,896,311	20,211,881	684,430	3.3 %
April 2015	19,155,675	18,552,874	602,801	3.1 %
May 2015	584,496	131,040	453,456	77.6 %
June 2015	371,664	0	371,664	100.0 %
<b>Totals</b>	<b>139,472,653</b>	<b>134,768,973</b>	<b>4,703,680</b>	<b>3.4 %</b>

Date	MU 8 Monthly Totals			
	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2015	85,843,708	85,251,363	592,345	0.7 %
February 2015	89,750,513	89,170,114	580,399	0.6 %
March 2015	49,769,619	49,509,517	260,102	0.5 %
April 2015	49,698,028	48,964,726	733,302	1.5 %
May 2015	4,248,720	3,301,344	947,376	22.3 %
June 2015	951,840	0	951,840	100.0 %
<b>Totals</b>	<b>280,262,428</b>	<b>276,197,064</b>	<b>4,065,364</b>	<b>1.5 %</b>

**Table 1**  
**Page 2 of 2**  
**Uranium One USA, Inc. - Willow Creek Project**  
**2015 Semi-Annual Effluent and Monitoring Report**  
**Groundwater Volumes Injected and Recovered**

Date	MU 10A Monthly Totals			
	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2015	41,399,371	40,906,473	492,898	1.2 %
February 2015	41,839,607	41,316,076	523,531	1.3 %
March 2015	23,990,898	23,704,458	286,440	1.2 %
April 2015	29,731,574	29,260,889	470,685	1.6 %
May 2015	2,061,504	1,631,808	429,696	20.8 %
June 2015	580,320	0	580,320	100.0 %
<b>Totals</b>	<b>139,603,274</b>	<b>136,819,704</b>	<b>2783570.0</b>	<b>2.0 %</b>

Date	MU 10B Monthly Totals			
	Production (gallons)	Injection (gallons)	Bleed (gallons)	% Bleed
January 2015	69,991,831	69,408,422	583,409	0.8 %
February 2015	69,490,523	69,157,433	333,090	0.5 %
March 2015	39,517,487	39,200,314	317,173	0.8 %
April 2015	35,688,054	35,224,729	463,325	1.3 %
May 2015	2,771,136	2,298,240	472,896	17.1 %
June 2015	511,920	0	511,920	100.0 %
<b>Totals</b>	<b>217,970,951</b>	<b>215,289,138</b>	<b>2,681,813</b>	<b>1.2 %</b>

<b>Overall</b>	<b>778,959,314</b>	<b>764,163,039</b>	<b>14,796,275</b>	<b>1.9 %</b>
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Table 2  
Page 1 of 4  
Uranium One USA, Inc. - Willow Creek Project  
2015 Semi-Annual Effluent and Monitoring Report  
Injection Manifold Pressures

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

**Mine Unit 7**

Week Ending	Weekly Maximum injection Pressure (Maximum Permissible 140 psi)					
	Module 7-1	Module 7-2	Module 7-3	Module 7-4	Module 7-5	Module 7-6
1/4/2015	112	Not in operation	125	105	136	123
1/11/2015	109	Not in operation	114	105	124	110
1/18/2015	110	Not in operation	120	105	121	117
1/25/2015	110	Not in operation	116	104	125	107
2/1/2015	120	Not in operation	124	124	135	105
2/8/2015	118	Not in operation	123	105	129	96
2/15/2015	106	Not in operation	120	110	126	104
2/22/2015	110	Not in operation	130	106	130	105
3/1/2015	125	Not in operation	130	115	130	115
3/8/2015	125	Not in operation	130	120	139	124
3/15/2015	110	Not in operation	140	116	135	129
3/22/2015	114	Not in operation	135	111	130	106
3/29/2015	120	Not in operation	135	96	135	134
4/5/2015	107	0	132	109	134	134
4/12/2015	108	0	150	118	139	140
4/19/2015	106	0	139	114	140	138
4/26/2015	115	0	142	125	135	151
5/3/2015	115	0	125	121	137	150
5/10/2015	73	0	0	51	0	75
5/17/2015	0	0	0	0	0	0
5/24/2015	0	0	0	0	0	0
5/31/2015	0	0	0	0	0	0
6/7/2015	0	0	0	0	0	0
6/14/2015	0	0	0	0	0	0
6/21/2015	0	0	0	0	0	0
6/28/2015	0	0	0	0	0	0

Table 2  
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Uranium One USA, Inc. - Willow Creek Project  
2015 Semi-Annual Effluent and Monitoring Report  
Injection Manifold Pressures

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

<u>Mine Unit 8</u>						
Week Ending	Weekly Maximum injection Pressure (Maximum Permissible 140 psi)					
	Module 8-1	Module 8-2	Module 8-3	Module 8-4/5	Module 8-6	Module 8-7
1/4/2015	100	90	127	85	60	120
1/11/2015	76	90	80	79	65	116
1/18/2015	78	84	77	105	77	110
1/25/2015	90	75	80	118	104	118
2/1/2015	89	80	75	120	104	110
2/8/2015	86	94	87	106	104	112
2/15/2015	86	95	80	100	104	127
2/22/2015	85	96	77	100	101	101
3/1/2015	86	101	75	98	105	110
3/8/2015	83	102	75	100	95	111
3/15/2015	95	100	80	105	95	125
3/22/2015	100	100	90	104	95	136
3/29/2015	96	95	80	105	100	125
4/5/2015	110	95	81	90	110	135
4/12/2015	115	0	80	118	109	136
4/19/2015	95	0	82	131	110	112
4/26/2015	106	0	72	120	110	125
5/3/2015	126	0	72	136	0	129
5/10/2015	193	0	0	0	0	125
5/17/2015	0	0	0	0	0	0
5/24/2015	0	0	0	0	0	0
5/31/2015	0	0	0	0	0	0
6/7/2015	0	0	0	0	0	0
6/14/2015	0	0	0	0	0	0
6/21/2015	0	0	0	0	0	0
6/28/2015	0	0	0	0	0	0

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Uranium One USA, Inc. - Willow Creek Project  
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Injection Manifold Pressures

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

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

Week Ending	Weekly Maximum injection Pressure (Maximum Permissible 140 psi)					
	Module 8-8	Module 8-9		Module 5-2		
1/4/2015	125	107		150		
1/11/2015	125	110		Not in operation		
1/18/2015	114	105		Not in operation		
1/25/2015	102	110		Not in operation		
2/1/2015	100	115		Not in operation		
2/8/2015	95	115		Not in operation		
2/15/2015	100	111		Not in operation		
2/22/2015	105	115		Not in operation		
3/1/2015	100	116		Not in operation		
3/8/2015	100	119		Not in operation		
3/15/2015	101	118		Not in operation		
3/22/2015	100	117		Not in operation		
3/29/2015	100	120		Not in operation		
4/5/2015	160	121		0		
4/12/2015	90	121		0		
4/19/2015	80	115		0		
4/26/2015	0	127		0		
5/3/2015	0	120		0		
5/10/2015	0	106		0		
5/17/2015	0	0		0		
5/24/2015	0	0		0		
5/31/2015	0	0		0		
6/7/2015	0	0		0		
6/14/2015	0	0		0		
6/21/2015	0	0		0		
6/28/2015	0	0		0		

**Table 2**  
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**Uranium One USA, Inc. - Willow Creek Project**  
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**Injection Manifold Pressures**

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

**Mine Unit 10**

<b>Week Ending</b>	<b>Weekly Maximum injection Pressure (Maximum Permissible 140 psi)</b>					
	<b>Module 10-1</b>	<b>Module 10-2</b>	<b>Module 10-3</b>	<b>Module 10-4</b>	<b>Module 10-5</b>	<b>Module 10-6</b>
1/4/2015	99	128	125	130	128	127
1/11/2015	100	130	125	133	129	127
1/18/2015	100	131	120	130	129	126
1/25/2015	90	127	120	126	130	131
2/1/2015	96	121	125	130	130	129
2/8/2015	100	123	125	132	130	127
2/15/2015	100	129	126	132	130	130
2/22/2015	105	130	125	127	136	130
3/1/2015	107	120	120	130	130	128
3/8/2015	113	125	125	130	130	125
3/15/2015	116	125	125	128	132	125
3/22/2015	115	127	125	133	130	125
3/29/2015	115	127	123	155	130	125
4/5/2015	114	135	120	137	131	125
4/12/2015	120	140	0	125	130	125
4/19/2015	117	130	0	125	131	116
4/26/2015	105	127	0	125	96	125
5/3/2015	0	145	0	126	0	120
5/10/2015	0	138	0	125	0	121
5/17/2015	0	0	0	0	0	0
5/24/2015	0	0	0	0	0	0
5/31/2015	0	0	0	0	0	0
6/7/2015	0	0	0	0	0	0
6/14/2015	0	0	0	0	0	0
6/21/2015	0	0	0	0	0	0
6/28/2015	0	0	0	0	0	0

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Uranium One USA, Inc. - Willow Creek Project  
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Regional Ranch Wells

Sample Location	Christensen Ranch House #3					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	DOWN	NA	NA	1.0E-08	NA	3.3
Uranium (Suspended)	DOWN	NA	NA	ND	NA	NA
Thorium-230 (Dissolved)	DOWN	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	DOWN	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	DOWN	NA	NA	9.0E-10	1.0E-10	0.9
Radium-226 (Suspended)	DOWN	NA	NA	ND	NA	NA
Lead-210 (Dissolved)	DOWN	NA	NA	ND	NA	NA
Lead-210 (Suspended)	DOWN	NA	NA	2.1E-09	4.0E-10	21.0
Polonium-210 (Dissolved)	DOWN	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	DOWN	NA	NA	1.3E-09	8.0E-10	0.4

Sample Location	Christensen Ranch Ellendale #4					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	1.8E-09	NA	0.6	DOWN	NA	NA
Uranium (Suspended)	ND	NA	NA	DOWN	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	DOWN	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	DOWN	NA	NA
Radium-226 (Dissolved)	4.0E-10	1.0E-10	0.4	DOWN	NA	NA
Radium-226 (Suspended)	ND	NA	NA	DOWN	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	DOWN	NA	NA
Lead-210 (Suspended)	ND	NA	NA	DOWN	NA	NA
Polonium-210 (Dissolved)	ND	NA	NA	DOWN	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	DOWN	NA	NA

Sample Location	Christensen Ranch First Artesian #1					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	7.0E-10	NA	0.2	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	2.0E-10	1.0E-10	0.2	4.0E-10	1.0E-10	0.4
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Dissolved)	1.1E-09	NA	11.0	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch Corral #32					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	9.0E-10	NA	0.3	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	4.0E-10	1.0E-10	0.4	2.0E-10	1.0E-10	0.2
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

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Uranium One USA, Inc. - Willow Creek Project  
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Sample Location	Christensen Ranch Middle Artesian					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	1.4E-08	NA	4.7	5.6E-09	NA	1.9
Uranium (Suspended)	7.0E-10	NA	0.2	3.7E-09	NA	1.2
Thorium-230 (Dissolved)	ND	NA	NA	1.1E-09	5.0E-10	18.3
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	3.0E-10	1.0E-10	0.3	3.0E-10	1.0E-10	0.3
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	ND	5.0E-10	NA
Lead-210 (Suspended)	5.5E-09	6.0E-10	55.0	9.0E-09	7.0E-10	90.0
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	1.3E-09	4.0E-10	0.4	2.3E-09	9.0E-10	0.8

Sample Location	Christensen Ranch Dell Gulch # 13					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	8.0E-10	NA	0.3	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	2.0E-10	1.0E-10	0.2	2.0E-10	1.0E-10	0.2
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	6.0E-10	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Irigaray Willow #2					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	6.0E-10	NA	0.2	ND	NA	NA
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	ND	NA	NA	ND	NA	NA
Radium-226 (Suspended)	2.0E-10	1.0E-10	0.2	ND	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	5.0E-10	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

LLD's

Uranium 2.0E-10  $\mu\text{Ci/ml}$   
 Thorium-230 2.0E-10  $\mu\text{Ci/ml}$   
 Radium-226 2.0E-10  $\mu\text{Ci/ml}$   
 Lead-210 1.0E-9  $\mu\text{Ci/ml}$   
 Polonium-210 1.0E-9  $\mu\text{Ci/ml}$

ND = NON DETECTABLE

NA= NOT APPLICABLE

\*10 CFR 20 Appendix B Table 2 values

Uranium 3.0E-7  $\mu\text{Ci/ml}$   
 Thorium-230 6.0E-8  $\mu\text{Ci/ml}$   
 Radium-226 1.0E-7  $\mu\text{Ci/ml}$   
 Lead-210 1.0E-8  $\mu\text{Ci/ml}$   
 Polonium-210 4.0E-8  $\mu\text{Ci/ml}$



**Table 4**  
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**Uranium One USA, Inc. - Willow Creek Project**  
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**Surface Water**

Sample Location	Irigaray-9					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	4.1E-08	NA	13.7	9.1E-09	NA	3.0
Uranium (Suspended)	ND	NA	NA	3.0E-10	NA	0.1
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	2.0E-10	NA	0.2	2.0E-10	1.0E-10	0.2
Radium-226 (Suspended)	ND	NA	NA	2.0E-10	1.0E-10	3.3
Lead-210 (Dissolved)	ND	NA	NA	ND	5.0E-10	NA
Lead-210 (Suspended)	1.9E-09	5.0E-10	19.0	ND	5.0E-10	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	ND	NA

Sample Location	Irigaray-17					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	2.2E-08	NA	7.3	6.6E-09	NA	2.2
Uranium (Suspended)	ND	NA	NA	4.0E-10	NA	0.1
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	3.0E-10	1.0E-10	5.0
Radium-226 (Dissolved)	ND	NA	NA	2.0E-10	1.0E-10	0.2
Radium-226 (Suspended)	ND	NA	NA	4.0E-10	1.0E-10	0.4
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch GS-03					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	5.4E-08	NA	18.0	1.4E-08	NA	4.7
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	3.0E-10	1.0E-10	0.3	ND	NA	NA
Radium-226 (Suspended)	6.0E-10	1.0E-10	0.6	ND	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Powder River					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	5.8E-09	NA	1.9	4.6E-09	NA	1.5
Uranium (Suspended)	3.0E-10	NA	0.1	1.8E-09	NA	0.6
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	1.1E-09	2.0E-10	18.3
Radium-226 (Dissolved)	ND	NA	NA	ND	NA	NA
Radium-226 (Suspended)	2.0E-10	1.0E-10	0.2	1.4E-09	1.0E-10	1.4
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	1.8E-09	6.0E-10	18.0
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

August 2015

Sample Location	Irigaray-14					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	2.4E-08	NA	8.0	5.8E-09	NA	1.9
Uranium (Suspended)	3.0E-10	NA	0.1	ND	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	4.0E-10	1.0E-10	0.4	3.0E-10	1.0E-10	0.3
Radium-226 (Suspended)	3.0E-10	1.0E-10	0.3	ND	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	4.0E-10	NA	ND	8.0E-10	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch GS-01					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	DRY	NA	NA	1.5E-08	NA	5.0
Uranium (Suspended)	DRY	NA	NA	3.0E-10	NA	0.1
Thorium-230 (Dissolved)	DRY	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	DRY	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	DRY	NA	NA	3.0E-10	1.0E-10	0.3
Radium-226 (Suspended)	DRY	NA	NA	ND	NA	NA
Lead-210 (Dissolved)	DRY	NA	NA	ND	NA	NA
Lead-210 (Suspended)	DRY	NA	NA	ND	NA	NA
Polonium-210 (Dissolved)	DRY	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	DRY	NA	NA	ND	NA	NA

Sample Location	Christensen Ranch CG-05					
Radionuclide	1st quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*	2nd quarter ( $\mu\text{Ci/ml}$ )	Uncertainty ( $\pm\mu\text{Ci/ml}$ )	% of EFF Conc*
Uranium (Dissolved)	1.6E-08	NA	5.3	6.2E-09	NA	2.1
Uranium (Suspended)	ND	NA	NA	ND	NA	NA
Thorium-230 (Dissolved)	ND	NA	NA	ND	NA	NA
Thorium-230 (Suspended)	ND	NA	NA	ND	NA	NA
Radium-226 (Dissolved)	8.0E-10	1.0E-10	0.3	ND	NA	NA
Radium-226 (Suspended)	ND	NA	NA	ND	NA	NA
Lead-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Lead-210 (Suspended)	ND	NA	NA	ND	NA	NA
Polonium-210 (Dissolved)	ND	NA	NA	ND	NA	NA
Polonium-210 (Suspended)	ND	NA	NA	ND	NA	NA

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

Uranium	3.0E-7 $\mu\text{Ci/ml}$	Lead-210	1.0E-8 $\mu\text{Ci/ml}$	ND = NON DETECTABLE
Thorium-230	6.0E-8 $\mu\text{Ci/ml}$	Polonium-210	4.0E-8 $\mu\text{Ci/ml}$	NA= NOT APPLICABLE
Radium-226	1.0E-7 $\mu\text{Ci/ml}$			

**LLD's**

Uranium	2.0E-10 $\mu\text{Ci/ml}$	Lead-210	1.0E-9 $\mu\text{Ci/ml}$
Thorium-230	2.0E-10 $\mu\text{Ci/ml}$	Polonium-210	1.0E-9 $\mu\text{Ci/ml}$
Radium-226	2.0E-10 $\mu\text{Ci/ml}$		

**Table 5****Page 1 of 1****Uranium One USA, Inc. - Willow Creek Project****2015 Semi-Annual Effluent and Monitoring Report****Soil Sampling**

Location	Uranium * μCi / gram	Th-230 μCi / gram	Ra-226 μCi / gram	Pb-210 μCi / gram
IRIGARAY PROJECT				
IR-1 (Downwind of Restricted Area)	9.60E-09	8.00E-10	2.50E-09	1.70E-09
IR-3 (Upwind of Restricted Area)	2.29E-08	5.00E-10	1.50E-09	1.80E-09
IR-4 (North Road - Background)	6.10E-09	8.00E-10	3.70E-09	3.70E-09
IR-5 (Irigaray Ranch - nearest resident)	7.00E-10	4.00E-10	1.00E-09	6.50E-09
IR-6 (Ridge Road S.E.)	1.30E-09	2.00E-10	8.00E-10	1.00E-09
IR-13 (Employee house trailer)	(This sample was missed during the sampling event)			
CHRISTENSEN PROJECT				
AS-1 (Table Mountain - Background))	9.00E-10	8.00E-10	1.10E-09	2.50E-09
AS-5A (CR Plant Upwind S.E.)	1.30E-09	6.00E-10	1.50E-09	2.10E-09
AS-5B (CR Plant Downwind N.W.)	1.20E-09	6.00E-10	1.00E-09	1.70E-09
AS-6 (Christensen Ranch-Nearest Resident)	9.00E-10	5.00E-10	2.00E-10	1.40E-09
AS-7 (Christensen Employee house trailer)	(This sample was missed during the sampling event)			

Analyses performed by Inter-Mountain 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) is listed below are based on the weight of the samples.

RL's ( $\mu\text{Ci} / \text{Kg}$ ): Uranium = 2.00E-10

Th-230 = 2.00E-10

Ra-226 = 2.00E-10

Pb-210 = 1.00E-9

Table 5A

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Uranium One USA, Inc. - Willow Creek Project  
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 Vegetation Sampling

Location	Uranium * $\mu\text{Ci} / \text{kg}$	Th-230 $\mu\text{Ci} / \text{kg}$	Uncertainty $\pm \mu\text{Ci} / \text{kg}$	Ra-226 $\mu\text{Ci} / \text{kg}$	Uncertainty $\pm \mu\text{Ci} / \text{kg}$	Pb-210 $\mu\text{Ci} / \text{kg}$	Uncertainty $\pm \mu\text{Ci} / \text{kg}$
<b>IRIGARAY PROJECT</b>							
IR-1 (Downwind of Restricted Area)	Resampled	1.8E-05	1.4E-05	1.5E-04	8.9E-06	1.1E-04	4.2E-05
IR-3 (Upwind of Restricted Area)	Resampled	9.0E-05	1.3E-05	4.2E-05	1.1E-05	2.4E-04	6.9E-06
IR-4 (North Road - Background)	8.7E-05	1.7E-05	1.5E-05	8.7E-06	4.6E-06	8.7E-05	4.6E-05
IR-5 (Irigaray Ranch - nearest resident)	9.4E-06	7.2E-06	8.2E-06	7.7E-06	5.5E-06	1.1E-04	6.1E-05
IR-6 (Ridge Road S.E.)	1.2E-05	1.4E-05	1.0E-05	9.1E-06	5.1E-06	1.4E-04	4.8E-05
<b>CHRISTENSEN PROJECT</b>							
AS-1 (Table Mountain - Background))	8.6E-05	1.7E-06	3.3E-06	7.6E-06	4.7E-06	2.2E-04	6.1E-05
AS-5A (CR Plant Upwind S.E.)	5.7E-06	5.2E-06	6.0E-06	1.2E-05	5.1E-06	8.3E-05	4.0E-05
AS-5B (CR Plant Downwind N.W.)	3.4E-06	3.3E-06	6.5E-06	8.9E-06	4.3E-06	9.0E-05	4.0E-05
AS-6 (Christensen Ranch-Nearest Resident)	1.1E-05	1.9E-05	1.2E-05	1.8E-05	7.1E-06	2.2E-04	6.6E-05

Analyses performed by Inter-Mountain 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 LLD's are listed below and are based on the weight of the samples.

LLD's      Uranium = 2.0E-07  
                  Th-230 = 2.0E-07  
                  Ra-226 = 5.0E-08  
                  Pb-210 = 1.0E-06

**Table 6**  
**Page 1 of 1**  
**Uranium One USA, Inc. - Willow Creek Project**  
**2015 Semi-Annual Effluent and Monitoring Report**  
**Environmental Radon Monitoring**

Location	1st Quarter μCi/ml (2014)	Uncertainty ± μCi/ml	2nd Quarter μCi/ml 2014	Uncertainty ± μCi/ml	Location Average 2014	10CFR APP B Table 2
<b>IRIGARAY PROJECT</b>						
IR-1 (Downwind of Restricted Area)	8.00E-10	6.00E-11	7.00E-10	5.00E-11	7.50E-10	1.00E-10
IR-3 (Upwind of Restricted Area)**	2.10E-09	1.10E-10	Damaged		2.10E-09	1.00E-10
IR-4 (North Road)	8.60E-10	6.00E-11	7.00E-10	5.00E-11	7.80E-10	1.00E-10
IR-5 (Irigaray Ranch)	5.80E-10	4.00E-11	3.00E-11	3.00E-11	3.05E-10	1.00E-10
IR-6 (Rigdge Road - S.E. - Background)	9.00E-10	6.00E-11	4.00E-10	4.00E-11	6.50E-10	1.00E-10
IR-13 (IR Employee House Trailer)	6.00E-10	5.00E-11	4.00E-10	4.00E-11	5.00E-10	1.00E-10
(IR-13 / nearest residence)						
<b>CHRISTENSEN PROJECT</b>						
AS-1 (Table Mountain - Background)	5.00E-10	4.00E-11	7.00E-10	5.00E-11	6.00E-10	1.00E-10
AS-5A (CR Plant Upwind S.E.)	6.00E-10	5.00E-11	4.00E-10	4.00E-11	5.00E-10	1.00E-10
AS-5B (CR Plant Downwind N.W)	6.00E-10	5.00E-11	3.00E-10	3.00E-11	4.50E-10	1.00E-10
AS-6 (Christensen Ranch)	7.00E-10	5.00E-11	7.00E-10	5.00E-11	7.00E-10	1.00E-10
AS-7 (CR Employee House Trailer)*	4.00E-10	4.00E-11	Found on Ground		4.00E-10	1.00E-10
(AS-7 / nearest residence)						

**LLD = 0.06 pCi/l**

\* Radon cup was found on the ground, value was not reported. \*\*Monitor Returned Damaged.

SUMMARY OF STACK EMISSIONS SURVEY RESULTS  
Irigaray Dryer and Packaging Circuit

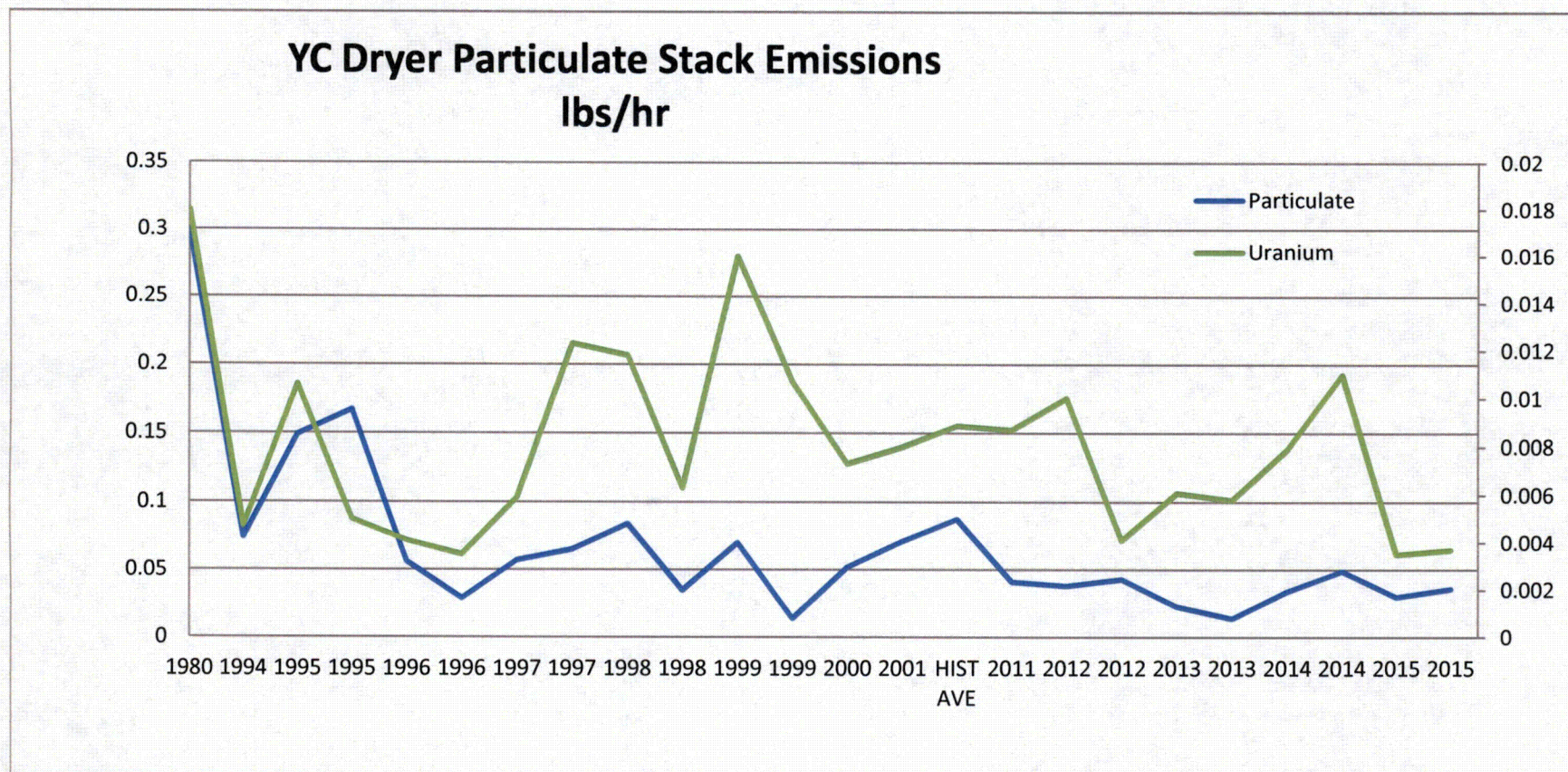
Time	Total Particulates lbs/hour (% limit)	U3O8 Emissions lbs	Unat. Released Ci	Unat. Uncertainty Ci	Th-230 Released Ci	Th-230 Uncertainty Ci	Ra-226 Released Ci	Ra-226 Uncertainty Ci	Pb-210 Released Ci	Pb-210 Uncertainty Ci
*Jan-March, 2015	0.030 (~10%)	7.56	2.39E-03	NA	4.80E-05	6.57E-06	1.01E-05	3.72E-06	3.39E-04	5.61E-05
**March-June 2015	0.036 (~12%)	5.94	1.83E-03	NA	5.10E-06	1.39E-06	1.89E-06	7.57E-07	1.50E-04	1.90E-05
Total		13.5	4.22E-03		5.31E-05		1.20E-05		4.89E-04	
	Permit Limit 0.30									

COMMENTS: Surveys occurred January 14, 2015 and April 21, 2015. The dryer was in operation for an approximate 2899 hours from January 01, 2015 through June 6, 2015. This is updated from the original amount estimated in the previous report. The total hours of operations were used to calculate the quantity of material released.

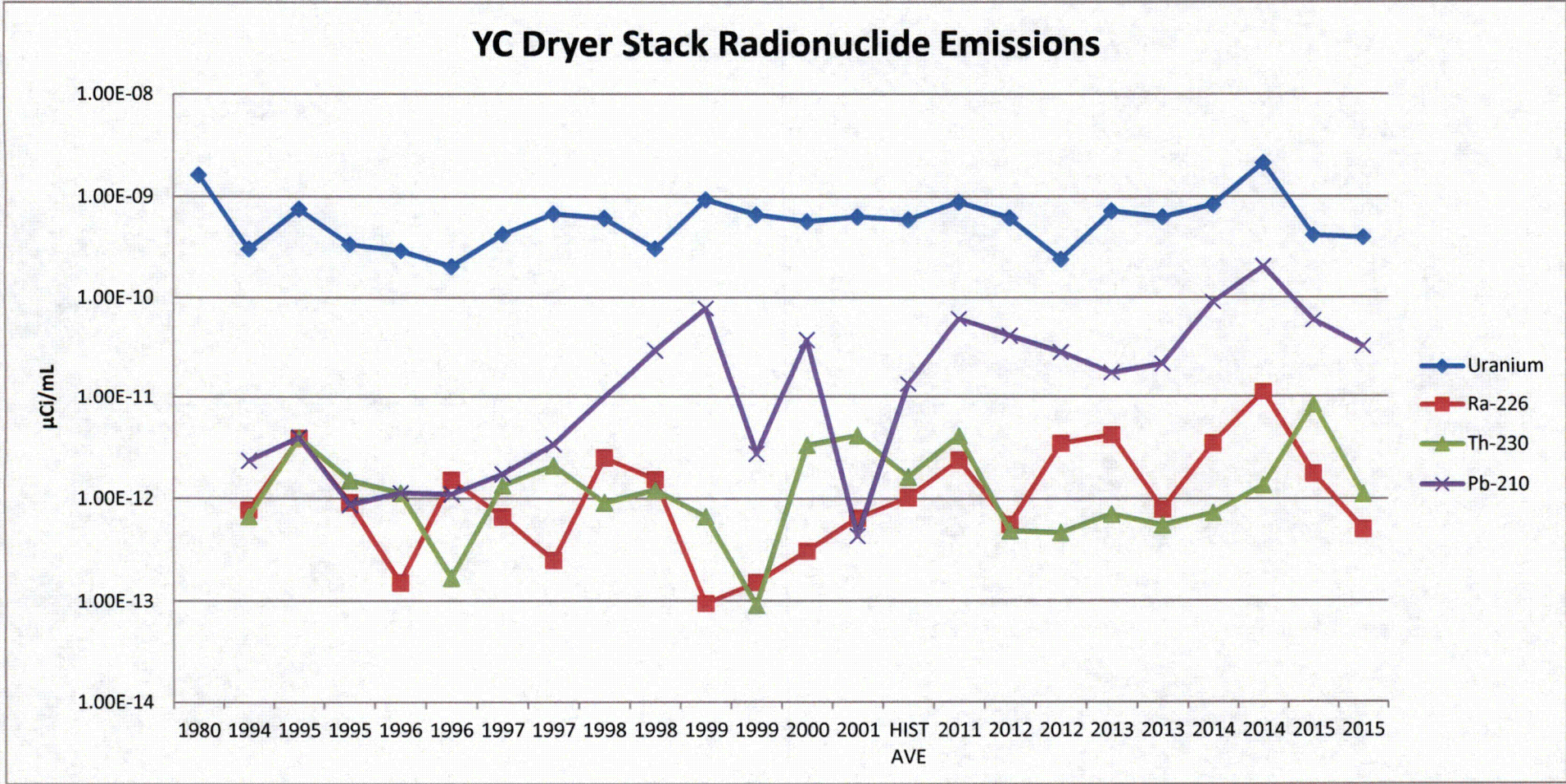
\* Honeymoon Processed materials  
\*\* Willow Creek Processed Materials

8.31E-4 Ci/month      9.17E-6 Ci/month      2.11E-6 Ci/m      9.06E-5 Ci/m

Table 7  
Page 2 of 3  
Uranium One USA, Inc. - Willow Creek Project  
2015 Semi-Annual Effluent and Monitoring Report  
Dryer Stack Emissions Testing Results







**Table 8**  
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**Uranium One USA, Inc. - Willow Creek Project**  
**2014 Semi-Annual Effluent and Monitoring Report**  
**Environmental Airborne Radionuclides**

1st Quarter 2015 Data				
	Uranium $\mu\text{Ci/ml}$	Th-230 $\mu\text{Ci/ml}$	Ra-226 $\mu\text{Ci/ml}$	Pb-210 $\mu\text{Ci/ml}$
IR-1 Downwind	1.7E-14	2.8E-16	5.7E-16	1.5E-14
Uncertainty	NA	1.0E-16	7.8E-17	1.4E-15
%of Pt, App. B Effluent Limit	0.9%	0.9%	0.1%	2.5%
IR-3 Upwind	3.8E-14	2.6E-16	8.6E-16	1.7E-14
Uncertainty	NA	7.8E-17	1.0E-16	1.5E-15
%of Pt, App. B Effluent Limit	1.9%	0.9%	0.1%	2.8%
IR-5 Brubaker Ranch	2.4E-15	2.5E-16	5.0E-16	1.3E-14
Uncertainty	NA	8.2E-17	8.2E-17	1.5E-15
%of Pt, App. B Effluent Limit	0.1%	0.8%	0.1%	2.2%
IR-6 Background	5.1E-15	2.5E-16	5.3E-16	1.6E-14
Uncertainty	NA	9.0E-17	9.0E-17	1.5E-15
%of Pt, App. B Effluent Limit	0.3%	0.8%	0.1%	2.7%
IR-13 Employee House Trailer	5.2E-15	2.8E-16	4.4E-16	1.5E-14
Uncertainty	NA	1.0E-16	7.8E-17	1.5E-15
%of Pt, App. B Effluent Limit	0.3%	0.9%	0.0%	2.5%

2nd Quarter 2015 Data				
	Uranium $\mu\text{Ci/ml}$	Th-230 $\mu\text{Ci/ml}$	Ra-226 $\mu\text{Ci/ml}$	Pb-210 $\mu\text{Ci/ml}$
IR-1 Downwind	2.1E-14	1.1E-16	1.3E-16	1.4E-14
Uncertainty	NA	5.5E-17	5.5E-17	1.4E-15
%of Pt, App. B Effluent Limit	1.1%	0.4%	0.0%	2.3%
IR-3 Upwind	6.6E-14	ND	ND	1.4E-14
Uncertainty	NA	NA	NA	1.3E-15
%of Pt, App. B Effluent Limit	3.4%	NA	NA	2.3%
IR-5 Brubaker Ranch	1.7E-15	ND	ND	8.1E-15
Uncertainty	NA	NA	NA	1.1E-15
%of Pt, App. B Effluent Limit	0.1%	NA	NA	1.4%
IR-6 Background	1.7E-14	ND	ND	2.7E-15
Uncertainty	NA	NA	NA	8.4E-16
%of Pt, App. B Effluent Limit	0.9%	NA	NA	0.5%
IR-13 Employee House Trailer	6.1E-15	ND	1.1E-16	9.1E-15
Uncertainty	NA	NA	2.8E-17	1.1E-15
%of Pt, App. B Effluent Limit	0.3%	NA	0.0%	1.5%

2015 Summary (Averages)				
	U ( $\mu\text{Ci/ml}$ )	Th-230 ( $\mu\text{Ci/ml}$ )	Ra-226 ( $\mu\text{Ci/ml}$ )	Pb-210 ( $\mu\text{Ci/ml}$ )
IR-1	1.9E-14	2.0E-16	3.5E-16	1.5E-14
IR-3	9.3E-14	2.6E-16	8.6E-16	1.6E-14
IR-5	2.1E-15	2.5E-16	5.0E-16	1.1E-14
IR-6	1.1E-14	2.3E-16	5.3E-16	9.4E-15
IR-13	5.7E-15	2.8E-16	2.8E-16	1.2E-14

10 CFR Pt. 20, App. B, Effluent Limits ( $\mu\text{Ci/ml}$ )  
Uranium =  $1.95\text{E-}12$  (50%D & 50%W)  
Th-230 =  $3.0\text{E-}14$  (Y)  
Ra-226 =  $9.0\text{E-}13$  (W)  
Pb- 210 =  $6.0\text{E-}13$  (D)

Lab LLD's  
Uranium =  $1.0\text{E-}16$   
Th-230 =  $1.0\text{E-}16$  N/D =Non Detectable  
Ra-226 =  $1.0\text{E-}16$   
Pb-210 =  $2.0\text{E-}15$



**Table 9**  
**Page 1 of 1**  
**Uranium One USA, Inc. - Willow Creek Project**  
**2015 Semi-Annual Effluent and Monitoring Report**  
**Environmental Gamma Radiation Monitoring**

Location	1st Quarter 2015 mrem/quarter	2nd Quarter 2015 mrem/quarter	Location Average 2015 mrem/quarter	Year to Date Total 2015 mrem/quarter
<b>IRIGARAY PROJECT</b>				
Control	103.4	36.2	NA	NA
IR-1 (Downwind of Restricted Area)	-0.6	6.2	2.8	5.6
IR-3 (Upwind of Restricted Area)	23.7	13.4	18.6	37.1
IR-4 (North Road)	17.2	3.9	10.6	21.1
IR-5 (Irigaray Ranch)	-4.6	2.0	-1.3	-2.6
IR-6 (Ridge Road S.E. - Background)	0.3	4.9	2.6	5.2
IR-13 (I.R. Employee House Trailer) (nearest residence)	2.3	3.8	3.1	6.1
Quarterly Average	6.4	5.7	6.0	6.0
<b>CHRISTENSEN PROJECT</b>				
AS-1 (Table Mountain - Background)	8.5	4.1	6.3	12.6
AS-5A(CR Plant Upwind S.E. )	-3.4	6.8	1.7	3.4
AS-5B (CR Plant Downwind N.W. )	13.7	7.1	10.4	20.8
AS-6 (Christensen Ranch )	3.3	12.1	7.7	15.4
AS-7 (C.R. Employee House Trailer) (nearest residence)	-1.4	-0.8	-1.1	-2.2
Quarterly Average	4.1	5.9	5.0	5.0

**Table 10**  
**Page of 1 of 1**  
**Uranium One USA, Inc-Willow Creek Project**  
**2015 Semi-Annual Effluent and Monitoring Report**  
**SERP Summary**

<b>SERP No.</b>	<b>Date</b>	<b>SERP Topic</b>	<b>Evaluation Summary</b>
SERP 15-01	1/15/2015	Review and Approval of RST Qualifications	The purpose of the SERP evaluation is to change the dryer temperature to allow the yellowcake product to reach temperatures that are sufficient to convert the uranium mineralogy for the Willow Creek to a more stable $UO_3$ or $U_3O_8$ product.

# APPENDIX B

## ALARA Audit

August 2015

2015 Semi-Annual Effluent  
And Monitoring Report  
Willow Creek Project  
SUA-1341



**R AND D ENTERPRISES, INC.**

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## **2014 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**  
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MAY 30, 2015



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## 1.0 EXECUTIVE SUMMARY

The annual 2014 ALARA audit was performed on March 31 and April 1, 2015 for Uranium One USA, Inc. (U1) Willow Creek ISR Project, 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 start up of the current Willow Creek ISR Project was on December 22, 2010 followed by dryer operations beginning September 30, 2011. Christensen Ranch satellite recovery and Irigaray Central Processing facilities have been in continuous operation since. The Irigaray facility began reprocessing U1 Honeymoon project product in late 2014 with the campaign running through the first quarter of 2015 utilizing the high temperature dryer to reduce organic carbon concentrations in the Australian yellowcake. This process probably presented the greatest occupational exposure, radiation safety risk for 2014.

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.

The Radiation Safety Staff continued to assess the operations and make recommendations for improvement using engineering techniques (process isolation, ventilation, controls, etc.) to reduce further occupational exposures. Corporate and Site managers are committed to maintaining ALARA 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 site's 2014 average TEDE of 0.19 rem, compared to 0.21 rem reported for 2013.

## 2.0 2014 ALARA SUMMARY

The audit team comprised of Sheryl Garling and Roger A. Garling of R and D Enterprises, Inc. (RDE). U1 Willow Creek Project's Irigaray Plant & Christensen Ranch Satellite Radiation Safety Officer (RSO) Ryan Schierman and Radiation Safety Technician (RST) Larry Arbogast accompanied the audit team. This audit serves as the annual review of the content and implementation of the radiation protection program for 2014 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 2012 and 2013,
- ✓ USNRC License SUA-1341, Amendment No.3,
- ✓ 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 (and notice of violation) 040-08502/13-002 and 040-08502/14-001 (December 11, 2014) and U1 response,
- ✓ 2014 Monthly Radiation Safety Summary Reports, and
- ✓ Licensee documentation, site records and reports generated by the Radiation Safety Officer and Health Physics staff.

The audit team incorporated the content of RG 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*, as guidance.

## 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 [occupation] 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 sampling, measurement and analysis was performed within time constraints in accordance with the sampling procedures and analytical methods required for the analytical and monitoring program.

## 2.2 SAFETY AND ENVIRONMENTAL REVIEW PANEL (SERP)

The following table represents the Safety and Environmental Review Panel (SERP) proposed changes evaluated during 2014. 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 as long as such changes follow the specified criteria identified in the LC.



Date	SERP ID	Proposed Changes
March 26, 2014	Evaluation Report – SERP 14-02	Review and Approval of RST Qualifications
April 1, 2014	Evaluation Report – SERP 14-03	Review and Approval of Addition of Spray Nozzles to YC Scrubber System
August 4, 2014	Evaluation Report – SERP 14-04	Review and Approval of Brine Solution Being Recycled into the Injection Stream
September 22, 2014	Evaluation Report – SERP 14-05	2013 Annual Review of License Renewal Application Section 7.5 Effects of Accidents
November 4, 2014	Evaluation Report – SERP 14-06	Review and Implementation of Root Cause Findings Regarding Honeywell Drum Pressurization Incident
December 10, 2014	Evaluation Report – SERP 14-07	Terminating the Use of Organic Filtration in the Honeymoon Reprocessing Enclosure

### 2.3 NRC LICENSING ACTIVITIES

The license renewal for SUA-1341 was issued on March 7, 2014. License Condition 9.8 and 9.12 contain obligations for submittal of information within 90 days of license renewal regarding Standard Operating Procedures (SOPs) for training of personnel other than HPT's. Information on the following was submitted and U1 has not received correspondence from the NRC regarding approval.

- Perform surveying on resin trucks and conducting inspections in the absence of the RSO or HPT. This information was submitted on June 5, 2013.
- LC 9.8 requires the submittal of a Contamination Control Plan ("CCP") to NRC within 90 days of license renewal. Implementation of the CCP is contingent on the licensee receiving written verification from NRC prior to implementation. The Contamination Control Plan ("CCP") was submitted on August 8, 2014.
- LC 11.3 identifies that the licensee may provide alternative procedures specific to in-plant air particulate sampling to show compliance with 10 CFR 20.1204 to NRC for review and verification within 6 months of license renewal. In September 2013 and August 2014 the licensee provided additional information justifying the current method of counting in-plant air particulate sampling for gross alpha was compliant with 10 CFR 20.1204.
- LC 11.3 requires the licensee to collect environmental air particulate sampling for the Christensen Ranch Satellite facility. U1 provided NRC justification for using Irigaray environmental air particulate sampling result for the Christensen Ranch Satellite as a conservative estimate to demonstrate compliance with 10 CFR 40.31(h) in September 2014. Denial of the submittal was documented in a November 12, 2014 NRC letter and further correspondence has been initiated.





- LC 9.15 requires a review and comparison of regional weather station data with onsite meteorological data to determine if the onsite data is representative of long-term conditions. U1 submitted an evaluation on September 5, 2013.
- Amendment No. 3, to the renewed license, was received October 2014, which allowed U1 to reprocess the Honeymoon, out of spec, yellowcake through the Irigaray calciner.

## **2.4 FACILITY AND 2014 PROGRAM IMPROVEMENTS**

Improvements during 2014 include:

- Progress continued on incorporating exposure calculations into an electronic format, revising forms so they are consistent between monitoring programs and sites;
- Graphing uranium particulate and radon progeny results was incorporated into the RSO monthly reports;
- The RSO continued the practice of conducting investigation/evaluation of monitoring data anomalies or detection that could identify a compromise in an operational or personnel procedure resulting in a potential occupational exposure;
- The radiation safety staff continued to revise and update SOPs and survey/monitoring data forms. This is a dynamic process to migrate forms and calculations to electronic/digital format.

## **3.0 2014 ASSESSMENTS AND AUDITS**

### **3.1 NRC INSPECTIONS AND RELATED ACTIONS DURING 2014**

The following summarizes NRC inspections and related actions at Willow Creek during 2014:

- An announced NRC routine inspection was conducted July 31 - August 3, 2013.
- An announced routine inspection was performed on May 13 - 15, 2014. NRC consolidated the July 2013 and May 2014 inspections findings into one report that was dated December 11, 2014.
- On August 5-7, 2014, the NRC "dropped in" on the site on an unannounced inspection to review the Honeymoon material processing operation.
- On September 23-26, 2014, the NRC visited the site on an announced visit to discuss the "reactive investigation", referring to incident that occurred at the Honeywell Metropolis Conversion Facility involving a drum of yellowcake from U1's Willow Creek Project. Due to decomposition of uranyl hydrates, the byproduct of oxygen off gassed and increased the pressure in the sealed drum.



#### **3.1.1 JULY 31 – AUGUST 3, 2013**

One Severity Level IV violation of LC 10.9 was identified. The violation identified *that the licensee shall use a Radiation Work Permit for all work or non-routine maintenance jobs where the potential for significant [occupational] exposure to radioactive materials exists and for which no standard written operating procedure exists....*

#### **3.1.2 MAY 13 – MAY 15, 2014**

One Severity Level IV violation of LC 9.3 was identified. The violation identified *during the months of November 2013 and January through April 2014, no gamma exposure rate surveys were performed in areas posted as radiation areas. Specifically, 21 modular buildings were not surveyed on a monthly basis, although all were posted as radiation areas and exceeded the 2.0 milliRem/hr administrative limit.*

#### **3.1.3 SEPTEMBER 8, 2014**

U1 received correspondence from NRC that the Special Investigation performed in late 2013 was completed and a Level IV violation was issued by the NRC for failure to maintain the 4.5 hour drumming time.

#### **3.1.4 NOVEMBER 11, 2014**

U1 submits a report containing the root cause analysis/investigation of the Honeywell drum incident of September 9, 2014.

#### **3.1.5 U1 JANUARY 9, 2015 RESPONSE**

U1 submits a response containing reasons and corrective actions in response to the above Notice of Violations. The violations were identified as Self Identified Violations (SIV) prior to the NRC inspections and corrective actions and full compliance were achieved as soon as practical after the incidents were discovered and identified.

### **3.2 2013 ANNUAL ALARA AUDIT**

All recommendations from the 2013 ALARA audit were implemented and incorporated into U1's Willow Creek Project Radiation Safety and Health Physics program and operating procedures.

### **3.3 SELF-IDENTIFIED VIOLATIONS (SIV)**

There were three SIVs reported in 2014. The SIVs will be made available to the NRC during their next routine inspection. Corrective actions have been implemented. The violations did not result in



significant impact to worker health or the environment.

- In February 2014, an SIV was documented for an event that occurred in December 2013. An SOP deviation was identified. A drum was filled in less than 4.5 hours and was not set aside to properly cool before shipping procedures were initiated.
- In May 2014, an SIV was documented for an event that was identified in April 2014. License Condition 5.7.2 identifies that monthly gamma surveys will be performed for areas greater than 2 mR/hr. There was a miscommunication between the RSO and RST regarding the frequency of surveys and the proper forms required for documentation, which resulted in surveys not being conducted for modular buildings. This omission was immediately remedied upon identification. The RSO and RST reviewed forms and documentation, calendars and schedules to initiate a corrective action and mitigate the root cause of the monitoring omission.
- In May 2014, an SIV was documented for an event that occurred in May 2014 regarding a weekly contamination control survey. Due to unusual circumstances, the individual responsible for performing the weekly survey, could not complete the task and did not convey the need to perform the survey to others. The root cause of the event was identified and discussed with the responsible employee.

## 4.0 RADIATION PROTECTION AND ALARA PROGRAM

### 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]

U1 commenced operations in Mine Unit 7 December 22, 2010 with dryer operations starting on September 30, 2011.

Historically, employee exposures have been very low due to stand-by operations, non-operational or renovation mode. The following table summarizes the 2014 employee occupational exposures.

2014 Employee Occupational Exposure Summaries –Willow Creek Site (2013 Data Provided in Parentheses)				
Exposure Category	rem		% of Regulatory Limit (Limit = 5 rem/year)	
	Average	Maximum	Average %	Maximum %
External (DDE)	0.074 (0.098)	0.243 (0.39)	1.48	4.86
Radon Progeny (CEDE)	0.097	0.151	1.94	3.02



2014 Employee Occupational Exposure Summaries –Willow Creek Site (2013 Data Provided in Parentheses)				
Exposure Category	rem		% of Regulatory Limit (Limit = 5 rem/year)	
	Average	Maximum	Average %	Maximum %
Airborne Uranium (CEDE)	0.014 (0.12)	0.024 (0.18)	0.28	0.48
Dry Pack Airborne Uranium (CEDE)	0.024	0.047	0.48	0.94
CEDE combined	0.135 (0.085)	0.222 (0.19)	2.7	4.4
Beta Ring Honeymoon Project, Skin/Extremity Dose (SDE) Limit = 50 rem/year	0.170	0.320 (0.384)	0.34 (of 50 rem/year)	0.64 (of 50 rem/year)
Total Equivalent Dose Equivalent (DDE+CEDE = TEDE)	0.187 (0.21)	0.379 (0.55)	3.74	7.58

2014 Employee Category Occupational Exposure Summaries Regulatory Limit 5 rem/year								
Employee Category	TEDE (2013 Data)		External - DDE		CEDE (2013 Data)			
	Avg	Max	Avg	Max	Rn Daughters		U Particulate	
					Avg	Max	Avg	Max
Irigaray (IR)	0.306 (0.17)	0.379 (0.55)	0.104	0.164	0.097 (0.12)	0.151	0.012	0.024
Christensen Ranch	0.112 (0.28)	0.252	0.032	0.121	0.097 (0.10)	0.151	0.012	0.024
Wellfield	0.173 (0.37)	0.329	0.096	0.243	0.160 (3.2)	0.160	-	-
Dry Pack	IR	IR	IR	IR	IR	IR	0.024	0.047
All Locations (rounding errands)	0.197 (0.21)	-	-	-	-	-	-	-

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 RSO has been compliant with the timely review of data to assess employee occupational exposures, to comply with the ALARA principle.

In 2014, the maximum TEDE for occupational exposure of 0.379 rem assessed to the Irigaray operators as compared to the maximum assessment of 0.550 for 2013. Trend analyses will be more relevant as mining and process operations stabilize.

The audit results indicate that U1 is operating in a manner consistent with the ALARA principle, represented by the overall Willow Creek Site 2014 average TEDE of 0.20 rem, compared to 0.21



rem reported for 2013.

#### 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.

The 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 routinely 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. This activity supports the ALARA principle.

All postings were current.

#### 4.1.2 EXTERNAL RADIATION – BETA

Beta/gamma surveys are conducted on semi annually schedule.

2014 Beta Dose Measurements			
Month	Location	Description	Beta Dose mrem/hr
July 2014	IR	Honeymoon drum area	1.5
	CR	IX Column #10 expansion area	1.09
	CR	Expansion plant area bag filters	1.09
	CR	Modular Building wellfield	1.09
December 2014	IR	Contaminated waste storage consisting of used HEPA filters	9.9
	CR	IX in expansion area	0
	CR	RO area	0.25
	CR	Modular Building wellfield	2.54



The Shallow Dose Equivalent (SDE) to workers from whole body dosimeter results were reviewed and found to be consistent with the levels that were measured during the annual beta survey to workers. The highest SDE measured during 2014 from an OSL badge monitoring was 0.320 rem, or <1% of the 50 rem/year limit for extremity dose.

#### 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. The Derived Air Concentration (DAC) at the Irigaray Plant is based on lung solubility studies showing the yellowcake product is 85% Class D and 15% Class W resulting in a DAC of  $4.7\text{E-}10$  microcurie per milliliter (uCi/mL). During the Honeymoon product drying campaign, occupational exposures were evaluated using the Y-class Unat DAC. The conservative Y-class DAC was used due to the lack of scientific supporting solubility data available on the yellowcake product at the new drying parameters.

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. As a result, air particulate monitoring in other areas of the building indicate that dryer controls and proper operations are effectively containing airborne uranium to the dryer room. Review of results from areas outside the dryer including in the drum storage area show an average of less than 1 percent of the 85% Class D/15% Class W DAC.

In 2014, routine air particulate sampling results 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 - 2014		
Sampler Location	Average Result % DAC	Maximum Result % DAC
Locker Room	<1.1	<2.0
Control Area	<1.2	<2.0
Drum Loading Room	<9.0	<24.0
Furnace Room	<14.5	<25.0
Drum Storage	<1.4	<3.0

The DAC for IR has been identified as 85% Class D/15% Class W DAC of 4.7E-10  $\mu\text{Ci/ml}$ .

In November 2014, the drum loading/packaging enclosure had a uranium particulate measured at <24% of the DAC, which was the maximum measurement for 2014. The average measurement for 2014 was <9.0% of DAC.

The furnace room maximum uranium air concentration was <25% of DAC. The average of the 2014 measurements was <14.5% of the DAC

Review of the continuous air sampling data indicates that airborne radioactivity levels with very few exceptions are being maintained well below site action levels and are compliant with the ALARA principle.

Airborne uranium sampling from the Christensen Satellite facility is collected on a monthly basis 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  $\mu\text{Ci/ml}$ . No sample location exceeded 5% of the DAC during 2014.

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 2014, radon progeny sampling was conducted on a monthly basis. Nine (9) occurrences were identified exceeding 0.08 WL, which is 25% of the regulatory limit of 4WLM, or 0.33 WL in one month. Upon measurement confirmation and data validation, an investigation commenced to determine the root cause of the elevated radon progeny incidents. The RSO initiating an increase sampling



schedule to weekly as prescribed in RG 8.30.

The incidents were related to the malfunction of a ventilation system, which resulted in the buildup of radon progeny in the area.

Trend analysis for the wellfield modular buildings show radon daughter levels were maintained below 25% of the DAC with one exception in November 2014. Review of radon progeny data indicates that levels are being maintained ALARA.

#### **4.1.4 COMMITTED EFFECTIVE DOSE EQUIVALENT**

The Committed Effective Dose Equivalent (CEDE) was calculated for employees for 2014, 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, excluding administrative and laboratory areas, for employees that worked a full year for 2014 is 0.10 rem. The average level for all locations, excluding administrative and laboratory areas, in 2013 was 0.12 rem.

#### **4.1.5 TOTAL EFFECTIVE DOSE EQUIVALENT**

The Total Effective Dose Equivalent (TEDE) was calculated for employees for 2014 as shown in the tables located in 4.1 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 2014, there were no incidents documented associated with RWPs. RWPs 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 RSO is migrating tasks that have become routine and performed under a 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 2014, the dose to public, using the Irigaray Man Camp location, was 9.2 mrem, or 9.2% of the 100 mrem limit, compared to 2013 reported dose to public of 9.3 mrem. In 2014, the Christensen Man Camp location was documented at 0 mrem, compared to 0.06 mrem in 2013.

## 4.2 BIOASSAY RESULTS

Bioassay analyses are performed by a third party outside laboratory. Routine samples are 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 2014, there were 14 bioassay results reported in excess of 5 ug/L, but less than 15 ug/L, and two bioassays were reported in excess of 15 ug/L but less than 35 ug/L (17ug/L and 21 ug/L). The elevated bioassay samples reported between 5-15 ug/L resulted from inappropriate personal hygiene practices. The RS staff investigated the root cause of the events and provided additional consultation to the employees regarding the issues of properly donning and removing PPE and proper personal hygiene procedures. The two bioassays in excess of 15ug/L, but less than 35 ug/L, resulted from two separate events; one associated with equipment mechanical failure and the other was due to improper personal hygiene. U1 investigates and documents mitigation when bioassay results are in excess of 5 ug/L, however a formal report is generated when bioassay results are in excess of 15 ug/L. The RS staff documentation and mitigation of the bioassays results (above 15 ug/L) were in order, which demonstrated U1's commitment to maintaining occupational exposure ALARA.

Spiked samples are prepared in accordance with RG 8.22, 1988 version, one at 10-20 ug/L and one 40-60 ug/L, and submitted monthly. The SOP (HP-4) was revised to reflect 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. Review of the current RG 8.22, 2014 version may provide a more efficient procedure for submitting spikes to the third party laboratory.

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 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.

##### **4.3.3 MONTHLY RSO REPORTS**

The RSO provides a monthly report 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 2014, employees and contractors 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 2014, annual radiation protection refresher and DOT Hazmat training was completed in the second quarter.

##### **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 2014, 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 and or designee will be notified if any samples exceed the action level, 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.

The dry pack change room, located in the vicinity of the yellowcake drying area, periodically has surface contamination that exceeds 1000 dpm/cm<sup>2</sup>. When the RS staff observes elevated measurements or visual contamination, they determine the cause, discuss with employees the events that led to the elevated measurement and provide direction for proper mitigation.

#### **4.7 REPORTS ON OVEREXPOSURES OF WORKERS**

There were no employee overexposures during the 2014 report period.

#### **4.8 OPERATING PROCEDURES**

The 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 improve the SOPs.

In 2014, the RSO 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**

In 2014, the preparation and reprocessing of the Honeymoon yellowcake product commenced. There were minimal incidents relating to the re-drying of the Honeymoon product while maintaining the ongoing Willow Creek Project's ISR uranium recovery process. This underscores U1's commitment to the ALARA principle.

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.

### **5.1 SUMMARY OF RECOMMENDATIONS**

Forms and documentation are in the process of being revised. All transportation documentation should be reviewed for consistency and confirm that the necessary information is included. Hazmat shipping papers are required to contain the certification statement per 49 CFR Part 172.204. This statement was omitted from the resin transfer shipping paper documentation.

Continue to improve and revise monitoring forms so that migration to an electronic/digital system could be accomplished.

Continue to improve and revise SOPs.