
**Draft Safety Evaluation Report
License Amendment for Expansion of the Lost Creek Project into the
Lost Creek East and KM Horizon, Sweetwater County, Wyoming**

Materials License No. SUA-1598

Docket No. 040-09068

Lost Creek ISR, LLC



August 5, 2018

Note

The State of Wyoming has applied to the NRC to become an Agreement State with respect to regulation of uranium recovery or milling facilities. Section 274 of the Atomic Energy Act of 1954 provides a basis for the Nuclear Regulatory Commission (NRC) to relinquish to the States portions of its regulatory authority to license and regulate specific categories of materials or classes of facilities. In February 2015, Wyoming submitted a letter of intent to the NRC to regulate source material involved in uranium or thorium recovery or milling facilities, including uranium in-situ recovery (ISR) facilities, and byproduct material as defined in Section 11e.(2) of the AEA. Wyoming submitted a draft Agreement application to NRC in October 2016, and NRC staff provided completeness review comments in April 2017. Wyoming submitted a final application and certification that it has a regulatory program that conforms to NRC regulations in November 2017. The draft Agreement was published in the Federal Register for public review and comment on June 26, 2018. If the Agreement process is completed, the NRC will transfer the licenses for uranium milling facilities, including the Lost Creek ISR Project, to the State of Wyoming. At that time, the State of Wyoming would assume regulatory authority over the Lost Creek ISR Project.

This safety evaluation report (SER) documents the NRC staff's review of the Lost Creek ISR Project's application for expansion as of the time that it was determined that the licensing process would not be completed before the completion of the Agreement process. Although the NRC staff's technical review is complete, in the ordinary application process, there may be further administrative revisions to the SER. For example, this SER includes proposed license conditions on which the staff would have further interactions with the applicant.

The SER was completed to document the NRC staff's work with the expectation that the State of Wyoming may refer to it in reviewing the Lost Creek expansion request.

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Appendix A: Site History

Appendix B: Summary of New or Revised License Conditions

LIST OF ACRONYMS AND ABBREVIATIONS

11e.(2) byproduct material	Tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material" within this definition.
°C	degree Celsius
°F	degree Fahrenheit
%g	percent gravity
a	acre
ACL	alternative concentration limit
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
ANSI	American National Standards Institute
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
BAT	best available technology
bgs	below ground surface
BLM	Bureau of Land Management
BPT	best practicable technology
Bq	becquerel
CAP	corrective action program
CEDE	committed effective dose equivalent
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
CO ₂	carbon dioxide
cpm	counts per minute
C _r	concentration of radionuclide, <i>r</i> , in air
DAC	derived air concentration
DC	dose coefficient
DCF	dose conversion factor
DC _r	dose conversion
DDE	deep dose equivalent
DOT	Department of Transportation
dpm	disintegrations per minute
DQO	data quality objectives
EA	environmental assessment
Eh	oxidation-reduction potential
EHS	Environment, Health, and Safety
EHSM	Environment, Health, and Safety Manager

List of Acronyms and Abbreviations (continued)

EIS	environmental impact statement
ELI	Energy Laboratories, Incorporated
EPA	U.S. Environmental Protection Agency
ER	environmental report
FONSI	finding of no significant impact
<i>Federal Register</i>	FR
ft	feet
ft/d	feet per day
ft ² /d	square feet per day
ft/s	feet per second
g	acceleration of gravity
^(g)	gaseous form
g/cm ³	grams per cubic centimeter
GEIS	Generic Environmental Impact Statement
gpd/ft	gallons per day per foot
gpm	gallons per minute
GPS	Global Positioning System
h	hour
H	number of hours of exposure
ha	hectare
HPIC	high-pressure ionization chamber
HPT	health physics technician
HV	high velocity
HVAC	heating, ventilation, and air conditioning systems
<i>i</i>	exposure period, <i>i</i>
IBC	International Building Code
ICRP	International Commission on Radiological Protection
in	inch
I_r	annual intake of radionuclide <i>r</i> by inhalation
ISR	in situ recovery
IX	ion exchange
JFD	joint frequency distribution
kg	kilogram
km	kilometer
km ²	square kilometers
L	liter
LC	Lost Creek
LCE	Lost Creek East
lb	pound
lb/ft ³	pound per cubic foot
LCI	Lost Creek ISR, LLC
LLD	lower limit of detection
Lpm	liters per minute
LS	Lost Soldier

List of Acronyms and Abbreviations (continued)

m	meter
m ²	square meter
m ² /d	square meter per day
m ³	cubic meter
m ³ /h	cubic meter per hour
m ³ /s	cubic meter per second
m ² /s	square meter per second
m/s	meter per second
ma	million years ago
man-Sv	man-sievert
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum contaminant level
MDC	minimum detectable contamination
mg	milligram
mg/L	milligram per liter
mi	mile
mi ²	square miles
MIT	mechanical integrity test
mm	millimeter
MOU	memorandum of understanding
mR/hr	milliroentgens per hour
mrem	millirem
mrem/yr	millirem per year
mSv	millisievert
t	metric ton
n	number of exposure periods n, in the year
NA	not applicable
NaHCO ₃	sodium bicarbonate
Na ₂ CO ₃	sodium carbonate
NaI	sodium iodide
NCDC	National Climatic Data Center
NELAC	National Environmental Laboratory Accreditation Conference
NEPA	National Environmental Protection Act
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation
NWS	National Weather Service
OSHA	U.S. Occupational Safety and Health Administration
Pb-210	lead-210
pCi/L	picocuries per liter
person-rem/yr	person-rem per year
Po-210	polonium-210
PM ₁₀	particulate matter less than ten micrometers
PPE	personal protective equipment
ppm	parts per million
psi	pounds per square inch
PV	pore volumes

List of Acronyms and Abbreviations (continued)

QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
R&D	research and development
Ra-226	radium-226
Ra-228	radium-228
RAI	request for additional information
rem	roentgen equivalent man
RG	regulatory guide
Rn-222	radon-222
RO	reverse osmosis
RWP	radiation work permit
SEIS	Supplemental Environmental Impact Statement
SER	safety evaluation report
SERP	Safety and Environmental Review Panel
SPT	standard penetration tests
SHPO	State Historic Preservation Office
SM	source material
SOP	standard operating procedure
SRP	standard review plan
Sv	sievert
Sv/Bq	sievert per becquerel
TAC	technical assignment control
TEDE	total effective dose equivalent
TER	technical evaluation report
Th-230	thorium-230
TLD	thermoluminescent dosimeter
TG	Technical Guide
TR	technical report
TWA	time-weighted average
UBC	Uniform Building Code
UCL	upper control limit
UIC	Underground Injection Control
µg	microgram
U-nat	natural uranium
U ₃ O ₈	uranium oxide
UO ₂	uranium dioxide
UO ₃	uranium trioxide
UO ₂ (CO ₃) ₂ ²⁻	uranyl dicarbonate
UO ₂ (CO ₃) ₃ ⁴⁻	uranyl tricarbonate
UPS	uninterruptible power supply
Ur-E	Ur-Energy USA, Inc.
URPA	Ur-Energy Passive Air
U.S.	United States
USGS	United States Geological Survey

List of Acronyms and Abbreviations (continued)

WDEQ	Wyoming Department of Environmental Quality
WQD	Water Quality Division
wt.	weight
WY	Wyoming

INTRODUCTION

By letter dated February 27, 2017, Lost Creek ISR, LLC (Lost Creek, LCI, applicant or licensee) submitted to the U.S. Nuclear Regulatory Commission (NRC) two applications to amend its Source and Byproduct Materials License SUA-1597 (LCI, 2017a). The amendments consist of (1) the horizontal expansion of operations in the subsurface HJ Horizon (the current horizon that is licensed) within the existing licensed area (hereinafter the KM Horizon amendment or KM Amendment), (2) horizontal and vertical expansions of its operations to the HJ and KM Horizons in the abutting area referred to as Lost Creek East (hereinafter the Lost Creek East amendment or LCE Amendment), (3) a request to authorize 100 percent of the annual production of yellowcake from toll milling (currently approved at 50 percent), and (4) a request to increase the licensed maximum annual production of yellowcake to 2.2 million pounds [1.0 million kilograms (kg)].

The applications originally included requests (1) to modify the method for calculating the Upper Control Limits (UCL's) for the NRC excursion monitoring program and (2) for the vertical expansion of operations to the KM Horizon in the Lost Creek licensed area. At the request of the applicant, those items are not included as part of the proposed action. In the case of the UCL calculations, NRC is a cooperating agency with the Bureau of Land Management (BLM) for the environmental review required for the proposed action by the National Environmental Policy Act (NEPA). However, the UCL calculations is not part of BLM's review and would have complicated the preparation of any NEPA document. In the case of vertical expansion, the applicant has elected to withdraw Mine Unit 3 and Mine Unit 12 from consideration in the KM Amendment application because of the NRC staff's issues with confinement. Although the vertical expansion is withdrawn, staff elected to document its analyses of the confining issues as well as included the impact of those withdrawn mine units in several areas (e.g., the schedule, collective drawdown). Staff will document the results of those reviews and treat them as a "bounding analysis" though because of the withdrawal will not approve operations at those mine units.

For this Safety Evaluation Report (SER), the amendments include several sections with text that is identical in each amendment. Both amendment applications (i.e., KM Amendment and the LCE Amendment) may be collectively referred to as "the Amendment" for those specific sections. In addition, the applicant submitted an Environmental Report in accordance with requirements of 10 CFR 40.31(f). While the general narrative of the Environmental Report is not incorporated wholesale in this SER, the applicant refers to its Environmental Report in several sections of the Amendment application. The NRC staff's review of those sections includes specific references to the Environmental Report that were reviewed in those cases.

The NRC is authorized to issue licenses for the possession and use of source and byproduct materials by the Atomic Energy Act of 1954 (AEA), as amended by the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). The implementing regulations for NRC's authority under AEA/UMTRCA to issue a license are found in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40 "Domestic Licensing of Source Material" using standards in 10 CFR Part 20 "Standards for Protection Against Radiation."

Pursuant to 10 CFR 40.45, the [Nuclear Regulatory] Commission will apply the applicable criteria set forth in 10 CFR 40.32 in considering an application by a licensee to renew or amend his license. In accordance with 10 CFR 40.32, "General Requirements for Issuance of Specific Licenses," the NRC is required to make the following safety findings when amending a license:

- The application is for a purpose authorized by the Atomic Energy Act.
- The licensee is qualified by reason of training and experience to use the source material for the purpose requested in such a manner as to protect health and minimize danger to life or property.
- The licensee's proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property.
- The issuance of the license amendment will not be inimical to the common defense and security or to the health and safety of the public.

The generic process for reviewing an amendment (or license) application by NRC staff is to: (1) review the application for administrative completeness; (2) formally docket the application (for the adjudicatory process); (3) perform a detailed technical and environmental review; (4) issue a request for additional information (RAI); (5) complete a SER, documenting the technical review, and either an Environmental Assessment (EA) or Environmental Impact Statement (EIS) documenting the environmental review; and (6) amend (or issue) the license that contains standard and facility-specific conditions as requirements that staff has determine is appropriate and to which the applicant as agreed can be implement.

The NRC staff performs its technical or safety evaluation of a proposed license application (or an amendment to an existing license) using guidance in NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications" (NRC, 2003aa) (hereinafter referred to as the SRP). Reviews using the SRP guidance are comprehensive assessments of an applicant's license or amendment application. This SER is presented in accordance with the general organization of the SRP though several sections and acceptance criteria in the SRP that specifically address environmental aspects of an application are not evaluated in this SER. Those sections and criteria are addressed in a separate document prepared to meet requirements of the National Environmental Policy Act (NEPA) and evaluated using the guidance in NUREG-1748 (NRC, 2003b).¹

For several review areas listed in the SRP, the applicant has stated that the details remain unchanged from those previously approved in the application for issuance of the license

¹ Various "Evaluation Findings" sections in the SRP for subject areas reviewed for this SER contain recommended statements that the reviews determined compliance with sections in 10 CFR Part 51 "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," which are the NRC's implementing regulations for NEPA. For this SER, the NRC Staff's review does not include findings with respect to requirements under 10 CFR Part 51. Furthermore, sections 3.14, 3.24, 5.1.4, 5.3.4, 5.7.8.4, 6.1.4, 6.4.4, and 7.1.4 of the SRP contain recommended statements that the reviews determined compliance with 10 CFR 40.32(d) "[t]he issuance of the license will not be inimical to the common defense and security or to the health and safety of the public" In the 2011 SER for the initial license application (NRC, 2011a), the NRC staff did not use the recommended language for each SRP section; however, staff made a "global" or "omnibus" finding in the prior SER that the initial license application met the requirements of 10 CFR 40.32(d) because it met the requirements of 10 CFR Part 20 and Part 40 for all areas of review. The NRC staff will follow suit for this SER with respect to compliance with 10 CFR 40.32(d).

(hereinafter “the approved license application, as amended”). In light of the applicant’s operating history and the NRC staff’s previous reviews of its license applications, the NRC staff reviewed prior SERs for those portions of the application that the applicant has stated that the details remain unchanged. The NRC staff verified that: (1) those areas are unchanged by the amendment; (2) the project has operated safely and protective of human health and the environment consistent with the NRC staff’s previous findings; (3) no un-reviewed safety-related concerns have been identified in the current review; and (4), the project will continue to operate in the future consistent with the previous findings. Upon this verification, staff will determine whether to incorporate the appropriate portions of the review and whether to reach the same findings in the present amendment application.

The application includes several variants to the phrase “the approved license application, as amended”. The variants include the “approved Lost Creek Technical Report”, “approved Technical Report”, “original Lost Creek Technical Report”, “previous application”, and “Technical Report submitted March 2008, as amended.” The NRC staff considers those variants as meaning “the approved license application, as amendment” in its analysis documented in this SER. Furthermore, the NRC staff considers “the approved license application, as amended” to include revisions approved by NRC staff, as documented in an SER prepared for a prior amendment and memorialized as specific numbered amendment to the license, and changes approved by the licensee through its Safety and Environment Review Panels (SERPs). As such, the narrative in the March 2008 license application may not contain all commitments or evaluations of the sequent changes. The NRC staff has prepared a succinct history of the license (Appendix A).

A historical summary of documents submitted by the applicant for this application is as follows:

Lost Creek submitted previous versions of the amendment applications for which the NRC staff eventually found administratively incomplete and terminated the review. The initial version was submitted by letter dated September 30, 2015 (LCI, 2014a). This action involved undertakings by two Federal agencies, the NRC, for issuance of the amendment to a license, and the Bureau of Land Management (BLM), because the undertaking involved land own by the U.S. Government. The NRC and BLM elected to become cooperating agencies in development of a single report for the environmental review that is required for federal agencies to produce under NEPA. The BLM was designated as the lead agency in preparation of an Environmental Impact Statement (NRC, 2014a).²

By email dated November 3, 2014, the NRC staff informed Lost Creek of deficiencies in the submitted amendments (NRC, 2014b). The noted deficiencies included the lack of an Archeological Report, improper incorporation by reference to the State of Wyoming Permit to Mine, and the lack of an Environmental Report. However, rather than terminating the review entirely, the NRC staff asked Lost Creek to submit supplemental information in order to continue working as a cooperating agency with BLM (NRC, 2014b).

By letter dated February 2, 2015, Lost Creek submitted supplemental information (LCI, 2015a). The supplemental information consisted of a revised narrative from the original submittal and new Environmental Reports. The Archeological Report

² The BLM and NRC continued with the NEPA process though NRC ultimately terminated its review of the initial application.

was submitted under separate cover (because of sensitive information, the report remains confidential). By letter dated April 15, 2015, the NRC staff notified Lost Creek that the application with supplemental information was deficient (NRC, 2015a). The primary deficiency was inadequate characterization of the KM Horizon underlying confining unit and aquifer. Such a characterization is needed to establish that an application has adequate controls to prevent excursions. By email dated June 26, 2015, Lost Creek provided a proposed work plan intended to address deficiencies noted by staff in the application (LCI, 2015b). However, no additional documentation by the NRC staff or Lost Creek followed this email during the calendar year.

By letter dated February 26, 2016 (LCI, 2016a), Lost Creek submitted a response to the NRC's April 15, 2015 deficiency letter. Lost Creek's submittal included a point-by-point response to issues raised in the NRC staff's deficiency letter, change pages, and a technical report containing results of a new groundwater numeric flow model that focused on evaluations of impacts from operations in the KM Horizon. Lost Creek's response was supplemented with electronic files submitted by letter dated March 11, 2016 (LCI, 2016b).

By letter dated May 18, 2016 (NRC, 2016a), the NRC notified Lost Creek that the application, including the subsequent submittals, was still deficient in characterizing the proposed confining unit (K Shale) that separates the KM Horizon from the proposed underlying aquifer (L Horizon). The letter stated that that staff had terminated the acceptance review of the application. However, the letter also stated that should Lost Creek intend to pursue the amendments, it should respond within 30 days.

Lost Creek responded to the NRC's notification by providing, through an unpublished email, a proposed LCE Hydrologic Pumping Test Plan for the KM and L Horizons dated June 2016 (LCI, 2016c). The NRC staff verbally informed Lost Creek that it was not NRC's policy to review and approve a test plan such as was submitted; however, Lost Creek expressed a desire to have some feedback from the regulatory agencies on the testing plan.³ Consequently, the NRC staff held a public meeting to offer feedback on the plan (NRC, 2016b). Through an unpublished email, Lost Creek provided NRC with a revised testing plan to NRC (LCI, 2016d).

By letter dated February 27, 2017 (LCI, 2017a), Lost Creek submitted an application for the KM Horizon and LCE amendment in its entirety to the NRC. This submittal is considered the Amendment application.

By email dated April 3, 2017, the NRC requested some clarifications to the application in order to complete the acceptance review (NRC, 2017a). In the acknowledgement letter, the NRC staff also posed several clarification questions.

³ In addition to NRC and BLM, Lost Creek submitted the 2014 application to the Wyoming Department of Environmental Quality (WDEQ). WDEQ had comments and determined the application submitted to WDEQ incomplete for reasons similar to those of NRC (WDEQ, 2014). It is NRC's understanding that a revised application has been submitted to WDEQ but that review is incomplete (WDEQ, 2018).

By letter dated April 18, 2017, Lost Creek provided responses to staff's clarification questions (LCI, 2017b).

By letter dated May 2, 2017, the NRC staff documented that it found the application administratively adequate for a detailed technical and environmental review (NRC, 2017b).⁴ As a follow-up, the NRC provided a project schedule letter dated June 1, 2017 (NRC, 2017c). In both the acceptance and project schedule letters, the NRC staff stressed the fact that NRC and BLM were cooperating agencies in the preparation of a single environmental review document for this undertaking. Since the initial application submittal in 2014, BLM had been processing development of that document. However, the progress for its development was stymied because the application had been found administratively incomplete by NRC and the delay in resubmitting the application by Lost Creek during the interim. As a result, the NRC staff planned to expedite the review schedule by issuing any request for additional information (RAI) in three subsets, the first two of which were to be provided within a short timeframe.

The NRC staff issued the subsets of RAIs by letters dated July 27, August 28, and October 30, 2017, respectively (NRC, 2017d;e;f). By letter dated September 25, 2017 (LCI, 2017c), Lost Creek submitted responses to the first two subsets of the RAIs. The NRC staff requested a public meeting with Lost Creek to discuss the adequacy of the responses. A public meeting was held on November 16, 2017 (NRC, 2017g). By letter dated December 5, 2017 (LCI, 2017d), Lost Creek submitted responses to the third subset of the RAIs. By letter dated January 5, 2018 (LCI, 2018a), Lost Creek submitted responses to issues raised at the November 16, 2017 public meeting.

By email dated January 17, 2018 (LCI, 2018b), Lost Creek submitted corrected depths to the various stratigraphic units in response to a clarification request by the NRC staff.

By letter dated March 2, 2018 (LCI, 2018c), Lost Creek submitted a request to withdraw Mine Unit 3 and Mine Unit 12 from the KM Amendment.

The format for the Amendment application as submitted by the applicant did not follow the standard format outlined in Regulatory Guide 3.46 "Standard Format and Content of License Applications, including Environmental Reports, for *in Situ* Uranium Solution Mining" (NRC, 1982). The non-standard format was requested by the applicant prior to its submittal because the applicant desired to prepare a single document to meet the needs of the three regulatory agencies reviewing the application (i.e., NRC, Bureau of Land Management (BLM), and the Wyoming Department of Environmental Quality (WDEQ). Each agency is required to review aspects of the proposed action though under different statutory authorities. The NRC staff agreed to a single format provided that Lost Creek clearly identified the location of the material within the application. The non-standard format that Lost Creek utilized resulted in difficulties in

⁴ Acceptance of the application for detailed technical and environmental review also initiated NRC's adjudicatory process. A 60-day period for the public to respond was initiated on July 17, 2017 by a notice of receipt of the application, opportunity for hearing and petition for leave to intervene being published in the *Federal Register* (82 FR 32382) and NRC's webpage. No party requested a hearing or petition for leave to intervene.

identifying the locations in the application in which the applicant addressed certain aspects as well as documenting with specificity sections of the approved license application, as amended, are incorporated by reference. The non-standard format was rectified by the applicant's cross-walk and subsequent clarifications (LCI, 2017b; 2018d).

This SER documents the NRC staff's technical review and findings for determining that the Amendment application is in compliance with applicable requirements of 10 CFR Part 20 and Part 40, including the requirements set forth in 10 CFR Part 40, Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content". The NRC staff's evaluation identified facility-specific issues that require either new or revised license conditions to ensure that the operation of the facility will be adequately protective of public health and safety and the environment. The new or revised license conditions are discussed in the specific section of this SER where the need for the new or revised license conditions is described and are summarized in Appendix B.

The NRC staff concludes that the findings described in succeeding sections of this SER, including the necessary license conditions, support the issuance of an amended license authorizing the proposed licensed activities. Therefore, the NRC finds that issuance of the amendment meets requirements of 10 CFR 40.32(a) through (d) and in accordance with staff guidance.

1.0 PROPOSED ACTIVITIES

The NRC staff evaluated the applicant's summary of the proposed activities associated with the Amendment application. The purpose of this evaluation was to gain a basic understanding of the proposed activities and the likely consequences of any safety or environmental impact. The areas reviewed include: corporate entities involved; location of the proposed activities; land ownership; ore-body locations and estimated uranium (U_3O_8) content; proposed solution extraction method and recovery processes; operating plans, design throughput and anticipated annual U_3O_8 production; radiation safety protection; estimated schedules for construction, startup, and duration of operations; plans for project waste management and disposal; source and byproduct material transportation plans; plans for groundwater quality restoration, decommissioning, and land reclamation; and surety arrangements covering eventual facility decommissioning, groundwater quality restoration, and site reclamation.

1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that its summary of the proposed activities documented in the amendment application is compliant with applicable requirements in 10 CFR 40.31, "Application for Specific Licenses."

1.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with applicable requirements of 10 CFR 40.31 using acceptance criteria presented in SRP Section 1.3, "Acceptance Criteria," (NRC, 2003aa).

1.3 Staff Review and Analysis

As discussed in the "Introduction" Section of this SER, the Amendment did not follow the standard format for an application as recommended by RG 3.46. The information reviewed was from the descriptions of activities described in various sections of the Amendment. The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	Section 1.0
SER	Section 1.0
KM and LCE Application	Cover Letter, Form 313 Preamble (KM Amendment) Section 2.6, 2.7 (KM Amendment) Operations Plan (LCE Amendment) Sections D1, D5, D6.1, D6.2, (LCE Amendment)
RAI Responses	RAI-1, RAI-7
License SUA-1598	License Conditions 9.1, 9.2, 9.9, 12.1, 12.4

The NRC staff's understanding of the proposed activity based on the applicant's information is as follows:

The corporate entities associated with the Amendment are Lost Creek ISR, LLC, Casper, Wyoming, UR-Energy USA, Inc., Littleton, Colorado and UR-Energy, Inc, Ottawa, Ontario. Lost

Creek ISR, LLC is the licensee for the Source and Byproduct Materials License SUA-1598 and a subsidiary to the other corporations. This information is from the cover letter, the Form 313 that accompanied the application, references in the Amendment and the approved license application, as amended. The NRC staff's understanding is that the corporate entities involved in the Amendment application is Lost Creek ISR, LLC, that this corporation will be responsible for commitments and statements made in the Amendment application and that the corporate entities will remain unchanged by this amendment.

The location of the proposed activities is discussed in several sections of the Amendment as listed below. Section 3 of Form 313 reports the physical location at 3424 Wamsutter Crooks Gap Road, approximately 24 km (15 mi) southwest of the Town of Bairoil, Sweetwater County, Wyoming. The existing Lost Creek licensed area and the LCE amendment area are located within all or portions of Sections 13 and 23 through 26 of Township 25 North, Range 93 West and Sections 1, 2, 3, 10, 11, 12, 14 through 23, and 27 through 31 of Township 25 North, Range 92 West of the Sixth Principal Meridian.⁵ The location is graphically displayed on Plates OP-2a and OP-2b of the LCE Amendment. The LCE Amendment covers approximately 2327 hectares (ha) [5,751 acres (a)]. The existing licensed area is comprised of 1722 ha [4,254 a]. The LCE area directly abuts eastern boundary of the Lost Creek licensed area.

Land ownership is presented in several sections of the Amendment. For the KM Amendment application, the land ownership information in the approved license application, as amended, is incorporated by reference into this application. The LCE Amendment provides discussions and graphical presentations of the land (surface) ownership and mineral ownership within the application. The land ownership within the LCE Amendment is 100 percent Federal Government.

The ore-body locations and estimated uranium (U_3O_8) content for the proposed wellfields are depicted on the geologic cross sections, Plates OP-2a and OP-2b, and described by text in the geologic and hydrogeologic sections of the Amendment. The mineralization consists of roll-type front deposits that are stacked vertically within the subsurface. Lost Creek reports that nine individual roll fronts are identified within its designated mineralized areas. The "strike" of the main mineralized trend extends approximately 4.8 km [3 mi] in the southwest-northeast direction with a composite width along the trend between 152 and 610 meters (m) [500 and 2000 feet (ft)]. Thickness of an individual front is between 1.5 and 7.6 m [5 and 25 ft]. The applicant states that ore body geometries and uranium content of the proposed wellfields are consistent with those for the wellfields in the approved license application, as amended.

The depths to the top of the mineralized horizon are as follows:

Horizon	Existing License Area	LCE
HJ	145 to 85 m [475 to 280 ft]	114 to 0 m [375 to 0 ft]
KM	192 to 131 m [630 to 430 ft]	152 to 30 m [500 to 100 ft]

The uranium content for the various wellfields within the HJ and KM horizon is approximately 0.4 to 2.0 million pounds [0.18 to 0.91 million kg]. The average grade is 0.057 percent equivalent U_3O_8 .

⁵ The Principal Meridian was not reported on Form 313 but was reported in the approved license application.

The solution extraction method, recovery processes, operating plans and design throughput remain unchanged from those described in the approved license application, as amended. The Amendment proposes to increase the maximum annual U₃O₈ production rate to 2.2 million pounds [1.0 million kg] per year from the 2.0 million pounds [0.91 million kg] per year approved for the existing license. Of the 2.2 million pounds [1.0 million kg] annual production of yellowcake, a maximum of 1.2 million pounds [0.54 million kg] will be derived from the onsite wellfields. The current license application includes the ability of Lost Creek to produce 1.0 million pounds [0.46 million kg] of yellowcake annually from toll milling of resins from another facility. The Amendment also proposes to increase the portion of toll milling to 100 percent of the maximum annual yellowcake production (i.e., 2.2 million pounds [1.0 million kg]).

The applicant reports that the radiation safety protection program will be unchanged from existing licensed program.

The estimated schedules for construction, startup, and duration of operations are based on timing for NRC's approval of the Amendment. For the existing licensed area, the construction and operation of the wellfields can begin immediately after the approval. For the LCE area, construction of the access roads and pipelines may start immediately after approval (provided sampling of background quality data are completed). The operation of the first wellfield in the LCE area is scheduled to begin in Year 3 after approval. Using 2017 as the baseline year, that would mean operations of the first wellfield in the LCE area will begin in 2020.

Lost Creek's proposed revised schedule for each wellfield includes two years for wellfield development, one to two years of production, one to two years of restoration, one year of stability monitoring, and one to one-and-one-half years of regulatory approval and surface reclamation. The applicant states that production of individual wellfields will be staggered (or phased). As a result, completion of surface reclamation of the final wellfield is estimated at relative year 16 (year 2033 using 2017 as the baseline year).

The daily maximum production rate remains unchanged from the existing license maximum of 6000 gallons per minute (8.64×10^6 gallons over a single day) but the Amendment extends the life of the current central processing plant. The current life expectancy of the plant is to year 2026 (12.25 years after initial production at the first mine unit (October 2013)). The life of the plant may be extended beyond those estimates in the Amendment (i.e., 2033) based on the longer-than-expected production at Mine Unit 1 and possibly the addition other mine units in the future. The current license expires in 2021. For the purposes of this review, the NRC staff anticipates timely renewal of license SUA-1598 in 2021 for an additional 10- or 20-year period.

The applicant states that the plans for the project waste management and disposal remain unchanged from the current license. The current waste management plan for liquid byproduct material consists of treatment using reverse osmosis equipment, storage (and evaporation) in on-site ponds (surface impoundments), and on-site disposal through Class I deep disposal wells (brine) or Class V shallow wells (treated permeate). The Amendment includes the future possibility of three additional Class I deep disposal wells as well as longer operational life to the existing disposal systems beyond that depicted by the schedule in the approved license application, as amended.

The source and byproduct material transportation plans include the piping source and byproduct to and from the various wellfields in both the Lost Creek area and LCE area and increasing the number of vehicles associate with the increase toll milling request of the Amendment. The

Amendment does not include additional satellite facilities where the uranium would be captured by resins and the resins transported to the main processing plant for elution.

The applicant states that the plans for groundwater quality restoration, decommissioning, land reclamation, and surety arrangements covering eventual facility decommissioning, groundwater quality restoration, and site reclamation remain unchanged from the existing license. Due to the increase in number of wellfields, the plans for surety arrangements include increases in the amount required for the future annual surety.

The NRC staff finds that the applicant's summary of the proposed activities is adequate because the descriptions provide a basic understanding of the proposed activities and the likely consequences of any health, safety and environmental impact. Detailed reviews of individual elements of the proposed activities are found in the succeeding sections of this SER.

1.4 Evaluation Findings

The NRC staff reviewed the descriptions of the proposed activity provided in the Lost Creek KM Horizon and LCE amendments in accordance with review procedures in SRP Section 1.2, "Review Procedures," and acceptance criteria outlined in Section 1.3, "Acceptance Criteria." Information contained in the Amendment provide descriptions sufficient for the NRC staff's basic understanding of the proposed activities, including: (1) the corporate entities involved; (2) the location of the facility; (3) land ownership; (4) ore-body locations; (5) the proposed recovery process; (6) operating plans and design throughput; (7) schedules for construction, startup, and duration of operations; (8) waste management and disposal plans; (9) ground water quality restoration, decommissioning, and land reclamation plans; and (10) financial assurance.

The summary provides the NRC Staff with sufficient information to allow staff to perform detailed safety analyses which are documented in the succeeding chapters of this SER. Furthermore, the NRC staff's basic understanding of the proposed activity provided sufficient information to perform an evaluation of impacts to the affected environment, which will be documented in a separate report required by NEPA. In several areas, the NRC staff will include a new or revised license condition for the applicant's commitments in the Amendment or limitations upon which the NRC staff based its reasonable assurance determination.

In several review areas, the proposed activity is reportedly unchanged from the activity currently being performed by the licensee at the licensed facility in accordance with the approved license application, as amended, and license conditions in License SUA-1598. For those review areas, staff will confirm the following: that the bases for the conclusions of the prior evaluations remain valid (e.g., regulations have not been modified during the interim), incorporate those prior conclusions into this review, and extend them to the LCE expansion; that the history of operations at the Lost Creek ISR Project have demonstrated safe operations and are consistent with commitments made in the approved license application and upon which the NRC staff had based its approval for the prior licensing action; that no un-reviewed safety issue has been identified, and that the proposed activities continue in the future. Based on that review, the NRC staff will determine whether it has reasonable assurance of adequate protection of the public health and safety.

Based upon the above summary information, the NRC staff will revise License Condition 9.1 of Source Materials License SUA-1598 to include Plates OP-2a and OP-2b "Site Map Lost Creek East (East and West)" of the Amendment, which depict the license area boundaries as authorized places of use for licensed material.

License Condition 9.1

The authorized place of use shall be the licensee's Lost Creek Project and the Lost Creek East Project in Sweetwater County, Wyoming. The licensee shall conduct operations within the license area boundaries shown on Plates OP-2a and OP-2b (ML17275A669) with the exception that operations in the KM Horizon within the licensed area (Mine Unit 3 and Mine Unit 12) are not authorized.

In addition, the NRC staff will revise License Condition 9.2 of Source Material License SUA-1598 to include the Amendment and supplemental submittals.

License Condition 9.2

The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license application dated March 31, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML081060525), which is supplemented by the submittals dated December 12, 2008 (ML090080451), January 16, 2009 (ML090360163), February 27, 2009 (ML090840399), August 5, 2009 (ML092310728), April 22, 2010 (ML102100263, ML102420249), May 14, 2010 (ML101600528), June 17, 2010 (ML101720161), June 24, 2010 (ML101820155), November 11, 2010 (ML103210590), November 16, 2010 (ML103280186), December 3, 2010 (ML103490862), September 13, 2011 (ML112580267), November 8, 2011 (ML11319A196), January 6, 2012 (ML120470353), February 10, 2012 (No. ML12048A678), February 17, 2012 (ML12053A326), March 5, 2012 (120670278), July 27, 2012 (ML12219A076), July 31, 2012 (ML12244A404), November 8, 2012 (ML13029A734), November 29, 2012 (ML12335A016), March 27, 2013 (ML13100A138), January 16, 2015 (ML15029A423), March 3, 2015 (ML15076A380), July 28, 2015 (ML15218A055), August 17, 2015 (ML15239A726), January 26, 2016 (ML16043A365), February 8, 2016 (ML16042A069), February 27, 2018 (ML17069A296), April 18, 2017 (ML17115A215), September 25, 2017 (ML17275A669), December 5, 2017 (ML17353A211), January 5, 2018 (ML18017A809) and April 24, 2018 (ML18115A230). The approved application and supplements are, hereby, incorporated by reference, except where superseded by specific conditions in this license. The licensee must maintain the approved license application on site.

Whenever the word "will" or "shall" is used in the above referenced documents, it shall denote a requirement. The use of "verification" in this license with respect to a document submitted for U.S. Nuclear Regulatory Commission (NRC) staff review means a written acknowledgement by NRC staff that the specified submitted material is consistent with commitments in the approved license application, or requirements in a license condition or regulation. A verification will not require a license amendment.

Based on the review described above, the NRC staff concludes that the information in the Amendment meets the applicable acceptance criteria of SRP Section 1.3 and the requirements of 10 CFR 40.31, "Application for specific licenses," which describes the general requirements for the issuance of a specific license.

2.0 SITE CHARACTERIZATION

The NRC staff evaluated the applicant's site characterization as described in the Amendment. The evaluations include Site Location and Layout (SER Section 2.1), Uses of Adjacent Lands and Waters (SER Section 2.2), Meteorology (SER Section 2.3), Geology, Seismology and Soils (SER Section 2.4), Hydrology (SER Section 2.5), Non-Radiological Background Characteristics (SER Section 2.6) and Radiological Background Characteristics (SER Section 2.7).

2.1 Site Layout and Location

This section describes the NRC staff's evaluation of the applicant's description of the site layout and location.

2.1.1 Regulatory Requirements

The NRC staff must determine if the applicant has sufficiently identified the site location in accordance with the requirements of 10 CFR 40.32(c).

2.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the NRC staff reviewed the Amendment for compliance with the applicable requirements of 10 CFR Part 40 using acceptance criteria presented in SRP Section 2.1.3, "Acceptance Criteria" (NRC, 2003aa).

2.1.3 Staff Review and Analysis

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	Section 2.1
SER	Section 2.1
KM and LCE Application	Cover Letter, Form 313 Preamble (KM Amendment) Operations Plan (LCE Amendment)
RAI Responses	RAI-1

The location for the proposed activities is discussed in various sections of the amendment. Section 3 of Form 313 reports the physical address of 3424 Wamsutter Crooks Gap Road, which is approximately 24 km (15 mi) southwest of the Town of Bairoil, in Sweetwater County, Wyoming. With respect to the Public Land Survey System, both the existing licensed area and the Lost Creek East Amendment area are located within all, or portions of, Sections 13 and 23 through 26 of Township 25 North, Range 93 West and Sections 1, 2, 3, 10, 11, 12, 14 through 23, and 27 through 31 of Township 25 North, Range 92 West of the Sixth Principal Meridian.⁶ The location of both areas is graphically displayed on Plates OP-2a and OP-2b. The LCE Amendment covers approximately 2327 ha [5,751 a] (see Section OP-1 of the LCE

⁶ The Principal Meridian was not reported on Form 313 but was reported in the approved license application, as amended.

Amendment). The existing licensed area is comprised of 1722 ha [4,254 a]. Based on a comparison of the topographic contours for several maps, the topography of the LCE area is consistent with that in the existing licensed area though the topography may be slight higher in elevation (15 to 30 m [50 to 100 ft] above the maximum elevation in the approved licensed area).

The site layout for expansion into the LCE area includes new underground piping, several small buildings (e.g., header houses) and wellfield construction elements. The elements are consistent with those elements for the existing licensed area as described in the approved license application, as amended. The area proposed wellfield is between 8.1 and 40.4 ha [20 and 100 a]. The LCE area is contiguous to the existing licensed area and, if approved, both areas could collectively be considered a single licensed area.

The changes in site layout from the existing licensed area consist of longer segments of underground piping, slightly deeper production wells and potentially three additional deep disposal wells and ancillary surface infrastructure. With respect to the underground piping, the maximum approved length for the main underground piping at the existing licensed area is approximately 5.6 km [3.5 mi] whereas the maximum length of underground piping for the LCE area is approximately 8 km [5 mi]. The construction of the piping will be consistent with that used for the Lost Creek licensed area. With respect to depth of the production wells, the current maximum depth for a well is approximately 222.5 m [730 ft] for a monitoring well screened in the KM Horizon in the western portions of the existing licensed area. Staff estimates the maximum depth for the KM Amendment is approximately 244 m [800 ft] for a monitoring well screened in the L Horizon. The proposed changes (length of piping and depth of wells) are consistent with the layout at other NRC-licensed uranium recovery facilities (e.g., PRI Smith Ranch). Aspects of the potentially three additional deep disposal wells are discussed in SER Section 4.0.

The Amendment includes mapping that depicts geologic features, proposed fenced areas for the wellfields (controlled areas), land ownership and political subdivisions including population centers and transportation links.

The NRC staff finds the mapping to be legible, at appropriate scaling and with appropriate references to sources, if not generated solely by data collected by the applicant. In addition, the NRC staff finds that elements of the Amendment site layout are consistent with those in the approved license application, as amended.

2.1.4 Evaluation Findings

The staff has reviewed the site location and layout of the proposed KM Horizon and LCE amendments in accordance with the review procedures in SRP Section 2.1.2, "Review Procedures," and the acceptance criteria in SRP Section 2.1.3, "Acceptance Criteria." Many aspects of those processes and equipment remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion. For those aspects that have changed, the NRC staff finds that the applicant has described the site location and layout with appropriately scaled and labeled mapping that depicts the site layout, principal facilities and structures, boundaries, and topography. Based on the review described above, the NRC staff concludes that the

information in the KM Horizon and LCE amendments meet the applicable acceptance criteria of SRP Section 2.1.3, "Acceptance Criteria" and thus requirements of 10 CFR 40.32(c).

2.2 Uses of Adjacent Lands and Waters

This section describes the NRC staff's evaluation of the applicant's description of the uses of adjacent lands and waters in order to assess likely consequences of any impacts on the adjacent properties. The uses include location of residences, ground-water supply wells, surface-water reservoirs and estimated use of water in lands surrounding the facility.

2.2.1 Regulatory Requirements

The staff determines if the applicant has provided sufficient information to meet requirements of 10 CFR Part 40, Appendix A, Criteria 5B(3), 5B(4) and 5G(3).

2.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the staff reviewed the Amendment for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria in SRP Section 2.2.3, "Acceptance Criteria" (NRC, 2003aa).

2.2.3 Staff Review and Analysis

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application SER	Section 2.2 Sections 1.0, 2.5
KM and LCE Application	Preamble (KM Amendment) D1 (LCE Amendment)
RAI Responses	RAI-10
License SUA-1598	License Condition 12.8

The applicant provides descriptions of adjacent uses of land and water to encompass the LCE area beyond that described in the approved license application, as amended.⁷ The adjacent land uses as described in Section D-1 of the LCE Amendment application are limited primarily because of the remoteness of the setting (nearest population center with a population of 106 persons is 20 km [13 mi] from the proposed area), the weather which is dry and windy with short hot summers and cold long winters, and land ownership is either by the federal (97%) or State (3%) governments (LCI, 2017a). The regional land uses include grazing, industrial (mill), wildlife habitat, hunting and dispersed recreation, mining, oil and gas extraction, and energy infrastructure (LCI, 2017a).

The applicant provides a summary of existing and projected water uses of surface water and groundwater at the facility and adjacent lands including a summary of well information from

⁷ Unless otherwise stated, adjacent land means within 3.2 km [2 mi] of the boundary of the proposed areas in accordance with guidance in NUREG-1569.

available sources and/or investigations by the applicant, a summary table of abandoned wells and drill holes, and maps depicting nearest residences, roads, and locations of surface water drainages, reservoirs and groundwater supply wells.

The applicant reports the locations of nearby uranium exploration activities. The descriptions are similar to those presented in the approved license application, as amended. The applicant also reports the existence of the Lost Soldier-Wertz [Oil] Fields near Bairoil (LCI, 2017a). This industrial use was not described in the approved license application, as amended; however, the LCE area is closer to Bairoil and the oil field is now within the range of land uses to be evaluated.

For the licensed Lost Creek area, the NRC staff verified that the uses of adjacent lands and waters remain unchanged from those reviewed for the approved license application, as amended, that no un-reviewed safety issues were identified, and that the uses of the adjacent lands and waters will likely continue in the future. Therefore, the NRC staff did not re-exam the previous staff findings.

For the LCE area, the NRC staff verified the information provided by the Application through a review of data from external sources, on-site visits, consistency of the data with the applicant's conceptual model and consistency with the land uses described in the approved application, as amended. The NRC staff finds that the applicant's information on the uses of the adjacent lands and water was accurate and in sufficient detail such that the likely consequences of the proposed activities can be assessed. Details of the NRC staff review of the surface water and groundwater uses are discussed in depth in SER Section 2.5.3.

2.2.4 Evaluation Findings

The NRC staff has completed its review of the site characterization information concerned with uses of adjacent lands and waters near the LCE area. This review included evaluations using review procedures in SRP Section 2.2.2, "Review Procedures," and acceptance criteria outlined in SRP Section 2.2.3, "Acceptance Criteria."

The applicant has acceptably described the present and projected land use, including residential, commercial, agricultural, industrial, grazing, recreation (e.g., hunting, swimming, skiing), and infrastructure. Appropriate information on the location and extent of each use has been provided. In particular, the description and associated tabulated data of the location, nature, amounts, and population associated with each use point of present and projected (life of the facility) surface and ground water adjacent to the site including water supplies, irrigation, reservoirs, recreation, and transportation within at least 3.3 km [2 mi] of the propose site boundary are acceptable for determination of likely impacts of the proposed in situ leach facility. Tabulated data on present and projected water withdrawal rates, return rates, types of water use (e.g., municipal, domestic, agriculture, and livestock); source, water-use estimates, and abandoned well locations are acceptable. The applicant has identified and located other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site.

Based on the information provided in the application and staff's review of its accuracy, the NRC staff concludes that the information on uses of the adjacent lands and waters at or surrounding the Lost Creek licensed area and LCE area is acceptable and is in compliance with requirements of 10 CFR Part 40, Appendix A, Criterion 5B(3), which requires an evaluation of adjacent land uses in identifying the hazardous constituents from the proposed operations, Criterion 5B(4), which requires identifying underground sources of drinking water and exempted

aquifers in an evaluation of adjacent land uses or should an Alternate Concentration Limit be established. Because the applicant is not proposing a mill tailing disposal facility, Criterion 5G is not applicable for this application.

2.3 Meteorology

In this SER Section, the NRC staff's evaluation is focused on the applicant's description of the regional and site meteorology as described in the LCE Amendment. The applicant provided information on the regional and site meteorology in Section D4, "Meteorology," of the LCE Amendment and the "Preamble" in the KM Amendment (LCI, 2017a).

Meteorological data are used for the selection of environmental monitoring locations, assessing the impact of operations on the environment, and radiological dose assessments.

2.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the meteorology program, which is part of the site pre-operational and operation monitoring programs, as required by 10 CFR Part 40, Appendix A, Criterion 7, is sufficiently complete to allow for estimating radiological doses to workers and members of the public.

2.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment was reviewed for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria in SRP Section 2.5.3, "Acceptance Criteria" (NRC, 2003aa).

2.3.3 Staff Review and Analysis

The applicable sections reviewed by staff in the current and previous applications, previous SER's and related documents are as follows:

Approved License Application	2.5
SER	2.2
SER Amendment 1	Section 7
SER Amendment 6	all
KM and LCE Application	Appendix D4 (LCE Amendment) Figures D4-1 to D4-6 (LCE Amendment) Tables D4-1 to D4-11 (LCE Amendment)
LCE Environmental Report	Section 3.7
RAI Responses	RAI-12, RAI-13
License SUA-1598	License Conditions 9.2, 10.19 and 12.8

The applicant provides a summary of the meteorological data collected at the time of the LCE Amendment submission and its applicability to the LCE area in Appendix D4 of the LCE Amendment and Section 3.7 of the LCE Environmental Report (LCI, 2017a). For the licensed

area, the applicant states in the preamble for the KM Amendment that Section 2.5 of the approved license application, as amended, is incorporated by reference.

2.3.3.1 Approved Meteorological Data – Historical Summary

A summary of the NRC staff's technical reviews of meteorological data acquired from the Lost Creek meteorological station follows. Initially, in the SER for issuance of License SUA-1598 (NRC, 2011a), the NRC staff found that the meteorological data met the acceptance criteria in SRP Section 2.5.3, except for an element in criteria (1) and (3). The acceptance criteria element that was not met pertained to the meteorological data not being substantiated as representative of expected long-term meteorological conditions at or near the Lost Creek licensed area. The NRC staff had imposed a preoperational license condition (License Condition 12.8) that required the licensee to continue collection of data from the on-site meteorological station. With the imposition of this preoperational license condition, the NRC staff found that all the acceptance criteria were satisfied.

Following issuance of the license, the NRC staff reiterated in the SER for Amendment 1 that the licensee did not provide an adequate assessment of the long-term representativeness of the meteorological data (NRC, 2013a). In that SER, the NRC staff elected to move the license condition, as written, from License Condition 12.8, as "Preoperational License Condition," to License Condition 10.19, as a "Facility Specific Condition" under "Operations, Controls, Limits and Restrictions" of the license.

In the SER for Amendment 6 (NRC, 2018b), the NRC staff found that the licensee did provide an adequate assessment of the long-term representativeness of meteorological data acquired from the Lost Creek meteorological station. The evaluation was based largely on the consistency of data over a five-year period. In the SER for Amendment 6, the NRC staff removed License Condition 10.19 from the license, and amended License Condition 9.2 to include the commitments, representations and statements made in submittals supporting Amendment 6 (LCI, 2017e, 2018e). The NRC staff's SER for the approval of Amendment 6 established the approved meteorological data set for the Lost Creek property (NRC, 2018b). Additional information on Amendment 6 is contained in Appendix A of this SER.

Contemporaneous with its review and approval to remove License Condition 10.19, the NRC staff reviewed the KM and LCE amendments. As discussed below, the approved meteorological data set differs slightly from the summary of meteorological data in the LCE Amendment. For the KM and LCE amendments, the NRC staff's review included a comparison of the meteorological data summaries to the approved meteorological data set established by Amendment 6.

2.3.3.2 KM Amendment

The "Preamble" section of the KM Amendment (LCI, 2017a) states that Section 2.5, "Meteorology," of the approved license application, as amended, is incorporated by reference without change.

The NRC staff agrees that the proposed mine units in the KM Amendment are located within the existing Lost Creek licensed area boundary, and that changes to surface conditions from operations at this facility would not affect the meteorological data acquisition or meteorological conditions. However, the text as written in Section 2.5 has been superseded by Amendment 6

to License SUA-1598, which approves a 5-year data set and assessment of long-term representativeness of meteorological data obtained from the Lost Creek meteorological station. The NRC staff considers the meteorological data set and analyses approved by Amendment 6 applicable to the KM Amendment, and therefore meets Acceptance Criterion 2.5.3(3) of the SRP (NRC, 2003aa).

2.3.3.3 LCE Amendment

The NRC staff reviewed and analyzed various aspects of the meteorological conditions and monitoring described in Section D4, "Meteorology," of the Amendment (LCI, 2017a). The description of the meteorological conditions at LCE includes:

1. A summary and analysis of mean monthly temperatures, dew points, and humidity, based on eight years of data collected at the Lost Creek meteorological station;
2. A summary and analysis of hourly wind speed and direction data; and,
3. Analysis of the effects of local terrain to include the LCE.

The applicant used the Lost Creek meteorological station as a reference station for the LCE area. As discussed below, the NRC staff compared the text and data presented in Section D4 with multiple meteorological data sets, including the 5-year meteorological data set approved in Amendment 6, which was acquired from the Lost Creek meteorological station and found to be representative of expected long-term meteorological conditions at and near the Lost Creek area.

2.3.3.4 Wind Speed, Wind Direction and Atmospheric Stability

Some of the regional and on-site meteorological data described in Section D4 of the LCE Amendment, such as information on ranges of temperature, relative humidity, dew point, and precipitation, are not used for safety-related facility design or operation. Therefore, the NRC staff did not evaluate these data sets. The NRC staff focused its analysis of meteorological data representativeness on the parameters of wind direction, wind speed, and atmospheric stability class distribution. The reason for using these parameters is that they were used in the siting of LCI's environmental monitoring stations, in accordance with Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980). Also, these meteorological parameters were used in LCI's initial assessment of potential radiological impacts of its operations. Although the NRC staff has since approved (NRC, 2016d) LCI's methodology for evaluating the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302, further analyses using the MILDOS-AREA computer code should use meteorological data that are representative of long-term conditions at and near the site. In its use of the MILDOS-AREA code, the applicant developed a joint frequency distribution from meteorological data acquired from the Lost Creek meteorological station (i.e., a statistical summary of wind speed, wind direction and atmospheric stability class). The NRC staff's evaluation of the public dose assessment for the KM and LCE amendments is addressed in SER Section 5.7.7.

The NRC staff reviewed the wind roses for years 2008 through 2015 summarized in Figure D4-3, "Wind Speed and Wind Direction at Lost Creek." The wind roses depict wind speed and direction. The wind roses in Figure D4-3 include the same 5-year period of wind roses that have been approved in the meteorological data set established by Amendment 6. Although the binning of wind speed data into wind speed classes differed between the reports, precluding a

direct comparison of wind speeds between the data sets, the NRC staff found the wind directions and wind speeds to be similar. Also, the wind roses in Figure D4-3 are consistent with data initially evaluated by the NRC staff for the licensing review of the Lost Creek licensed area (NRC, 2011).

Meteorological data acquired from the Lost Creek meteorological station is also summarized as a joint frequency distribution (wind speed, wind direction, and stability class) in Appendix B, "Lost Creek Joint Frequency Distribution (2012-2014)," of Lost Creek letter dated March 4, 2016 (LCI, 2016e). The joint frequency distribution was compiled from meteorological data acquired from the Lost Creek meteorological station during years 2012 to 2014. The period represents three of the five years of the meteorological data set that was approved by Amendment 6. According to Acceptance Criteria 2.5.3(1) of the SRP, a minimum of one full year of joint frequency data presented with a joint data recovery of 90 percent or more is sufficient to satisfy the characterization of site meteorology. Therefore, the three years of meteorological data in the joint frequency distribution contained in Appendix B of Lost Creek letter dated March 4, 2016 satisfies this criterion. The wind roses in Figure D4-3 were also compared with wind speed and wind direction data the applicant submitted in its MILDOS-AREA calculations for the LCE Amendment (LCI, 2018a), in response to RAI-12 dated July 27, 2017 (NRC, 2017d). The NRC staff found the wind roses were found to be similar. In summary, these comparisons showed the wind roses in Figure D4-3 to be similar to the approved meteorological data set by Amendment 6.

The NRC staff compared the atmospheric stability class data listed in Table D4-5, for the years 2007 through 2015, with the 5-year data set that was approved by Amendment 6 (NRC, 2018b), and the 3-year joint frequency distribution contained in Appendix B of Lost Creek letter dated March 4, 2016 (LCI, 2016e). Also, the NRC staff compared atmospheric stability class data in Table D4-5 with the MILDOS-AREA calculations for the LCE Amendment (LCI, 2018a). The NRC staff found that, regardless of the chosen computational period, the atmospheric stability class information is similar for characterizing the predominant atmospheric stability class, Class D, which is designated as neutral to slightly unstable atmospheric conditions. For the four other atmospheric stability classes, summary information in Table D4-5 is in general agreement with the other data sets. The NRC staff considers the atmospheric stability class data for the approved meteorological data established by Amendment 6 (NRC, 2018b), the 3-year joint frequency distribution contained in Appendix B of Lost Creek letter dated March 4, 2016 (LCI, 2016e), and the MILDOS-AREA calculations for the LCE Amendment (LCI, 2018a) acceptable.

Based on these comparisons, the approved meteorological data set established by Amendment 6 differs only slightly from the summary of meteorological data in Appendix D4 of the LCE Amendment. Consequently, the NRC staff finds that the applicant used for the LCE Amendment meteorological data that is consistent with approved meteorological data for the Lost Creek licensed area.

2.3.3.5 Use of the Lost Creek Meteorological Station for LCE

In evaluating the use of the Lost Creek meteorological station for LCE, the NRC staff reviewed the following information: (1) wind direction and wind speed; (2) the distance to nearby natural or man-made obstructions (e.g., trees, buildings) that may have influence on measurements; and (3) effect of local terrain.

Acceptance criterion 2.5.3(1) of the SRP (NRC, 2003a), states that "The on-site program should be designed in accordance with Regulatory Guide 3.63, "Onsite Meteorological Measurement

Program for Uranium Recovery Facilities – Data Acquisition and Reporting” (NRC, 1988). Acceptance criterion 2.5.3(2) of the SRP (NRC, 2003a), states, in part, that “The impact of terrain and nearby bodies of water on local meteorology are assessed, and the occurrence of locally severe weather is described and its impact considered.” Section C.2 of Regulatory Guide 3.63 states, “The location of the meteorological instruments should represent as closely as possible the long-term meteorological characteristics of the area for which the measurements are being made. Whenever possible, the base of the instrument tower or mast should be sited at approximately the same elevation as the facility operation. Ideally, the instruments should be located in an area where localized singular natural or man-made obstructions (e.g., trees, buildings) will have little or no influence on meteorological measurements.” Also, Section C.2 of Regulatory Guide 3.63 states, “At most facilities the instruments could all be sited in one location. At some sites, instruments may need to be sited at more than one location if the meteorological conditions are not similar throughout the site vicinity.”

In response to RAI-12 dated July 27, 2017 (NRC, 2017d), the applicant provided information on the location of the Lost Creek meteorological station for use in collecting representative meteorological data for the LCE area (LCI, 2017c). The applicant states that the predominant wind directions are from the west, west-southwest and west, with an average annual wind speed, at a height of ten meters at the Lost Creek meteorological station, of approximately 5 meters per second (m/s) [16 feet per second (f/s)]. Also, the applicant states that the topography is similar between the Lost Creek licensed area and LCE areas, with no obstructions from vegetation, structures, or hills to cause an alteration in meteorological conditions. The NRC staff verified this information accurate, based on reviews of the data sets and onsite visits.

The proposed location of the LCE area is located in the Great Divide Basin at an elevation of approximately 2133 m [7,000 ft] above mean sea level. The topography has a low relief throughout the area. The terrain is characterized by rolling plains with vegetation dominated by sagebrush with no forested areas or perennial surface waters. Figure D4-6 shows the location of the Lost Creek meteorological station in relation to the Lost Creek licensed area and LCE areas and local topography. LCE is downwind of and contiguous with the eastern and southeastern boundaries of the Lost Creek licensed area where the Lost Creek meteorological station is located. The Lost Creek meteorological station is approximately 8 km [5 mi] from the furthest boundary of the LCE area, which is in the northeastern direction from the Lost Creek meteorological station.

The topography of the LCE area is consistent with that in Lost Creek licensed area, though slightly higher in elevation than the Lost Creek licensed area. The wellfields located in the Lost Creek licensed area range in elevation from approximately 2072 m [6,800 ft] in the southwestern area to 2158 m [7,080 ft] in elevation at the northeastern area. In comparison, the potential wellfield elevations in the LCE area range from approximately 2091 m [6,860 ft] in the southwestern area to 2195 m [7,200 ft] in elevation at the northeastern area. Therefore, at approximately 2131 m [6,990 ft] in elevation, the Lost Creek meteorological station is near the average elevation of the potential wellfields in the LCE area. The Lost Creek meteorological station site is also located in an area of the Lost Creek licensed area that is unobstructed in all directions by local terrain influences. Based on the above, the staff finds that the Lost Creek meteorological station is sited at an elevation similar to the LCE area with minimal local topographical impacts.

Based on its review of information submitted by the applicant and NRC staff tours of the Lost Creek licensed area and LCE area, the NRC staff concludes that the meteorological conditions

would be similar throughout the Lost Creek licensed area and LCE area vicinity, and finds that the location of the Lost Creek meteorological station is acceptable for representing the long-term meteorological characteristics of the LCE area for the measurements being made, and therefore meets the applicable portions of Acceptance Criterion 2.5.3(1) and Acceptance Criterion 2.5.3(2) of the SRP (NRC, 2003a).

2.3.4 Evaluation Findings

The NRC staff has completed its review of the site characterization information concerning meteorological conditions at the Lost Creek licensed area and LCE in situ leach facility. This review included an evaluation using the review procedures in SRP Section 2.5.2, "Review Procedures," and acceptance criteria outlined in SRP Section 2.5.3, "Acceptance Criteria."

The meteorological monitoring program remains unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, the staff has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion. Further, the NRC staff finds that the Lost Creek meteorological station is located in an area that is acceptable for use for monitoring the LCE area.

Based on the information provided in the KM and LCE amendments and the review conducted of the meteorological monitoring program by the NRC staff, as described above, the NRC staff concludes that the information is acceptable to allow evaluation of the spread of airborne contamination at the site and development of conceptual and numerical models. The characterization meets the requirements for a pre-operational and operation effluent monitoring program required by 10 CFR Part 40, Appendix A, Criterion 7.

2.4 Geology, Seismology and Soils

This section describes the NRC staff's evaluation of the applicant's description of regional and site geology, seismology and soils at the Lost Creek licensed area and LCE area. This information provides a characterization of the setting for staff to assess the feasibility of conducting ISR operations at the proposed site as well as the likely ability of the geologic formations to isolate production fluids.

2.4.1 Regulatory Requirements

The NRC staff determines if the applicant has demonstrated that its characterization of geology, seismology and soils at the facility is sufficient such the ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c) and, for impoundments, requirements of 10 CFR Part 40 Appendix Criterion 4(e), which requires locations away from fault capable of impacting the integrity of an impoundment, or Criterion 5G(2), which requires adequate descriptions of the underlying soil and geology that may affect the migration of solutions from an impoundment.

2.4.2 Regulatory Acceptance Criteria

Unless stated otherwise, the Amendment was reviewed for consistency with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in SRP Section 2.6.3, "Acceptance Criteria" (NRC, 2003a).

2.4.3 Staff Review and Analysis

The following sections present the NRC staff's review and analysis Lost Creek's characterization of the geology, seismology and soils as discussed in the Lost Creek KM Horizon and LCE amendments. Aspects reviewed include regional geology, site geology, soils, mineralogy, exploration boreholes, and seismology.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	Section 2.6
SER	Section 2.3
KM and LCE Application	Section 2.6 (KM Amendment) Section D5 (LCE Amendment)
RAI Responses	RAI-2, RAI-5, RAI6, RAI-24, RAI-25

As discussed below, the characterizations were compared to those in the approved license application, as amended, to ensure the updates are consistent with the prior characterizations as supplemented with the additional data presented in the amendments.

2.4.3.1 Regional Geology

The applicant characterizes the regional geological setting in Section 2.6.1 of the KM Amendment and Section D5.1 of the LCE Amendment (LCI, 2017a). The descriptions in both sections are, for all intents and purposes, identical. Furthermore, those descriptions are similar to the descriptions of the regional geology in the approved license application, as amended, except in one aspect:

- In the original application, the 'shallow' regional faulting in the center of the basin is characterized as on a "minor scale" whereas in the current amendment the shallow normal faulting is characterized as "common" in the Great Divide Basin.

The NRC staff evaluated this difference in characterization of the regional geology and determine that the change is not significant but refines the characterization based on data collected since the submittal of the license application. Lost Creek had identified faulting at the property, specifically the Lost Creek Fault, and related it to one regional fault system, the Chicken Springs Fault System. Furthermore, in Section 2.6.2 of the approved license application, as amended (LCI, 2008a), Lost Creek identified the regional faulting in the area as two systems, the Chicken Springs Fault System and the South Granite Mountain Fault System. Surface expression of those fault systems have been mapped at least 8 km [5 mi] from the project. Those fault systems do not have surface expression to the licensed area but as characterized by Lost Creek, may be "buried" faults. The identification of additional faults in the subsurface with additional data was expected.

For reasons discussed above, the NRC staff finds that the applicant has provided an adequate characterization of the regional geology, consistent with the published data and the conceptual model for the site geology.

2.4.3.2 Site Geology

The applicant characterizes the site geology in Section 2.6.2 of the KM Amendment and Section D5.2 of the LCE Amendment (LCI, 2016a). In addition to the narrative descriptions, the applicant provides geologic cross-sections, isopach mapping of the geologic units of interest, a structural contour map, stratigraphic columns identifying UR-Energy-derived stratigraphic nomenclature, geophysical type logs and well completion reports.

The applicant's descriptions of the site geology are similar for both the KM Horizon and LCE amendments except as follows:

- Depths to the various stratigraphic units are shallower in the LCE area compared existing licensed area. The depths are consistent with the regional dip (three degrees to the northwest) as reported by the applicant.
- In the LCE area, the mineralization is referred to by the applicant as the East Mineral Trend whereas for the licensed area, the mineralization is referred to as the Main Mineral Trend. The applicant states that it considers both trends to be a product of the same mineralization event.
- The descriptions differ slightly on the timing of shallow faulting. For the KM Horizon Amendment, the applicant states "[t]he latest displacement of these faults was post-mineralization and therefore has offset mineralization." For the LCE Amendment, the applicant states "[f]aulting occurred post-deposition and post-mineralization, therefore depositional patterns were not influenced by the fault movements and the mineral horizons are offset by faulting."

The applicant's descriptions in the Amendment are consistent with descriptions of the site geology in the approved license application, as amended. In general, the descriptions in this Amendment provide greater details because of the acquisition of data since the approved application was written. The primary differences in geologic descriptions from the approved license application are as follows:

- Greater focus on the deeper units (KM, L, M and N horizons)
- More emphasis on the variability of composition of the mudstones units
- Description of the faults as "en echelon" rather than a "scissor" fault system. (The scissor fault description in the approved license application, as amended, is a relict. That description was Lost Creek's interpretation when it submitted the original license application but its interpretation evolved to the "en echelon" fault during the review process as documented in the responses to the requests for additional information (LCI, 2010b). Therefore, the en echelon fault description in the Amendment is consistent with the prior descriptions but not the existing text in Section 2.6 of the approved license application, as amended.)

Staff finds that the characterization of the site geology because the conceptual model is consistent with the model and data presented in the approved license application, as amended, and supplemented with additional borings and wells, geophysical logging, isopach mapping, cross-sections and structural contour maps. The data were collected using established methodologies and the mapping was presented at legible scales. Based on the above, the NRC staff finds that the applicant satisfies Acceptance Criteria 2.6.3(1), (2), (3), (6) (8), (9) and (10) of the SRP (NRC, 2003a).

2.4.3.3 Ore Mineralogy

The text describing the ore mineralogy in the KM Amendment is identical to that in the approved license application, as amended, with the following additions:

- Additional details on the 2007 leach amenability test and subsequent testing in 2001. The applicant reported that recoveries of 84 to 93 percent using leaching solutions chemistry comparable to the lixiviant used for the project.
- The ore mineralogy in the KM Horizon was virtually identical to that in the HJ Horizon.
- The nature of mineralization in the HJ and KM horizons at the LCE area is identical to that at the licensed area and thus the applicant presumed identical ore mineralogy. No specific petrographic or leaching testing of the ore mineralogy was performed in the LCE area.

Staff reviewed the applicant's descriptions of the ore mineralogy and finds descriptions are acceptable because the information is consistent with, and supplements those descriptions in the approved license application, as amended. Staff agrees with the applicant that the ore mineralogy in the LCE area can be inferred from the data for the licensed area because the ore bodies were derived from the "same" event. In addition, based on staff's review of the geology, descriptions of the geologic units immediately surrounding the mineralized zone has been provided and found acceptable. Therefore, staff finds that the information meets Acceptance Criterion 2.6.3(4) of the SRP (NRC, 2003a).

2.4.3.4 Historic Drill Holes

The applicant provides information on historic drill holes in Section 2.6.2.2 "Exploration and Production Activities" of the KM Horizon Amendment, and, Section D2 "Brief History", OP 2.12 "Exploration and Delineation Drilling" and Attachment OP-1 "Historic Holes" of the LCE Amendment (LCI, 2017a;c).

In Sections 2.6.2.2 and D2, the applicant discusses the number of historic drill holes at the LCE area. The applicant reports 1,064 historic drill holes were completed in the LCE area prior to acquisition by UR-Energy, of which 16 drill holes were completed by UR-Energy (LCI, 2017a). In addition, subsequent to UR-Energy's acquisition of the mineral rights, 179 drill holes and 28 baseline monitoring or pumping test wells were completed by UR-Energy. In Section OP 2.12, the applicant reports that approximately 300 exploration holes will be drilled "throughout [Lost Creek] east [area] over the life of the mine and approximately 470 exploration holes will be drill at Lost Creek [area] as described in the original Lost Creek Permit to Mine application." In response to RAIs (LCI, 2017c), the applicant revised the table and figures in Attachment OP-1 to list or depict all holes in the Lost Creek and Lost Creek areas as of June 2016 (LCI, 2017c).

Staff reviewed the information on the drill holes provided by the applicant in the Amendment, information previously supplied by Lost Creek in the approved license application, as amended, and information included in the wellfield data packages for Mine Unit 1 and Mine Unit 2 (LCI, 2008a;2011a;2016g;2017c). In the approved license application, Lost Creek reported 570 historic drill holes within the lost Creek licensed area. Lost Creek reportedly re-abandoned 86 of 181 historic drill holes located within the perimeter well ring for Mine Unit 1 (LCI, 2012), and 137 of 144 historic drill holes within Mine Unit 2 (LCI, 2016g). The re-abandonment effectiveness for Mine Unit 1 was low with Lost Creek able to locate and abandon only 48% of the historic drill holes. The low effectiveness was due in part to widespread disturbance of the area prior to the re-abandonment effort. The re-abandonment effectiveness for Mine Unit 2 was excellent with 95% of the historic drill holes re-abandoned. The past re-abandonment efforts are consistent with the licensee's commitments associated with the approved license application (LCI, 2010a).

The applicant did not provide a summary nor discussion of the historic drill hole information in Attachment OP-1 of the LCE Amendment (LCI, 2017c). Based on the NRC staff's review, the applicant lists 5026 drill holes/wells list. The listing consists of all subsurface drillings including the historic drill holes, monitoring wells installed by Lost Creek, injection and production wells installed by Lost Creek, and, exploration and delineation wells completed by Lost Creek. The information is for both the Lost Creek licensed area and LCE area.

The NRC staff finds that the information contained in the amendment applications, a review of Lost Creek's efforts to re-abandon the historic drill holes in Mine Unit 1 and Mine Unit 2, and the commitment to take corrective action if any improperly plugged holes are located meets the applicable acceptance criteria in Section 2.6.3, "Acceptance Criteria," of the SRP (NRC, 2003a).

2.4.3.5 Seismology

The applicant provides information and analysis on the area seismology and seismic hazard in Section 2.6.3 "Seismology" of the KM Amendment and Section D5.3 "Seismology" of the LCE Amendment. The information is the same in both sections except Section 2.6.3 includes a history of seismic activity after 2007.

The information in the Amendment applications is the same as that reported in the approved license application except for (1) the updated information since 2007 and (2) removal of discussions on the International Building Code (IBC) criteria. The NRC staff reviewed the seismic activity since 2007 and agrees with the applicant that the updated data are consistent with the data previously provided in the approved license application, as amended. Therefore, staff finds that the updated data do not change the previous analyses and conclusions. The removal of discussions on the IBC is not detrimental to the seismic hazard evaluation. The applicant provided discussions of the seismic hazards with respect to the Uniform Building Code (UBC). Although the IBC was adopted recently by the State of Wyoming, local jurisdictions are allowed to retain UBC as part of their rules. In this case, Sweetwater County has elected to retain the UBC for their rules. The applicant committed to adhere to the UBC codes in building the plant, piping and other infrastructure. Consequently, the NRC staff finds this commitment acceptable.

2.4.3.6 Soils

In the KM Horizon Amendment, the applicant incorporates by reference descriptions of soils within the existing licensed area which were provided in the approved license application, as amended. In Section D7 of the LCE Amendment, the applicant provides a baseline assessment of the soils within the LCE area. In addition to mapping 100 percent of the LCE area, the applicant collected selected samples in order to perform analyses on the soils to determine their suitability as a plant growth medium and assessments of salvage depths, erosion properties and prime farmland.

The applicant's discussions of soils in the LCE area are more in-depth than that in the approved license application, as amended. For example, the soils in the LCE Amendment were mapped to the "series" category level rather than the more-broadly defined "family" category. Nevertheless, the overall conclusions are similar (e.g., suitability as a growth medium). The mappings were performed in accordance with the Natural Resource Conservation Service (NRCS) established mapping criteria and by qualified personnel.

The NRC staff finds the licensee's description of soils acceptable because it is consistent with published mapping and by qualified personnel. Thus, the NRC staff finds the description of the soils meets Acceptance Criteria 2.6.3(12) and 2.6.3(13) of the SRP.

2.4.4 Evaluation Findings

The NRC staff evaluated the applicant's characterization of information addressing geology, seismology and soils at the Lost Creek and Last Creek East areas in accordance with SRP Section 2.6.3, "Acceptance Criteria." The applicant adequately described the geology, seismology and soils by providing: (1) a description of the local and regional stratigraphy, (2) geologic, topographic, and isopach maps at acceptable scales showing surface and subsurface features and locations of all wells and site explorations used in defining stratigraphy, (3) a geologic and geochemical description of the mineralized zone and the geologic units adjacent to the mineralized zone, (4) a description of the local and regional geologic structure, (5) a discussion of the seismicity and seismic history of the region, (6) a generalized stratigraphic column that includes the thickness of rock units, a representation of lithologies, and a definition of mineralized horizon, and (7) a description and map of the soils. As noted in the sections above, several aspects the proposed facility and its operations, were not reexamined as the information was previously reviewed and approved by NRC staff (NRC, 2011a). Based on the review conducted by the staff as described above, the information provided in the Amendment meets the applicable acceptance criteria of SRP Section 2.6.3 and thus requirements of 10 CFR 40.41(c).

Because the applicant does not proposed additional impoundments, the NRC staff finds that requirements of 10 CFR Part 40 Appendix Criterion 4(e), which requires locations away from fault capable of impacting the integrity of an impoundment, or Criterion 5G(2), which requires adequate descriptions of the underlying soil and geology that may affect the migration of solutions from an impoundment, have been met based on staff's prior review as documented in the SER for the approved license application, as amended (NRC, 2011a).

2.5 Hydrology

This section describes the NRC staff's evaluation of the applicant's site hydrology conceptual model. As reported by the applicant, for the KM Amendment, information on the surface water and groundwater hydrology is found in the KM Amendment Environmental Report Section 3.5 and the KM Amendment application Section 2.7. For the LCE Amendment, the information is found in LCE Amendment Environmental Report Section 3.5 and LCE Amendment application section D6. Staff reviewed the documents and determined that the narrative in the environmental report is identical to that in the amendment application (i.e., technical report). Therefore, staff's discussion will be solely on the respective amendment applications.

2.5.1 Regulatory Requirements

The NRC staff determines if the applicant has developed an adequate conceptual model, supported by the surface water and groundwater hydrology characterization data, in order to document its ability to maintain control over production fluids containing source and byproduct materials as required by 10 CFR 40.41(c).

2.5.2 Regulatory Acceptance Criteria

Unless stated otherwise, the Amendment was reviewed for consistency with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in SRP Section 2.7.3, "Acceptance Criteria" (NRC, 2003a).⁸

2.5.3 Staff Review and Analysis

The applicable sections reviewed by the NRC staff in the Amendment, other referenced documents and associated SER's are as follows:

Approved License Application SER	Sections 2.7, 2.2.1 Section 2.4
KM and LCE Application	Section 2.7 (KM Amendment) Sections D6.1 and D6.2 (LCE Amendment) Attachments D6-4 and D6-5 (LCE Amendment)
RAI Responses	RAI-2, RAI-3, RAI-4, RAI-5, RAI-9, RAI-10, RAI-14, RAI-15, RAI-20, RAI-21, RAI-22, RAI-23, RAI-25
License SUA-1598	License Conditions 10.10, 10.11, 10.12

2.5.3.1 Surface Water

2.5.3.1.1 Regional Surface Water

The applicant reports that the drainages in the amendment areas are ephemeral because of: (1) the location is in the Great Divide Basin, which is an internal closed drainage basin thus limiting surface water run-on to the drainages; (2) low annual precipitation with the mean annual precipitation of 25.4 centimeters (cm) [10.0 inches (in)]; (3) annual potential evaporation higher

⁸ Compliance with Acceptance Criteria 2.7.3(4) (water quality) is evaluated in SER sections 2.6 and 2.7.

than precipitation (108 cm [42.5 in]); and (4) the coarse-grained semi-consolidated sedimentary bedrock and minor amount of overlying alluvium near the surface, which allows rapid infiltration of any surface water. Furthermore, the applicant states that surface water flow in a channel is observed only after high intensity rain events. Overland flow may be observed during spring snowmelt because of high soil moisture content (or frost in the subsurface). The drainage areas are commonly less than 25.9 square kilometers [10 square miles] and the runoff, if any, is ultimately to the Battle Spring Flat, which is a playa lake located approximately 14.5 kilometers (km) [9 miles (mi)] southwest of the Amendment areas.

2.5.3.1.2 Site-Specific Surface Water

For the KM Amendment, the applicant incorporates by reference the surface water information in the approved license application, as amended (LCI, 2017b). However, the preamble states that the information is updated in the KM Amendment Section 2.7. Staff reviewed the text in the KM Amendment Section 2.7.1 for the surface water and finds it is identical to the text in 2.71 (and a paragraph from Section 2.2.1) of the approved license application, as amended.

For the LCE Amendment, the NRC staff reviewed the additional information and finds it is consistent with the approved license application, as amended, except for the following:

- The applicant provides a quantitative infiltration rate of 0.2 to 0.8 inches per hour based on the soil types found within the areas whereas no rate was reported in the approved license application, as amended.
- The applicant states that infiltration-excess overland flow has not been observed except on compacted soils of existing 2-track roads which differs from the statement in the approved application, as amended, that “[d]rainages ... primarily flow during spring snowmelt as saturated overland flow when soil moisture is at a maximum.”

The NRC staff reviewed the surface water hydrology presented in both the KM and LCE amendments and finds that the applicant has provided adequate information in describing the location and uses of the surface water bodies and drainages within the licensed area and the LCE area.

An assessment of the potential for flooding and erosion of the processing facilities and surface impoundments was not included in the Amendment. Information on the potential for flooding and erosion was evaluated by the NRC staff for the approved license application, as amended. The applicant does not propose any modifications to the existing facilities in the amendments. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

2.5.3.2 Groundwater

2.5.3.2.1 Regional Hydrogeology

The shallow groundwater including that at the depths for the proposed operations is found in the Battle Spring Formation, a Tertiary-aged, semi-consolidated, arkosic, fine-to-coarse grained sandstone with interbedded mudstones and minor conglomerates. The interlayered mudstones result in confined conditions for the interbedded higher transmissive sandstones. The depth to the water table is 24 to 46 m [80 to 150 ft] below grade. The depth to the potentiometric surfaces for the stratigraphically deeper horizons is usually within 61 m [200 ft] of ground surface. Groundwater flow is generally from north-east to south-west with hydraulic gradients of approximately 0.01 feet per foot. The major east-west oriented fault, the Lost Creek Fault, acts as a barrier to flow, especially for the HJ Horizon.

For the KM Amendment, the narrative on the regional hydrogeology in Section 2.7.2.1 is identical to the narrative in Section 2.7.2.1 of the approved license application, as amended. For the LCE Amendment, the narrative on the regional hydrogeology in Section D6.2.1 is identical to the narrative in Section 2.7.2.1 of the approved license application, as amended.

2.5.3.2.2 Site Hydrogeology – KM Amendment (Existing Licensed Area)

For the KM Amendment, the narrative on the site hydrogeology in Section 2.7.2.2 is modified from the narrative in Section 2.7.2.1 of the approved license application, as amended, as follows:

- Global discussions of aquicludes and aquitards consisting of intervening “shaly” units separating “sand” units with an emphasis on the fact that the units, while dominated by mudstone and claystone lithology, may include substantial amounts of siltstone and fine-grained sands. The units have substantially lower permeabilities than the clean sands and the thicknesses of the aquicludes and sand packages are commonly in excess of 7.6 m [25 ft] but may thin to 0.3 to 1.5 m [1 to 5 ft]. The boundary between the shaly and clean sand may not be distinct; therefore, the applicant uses the term “horizon” rather than aquifer for the subsurface strata nomenclature.
- The descriptions for all subsurface horizons include more details (thickness and depths) than those descriptions in the approved license application, as amended.
- The description for the KM Horizon in the KM Amendment separates this horizon into the Upper KM Horizon (UKM), a No Name Shale and Lower KM Horizon (LKM) whereas the description in the approved license application, as amended, separates this horizon into the UKM, No Name Shale and Middle KM Horizon (MKM). (A note on Figure 2.6-2b of the approved license application, as amended, indicates that the MKM had been renamed as LKM).
- The applicant includes a brief description of the stratigraphically deeper horizons (i.e., K shale, L, M and N horizons) which was not included in the approved license application, as amended. The applicant designates the K Shale as the lower boundary to the KM Horizon and serves as an aquitard though acknowledging it as a leaky aquitard. The applicant reports that K Shale may be absent in small localities and, at times, may

represent multiple overlapping, but not contiguous, shales. The L Horizon is the designated underlying aquifer to the KM Horizon.

- The applicant did not reiterate the hydraulic properties determined for the HJ or stratigraphically higher horizons (i.e., DE, FG or Lost Creek Shale (LCS), which were documented in the approved license application, as amended. The applicant focused on the hydraulic properties of KM and stratigraphically lower horizons by including mapping of potentiometric surfaces, horizontal and vertical hydraulic gradients, properties based on pumping tests.

The applicant provided the following additional information in the KM Amendment with regard to the site hydrogeology:

- well construction information on 76 monitoring wells including 49 wells screened in the KM Horizon (either UKM, MKM, LKM or solely KM), 13 wells screened in the L Horizon, 10 wells in the M Horizon and 4 wells in the N Horizon;
- static groundwater elevations at 57 wells on at least two of the following dates: July 6, 2010, October 21, 2011, February 8, 2012, March 15, 2013 and March 10, 2014. The static water elevations may have been reported only on well completion reports included in the pumping tests reports;
- horizontal gradients in the UKM Horizon between eight well-pair sets;
- vertical gradients between the UKM and HJ horizons at 15 well-pair sets; and
- potentiometric surface contour maps for the UKM, L, M and N horizons.

The applicant provides data from 7 constant-rate, multiple-observation well pumping tests. The pumping wells for all tests were screened in the KM Horizon. The pumping tests (year of test) are referred to as follows: UKMP-103 (2007), KPW-2 (2009), KPW-1A (2009), MU-101 (2010), KPW-1A Re-test (2010), Composite KLM Horizon at KPW-3 (2011), and Composite KLM Horizon 5-Spot at 5S-KM3 (2012).

UKMP-103 (2007) Pumping Test

The pumping test was conducted for approximately 6 days at a pumping rate of 110 liters per minute (l/m) [29 gallons per minute (gpm)]. The pumping well was located north of the Lost Creek Fault and screened in the upper KM (UKM) Horizon. For wells that were monitored during this test, the applicant lists 19 monitoring wells in the UKM Horizon, 7 monitoring wells in the HJ Horizon, 3 monitoring wells in the LFG Horizon and 3 wells in the middle KM (MKM) Horizon, all of which are reportedly north of the Lost Creek Fault. The applicant provides a summary of results for the quantitative analysis of drawdown at 7 monitoring UKM wells at distances up to 640 m [2102 ft] from the pumping well. The calculated average value for transmissivity, hydraulic conductivity and storativity from the analyses was 1.48×10^{-4} square meters per second (m^2/s) [138 square feet per day (ft^2/d)], 9.7×10^{-4} centimeters per second (cm/s) [2.76 feet per day (ft/d)] and 1.07×10^{-4} , respectively. The applicant also provided qualitative summaries of several observations: the KM sub-horizons (i.e., UKM and LKM)

had a strong hydraulic connection suggesting the No Name Shale was not a contiguous aquitard as originally thought; the Lost Creek Fault acts as a partial barrier to flow with one well south displaying similar scale drawdown as wells on the north side of the fault but the other displaying one-fifth of the comparable drawdown observed at similarly distant wells north of the fault. The applicant did not provide the raw data for this pumping test in an attachment as was the case for the subsequent pumping tests (see discussion below regarding the lack of raw data).

KPW-2 (2009) Pumping Test

The pumping test was conducted for approximately 8 hours at a pumping rate of 259 l/m [68.3 gpm]. The pumping well is located north of the Lost Creek Fault. In addition to the 13 monitoring wells in the KM Horizon, monitoring was conducted at 6 wells in the overlying HJ Horizon and 4 wells in the deeper L Horizon during this test. The applicant reported no responses to the pumping at monitoring wells in the overlying HJ Horizon, drawdown up to 2.4 m [8 ft] at two monitoring wells screened in the KM Horizon south of the Lost Creek Fault, and drawdown of 3.54 m [11.6 ft] at the monitoring well screened in the L Horizon north of the fault nearest (52.7 m [173 ft]) the pumping well. The aquifer properties for the KM Horizon were similar to those reported for the 2007 pumping test. A detail report on the pumping test is provided in Attachment 2.7-2.

KPW-1A (2009) Pumping Test

The pumping test was conducted for approximately 7 days at a pumping rate of 238 l/m [63.0 gpm]. This well is located south of the Lost Creek Fault. In addition to the 13 monitoring wells in the KM Horizon, monitoring was conducted at 6 wells in the overlying HJ Horizon and 4 wells in the deeper L Horizon during this test. The applicant reported drawdown at all wells in all horizons on both sides of the Lost Creek Fault. Similar drawdowns of approximately 6.4 m [21 ft] were reported for the two closest monitoring wells in the L Horizon south of the fault though the distances of those two wells to the pumping well differed significantly (27 m [89 ft] versus 383 m [1257 ft]). Drawdowns of up to 0.55 m [1.8 ft] were reported for wells screened in the overlying HJ Horizon. The aquifer properties for the KM Horizon were similar to those for the 2007 pumping test. A detail report on the pumping test is provided in Attachment 2.7-2.

MU-101 (2010) Pumping Test

Based on the observed drawdown in the KPW-1A pumping test, the applicant reported that it re-abandoned four historic exploratory drill holes that penetrated to the K Shale and installed monitoring wells in the deeper L and M Horizons and then conducted a short-term pumping test. The pumping test was conducted for approximately 24 hours at a pumping rate of 189 l/m [50 gpm]. This well is located south of the Lost Creek Fault. The applicant provided only a qualitative analysis of the results limited to reporting a drawdown of 0.79 m [2.6 ft] was observed in the L Horizon compared to drawdown of 3.7 to 5.2 m [12 to 17 ft] in the KM Horizon. The applicant reported that no drawdown was observed in the M Horizon.

KPW-1A Re-test (2010) Pumping Test

The pumping test was conducted for approximately 4 days at a pumping rate of 235 l/m [62.2 gpm] to replicate the 2009 tests with additional monitoring of the L and M horizons. This well is located south of the Lost Creek Fault. The applicant provided only a qualitative analysis of the results. A maximum drawdown of 4.8 m [16 ft] was observed in the L Horizon wells and a drawdown of 2.1 m [6.8 ft] in the M Horizon compared to a drawdown of 13.1 m [43 ft] observed in the KM Horizon. The observed drawdown in the KM Horizon north of the fault was approximately 10 times less than observed south of the fault which the applicant attributed to the fault acting as a hydrogeologic barrier.

Composite KLM Horizon at KPW-3 (2011) Pumping Test

The pumping test was conducted for approximately 5 days at a pumping rate of 265 l/m [70 gpm] within the area of the proposed Mine Unit 3. This well is located south of the Lost Creek Fault. Additional monitoring wells in the overlying HJ Horizon and deeper L, M and N horizons were monitored during this test. The aquifer properties for the KM Horizon were similar to those for the 2007 pumping test. The applicant reported responses to the pumping at all monitoring in all horizons with the exception of wells screened in the overlying HJ Horizon north of the Lost Creek Fault. The applicant provides a ratio of observed drawdown in the HJ, L, M and N horizons compared to that observed in the KM Horizon, monitoring well completion information and vertical hydraulic gradients between the various horizons. A detail report on the pumping test is provided in Attachment 2.7-2.

Composite KLM Horizon 5-Spot at 5S-KM3 (2012) Extraction and Extraction/Injection Tests

The testing was conducted to simulate ISR operations at a typical 5-spot production unit (4 injection wells centered about a production well). The 5-spot production unit and monitoring wells are located south of the Lost Creek Fault within the area for proposed Mine Unit 3. Two tests were performed, the first was with extraction only at the center well and the second was extraction with balanced injection at one or more of the corner wells. The extraction test (first test) was conducted for approximately 3 days at a pumping rate of 108 l/m [28.5 gpm]. Prior to the test, grout was observed in one well and that well was recompleted for the testing. During the extraction test, drawdown of 7.07 to 18.6 m [23.2 to 61.2 ft] were observed at the wells at the 5-spot corners, a drawdown of 6.1 and 0.3 m [1.9 and 1.1 ft] was observed in the L and M Horizon, respectively, and no response was observed in the HJ and N horizons. The extraction/Injection test (second test) was originally designed to inject fluids at all four corner wells with production at the center well; however, the injectivity at two of the four corner wells was significantly reduced resulting in artesian conditions. Consequently, injection at one of those wells (the well in which grout was observed) was terminated and the injection at the other well was greatly reduced. The test was modified to a constant injection of approximately 14.4 l/m [3.8 gpm] at three wells and extraction of approximately 41.3 l/m [10.9 gpm] at the center production well. The injection at the one well resulted in dramatic increase in

water levels due to the low injectivity of that well. The test was then modified to the injection at approximately 43.5 l/m [11.5 gpm] at only two corner wells with the higher injectivity with extraction at approximately 85.6 l/m [22.6 gpm] at the center well. The applicant reported no responses in the HJ or N horizon well. The applicant also concluded that the difference in drawdown/injectivity of the corner KM wells is likely attributed to aquifer anisotropy as no discernable difference in the sand quality was noted in the geophysical logs for those wells.

In Attachment D6-6 of the LCE Amendment, the applicant provides results of a numeric groundwater flow model centered within the KM Horizon in the area of the proposed Mine Unit 3. The model consisted of 11 layers simulating the HJ to N horizons. The model was calibrated to two pumping tests, the KPW-1A Re-test (2010) Pumping Test and the Composite KLM Horizon 5-Spot at 5S-KM3 (2012) Extraction Test. The Applicant concludes that "...it is difficult to simulate an excursion if there was a competent confining unit, even if the vertical hydraulic conductivity is relatively high (as might be the case for a silty K Shale unit instead of a shaley unit)." Furthermore, the Applicant states that "[i]f the L horizon was adequately monitored no additional monitoring in the deeper M Horizon should be required."

The applicant adopts a conceptual model for the KM Horizon in the KM Amendment similar to that used for the HJ Horizon in the approved license application, as amended (i.e., the production horizon has sufficient conductivity to permit ISR operations and is surrounded by confining units which may permit minor communication to the underlying or overlying aquifer. The Lost Creek Fault acts a barrier to flow.) The slight differences in the conceptual model description are as follows:

- The K Shale (underlying confining unit to the KM Horizon) is not a single discrete shale unit but multiple overlapping, non-contiguous shales containing coalescing sands. In the approved license application, as amended, the confining units to the HJ Horizon are described as "sedimentary sequences dominated by mudstone and claystone lithology; but also may include substantial amounts of siltstone and fine-grained sands. These lithologies can exhibit considerable interfingering, and are often transitional to the aquifers above or below. As a result, dramatic thickening and thinning of the aquicludes can occur locally. In addition, their upper and lower boundaries are often gradational. Aquicludes may even exhibit localized occurrences of mineralization."
- The depositional environment for the Battle Spring Formation was a high-energy, over-bank, braided stream environment. The applicant states that, with respect to the non-textbook radial response observed during the pumping tests, "[i]t is easy to imagine that the depositional environment described above probably has a great deal to do with the [non-textbook] drawdown responses observed" (LCI, 2017c). In the approved license application, as amended, the Battle Spring Formation is described as "part of a major alluvial system, consisting of thick beds of very fine- to coarse-grained arkosic sandstones separated by various layers of mudstones and siltstones. Conglomerate beds may exist locally. The uranium mineralization is associated with finer-grained sandstones and siltstones, which may contain minor organic matter in a few areas" (LCI, 2008a).

The NRC staff reviewed the applicant's characterization of the KM Amendment hydrogeology. The staff finds that the descriptions of the regional hydrogeology and the site-specific hydrogeology for horizons above the Sage Brush Shale, which were incorporated by reference from the approved license application, as amended, was appropriate for the KM Amendment.

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Except as noted below, the NRC staff finds that the applicant has performed the testing by acceptable methods and provided data from a sufficient number of wells and pumping tests to define the characteristics of the KM and lower horizons in the KM Amendment. As noted above, the applicant did not provide the supplemental data for the 2007 pumping test at well UKMP-103. The lack of the supporting data for this pumping test did not affect staff's review for several reasons. Primarily, the information provided for this pumping test is consistent with that provided for the other multiple pumping tests for which the detailed supporting data has been provided. The data from this test were not used to calibrate the numeric groundwater flow model. The pumping well is located north of the fault and data from well KPW-2, which is also located north of the fault, provided sufficient information on the properties. This pumping test did not monitor any wells below the KM horizon and data for pumping tests in the HJ Horizon reported in other submittals reviewed by the NRC staff (the approved license application, Mine Unit 1 Wellfield data package) provided sufficient information on the hydraulic communication potential between the KM and overlying HJ horizons.

The exception to the sufficiency of data is the number of groundwater elevation measurements to evaluate seasonal fluctuations in water levels within in the KM and lower horizons. Acceptance Criterion 2.7.3(5) of the SRP states that "[t]he applicant has provided an assessment of the seasonal and the historical variability for potentiometric heads" (NRC, 2003a). While Acceptance Criterion 2.7.3(5) does not define the number of measurements needed for an assessment, Acceptance Criterion 2.7.3(4) states that "[a]t least four sets of samples" are sufficient to indicate seasonal variability in the groundwater chemistry. Staff's practice has been to use at least four measurements to define potential seasonal variability in the potentiometric heads (i.e., groundwater elevations at the monitoring wells).

The applicant provided only two to three groundwater elevations for the various wells. Furthermore, the reported elevations were for several sampling dates in the same month for differing which would not lead to an assessment of seasonal variations. The groundwater elevations were not reported for the four quarters of groundwater quality data. In addition, the applicant did not discuss the seasonal variability in the potentiometric heads. The NRC staff would have included a license condition requiring the applicant to supply potentiometric head data for a seasonal analysis prior to construction of the KM Horizon mine units in the Lost Creek licensed area should the NRC staff had approved the KM Horizon for those operations. However, the applicant requested that the mine units in the KM Horizon within the Lost Creek licensed area (Mine Unit 3 and Mine Unit 12) be withdrawn from consideration for the Amendment (LCI, 2018c). This action resulted in the Amendment consisting of only the horizontal expansion in the Lost Creek licensed area (i.e., only HJ Horizon mine units) and the vertical and horizontal expansion in the LCE area (i.e., HJ and KM horizons mine units). Because the KM Horizon mine units are withdrawn from consideration, the characterization of the KM Horizon performed for the approved license application, as amended is deem sufficient.

The NRC staff reviewed the applicant's data with respect to its conceptual model and finds that the applicant's conceptual model did provide a framework to minimize environmental and safety

concerns. Section 2.7.3 “Acceptance Criteria” of the SRP states that [t]he hydrologic characterization should establish a hydrologic conceptual model for the in situ leach site and surrounding region. The conceptual model provides a framework for the applicant to make decisions on the optimal methods for extracting uranium from the mineralized zones, and to minimize environmental and safety concerns caused by in situ leach operations. Hydrologic characterizations that accomplish this objective are considered acceptable” (NRC, 2003a).

The NRC staff’s initial review the KM Amendment had issues with the applicant’s data used for the hydrogeologic characterization of the lower confining unit within the Lost Creek licensed area (KM Amendment) supporting its conceptual model as documented in RAI-2 (NRC, 2017d). The responses to staff’s RAI provided insufficient supplemental data for staff to find reasonable assurance with respect to characterization of the lower confining unit within the licensed characterization for confinement. Consequently, in February 2018, the NRC staff scheduled a public meeting to discuss those issues with the applicant (NRC, 2018a). In making the arrangements with the applicant to have appropriate staff at the meeting to discuss the issues, the applicant proposed withdrawing two mine units in the KM Horizon for the KM Amendment (i.e., Mine Unit 3 and Mine Unit 12) from consideration. Subsequently, the applicant withdrew Mine Unit 3 and Mine Unit 12 from consideration for the KM Amendment (LCI, 2018c).

With the withdrawal of the KM Horizon mine units from consideration for the KM Amendment, the NRC staff finds that the characterization of the site hydrogeology in the approved license application, as amended, is applicable for the expansion of the HJ Horizon mine unit for the KM Amendment. Limiting the KM Amendment to only the horizontal expansion in the HJ Horizon will be memorialized as a license condition described in SER Section 2.5.4.

2.5.3.2.3 Site Hydrogeology – LCE Amendment (LCE Proposed Area)

For the LCE Amendment, the applicant’s discussions on the site hydrogeology in Section D6.2.2 of the LCE Amendment expands upon regional trends resulting in differences in the subsurface hydrogeology from that in the Lost Creek licensed area. The differences are summarized as follows:

- The DE Horizon becomes unsaturated and is eventually absent in the eastern third of the LCE area. The DE Horizon may coalesce with the underlying FG Horizon in the southern part of the LCE area.
- The FG Horizon is surficially exposed in the eastern third of the LCE area due to the regional structure of the stratigraphy. The FG Horizon transitions from confined to unconfined aquifer as it becomes shallower.
- The HJ Horizon may not be fully saturated in the extreme northeastern most corner of the LCE area.

The applicant provides the following additional information in the LCE Amendment with regard to the site hydrogeology:

- well construction information on 32 monitoring wells including 4 wells screened in the FG Horizon, 8 wells screened in the HJ Horizon, 8 wells screened in the KM Horizon (either UKM, MKM, LKM or solely KM), 7 wells screened in the L Horizon and 5 wells in the M or M/N Horizon;

- static groundwater elevations on one date (March 2014 based on the potentiometric surface contour mapping for the horizons (for the L Horizon, the date of measurement is not specified. The applicant notes that the potentiometric surface contours for the L and N horizons differed slightly from the regional trend to the potentiometric surfaces for the stratigraphically higher horizons but the applicant attributes the differences as an attribute to the limited datasets for the lower horizons;
- calculated horizontal gradients in the various horizons;
- vertical gradients between the FG and HJ, HJ and KM, and KM and N horizons at 9 well-pair sets (Attachment D6-4) and between the KM and L horizons at 4 well-pair sets (Attachment D6-5); and
- potentiometric surface contour maps for the FG, HJ, KM, L and N horizons (The potentiometric surface contour map for the L Horizon is in Attachment D6-5).

The applicant provides data from 11 constant-rate, multiple-observation well pumping tests. The pumping wells were screened either in the HJ Horizon (2 tests), KM Horizon (6 tests) or L Horizon (3 tests) at one of three locations (North, Central or South Cluster) within the LCE area. The pumping tests were conducted during 2013 or 2016 and are referred to as follows:

2013 (data from Attachment D6-4)
 North Cluster KM Horizon at M-KM9
 Central Cluster KM Horizon at M-KM7
 South Cluster KM Horizon at M-KM4A
 Central Cluster HJ Horizon at M-HJ4
 South Cluster HJ Horizon at M-HJ1

2016 (data from Attachment D6-5)
 North Cluster KM Horizon at M-KM9
 North Cluster L Horizon at M-L7
 Central Cluster KM Horizon at M-KM7
 Central Cluster L Horizon at M-L9
 South Cluster KM Horizon at M-KM4A
 South Cluster L Horizon at M-L11A

A summary of each pumping test is as follows:

North Cluster KM Horizon at M-KM9 (2013) Pumping Test

The pumping test was conducted for approximately 7 days at a pumping rate of 170 l/m [45 gpm]. In addition to 4 monitoring wells screened in the KM Horizon, drawdown was monitored at 1 well in the FG Horizon, 3 wells in the HJ Horizon, and 3 wells screened in the N Horizon. Except for two monitoring wells (HJ and N Horizon), the monitoring wells are located in excess of 1067 m [3,500 ft] from the pumping well. Drawdown was observed only at one well in the KM horizon. The calculated transmissivity was similar to results from pumping tests conducted in the KM Horizon as reported in the KM Amendment; however, the

storativity (1.97×10^{-2}) was 2 orders of magnitude greater than those calculated from the tests reported in the KM Amendment.⁹

Central Cluster KM Horizon at M-KM7 (2013) Pumping Test

The pumping test was conducted for approximately 7 days at a pumping rate of 151 l/m [40 gpm]. In addition to 2 monitoring wells screened in the KM Horizon, drawdown was monitored at 2 wells in the FG Horizon, 3 wells in the HJ Horizon, and 1 well screened in the M/N Horizon. Except for three monitoring wells (FG, HJ and M/N Horizon), the monitoring wells are located in excess of 1067 m [3,500 ft] from the pumping well. The applicant reports drawdown at two KM Horizon wells, 0.664 m [2.18 ft] at a well located 1174 m [3,851 ft] from the pumping well and 1.9 m [6.2 ft] at a well located 1282 m [4,206 ft] from the pumping well. The applicant calculates hydraulic properties only for the more distal well which were similar to properties from pumping tests conducted in the KM Horizon as reported in the KM Amendment. No drawdown was report at the other observation wells.

South Cluster KM Horizon at M-KM4A (2013) Pumping Test

The pumping test was conducted for approximately 3 days at a pumping rate of 231 l/m [61 gpm]. In addition to 3 monitoring wells screened in the KM Horizon, drawdown was monitored at 2 wells in the FG Horizon, 4 wells in the HJ Horizon, and 2 wells screened in the M/N Horizon. Six of the 11 monitoring wells are located in excess of 914 m [3,000 ft] from the pumping well. The applicant reports drawdown at the three KM Horizon monitoring wells, 3.13 m [10.28 ft] at a well located 244 m [799 ft] from the pumping well, 0.463 m [1.52 ft] at a well located 836 m [2,744 ft] from the pumping well, and 1.3 m [4.2 ft] at a well located 925 m [3,037 ft] from the pumping well. The applicant calculates hydraulic properties for the two of the three wells (the closest and farthest well from the pumping well) which were similar to properties from pumping tests conducted in the KM Horizon as reported in the KM Amendment. No drawdown was report at the other observation wells.

Central Cluster HJ Horizon at M-HJ4 (2013) Pumping Test

The pumping test was conducted for approximately 4 days at a pumping rate of 151 l/m [40 gpm]. In addition to 2 monitoring wells screened in the HJ Horizon, drawdown was monitored at 2 wells in the FG Horizon, 3 wells in the KM Horizon, and 1 well screened in the M/N Horizon (same wells included in the KM

⁹ Based on the partial differential equation for groundwater flow and the commonly accepted solution model curves to radially flow (e.g., Theis Equation), the temporal variation in head (or drawdown) is based on the ratio of two properties, the transmissivity and storativity. In general terms, for a given transmissivity typical for this setting, a two-order magnitude change in storativity may decrease the observed drawdown during a week-long pumping test by 80 percent. Eventually, for long times (i.e., steady-state), the storativity would not have an impact on the observed head. However, for a two-order-magnitude difference, the time period to reach “steady state” may be measured in years.

The subsequent pumping tests in the Lost Creek East area are consistent with the storativity of the KM Horizon reported in the Lost Creek License area. The reported variation in storativity values is consistent with the applicant’s conceptual model of heterogeneity.

pumping test at this cluster). Five of the 8 monitoring wells are located in excess of 1067 m [3,500 ft] from the pumping well. The applicant reports drawdown at both wells screened in the HJ Horizon, 0.4 m [1.31 ft] at the monitoring well located 1141 m [3,743 ft] from the pumping well and 0.323 m [1.06 ft] at a well located 1327 m [4,355 ft] from the pumping well. The applicant calculates hydraulic properties for the wells which were similar to properties from pumping tests conducted in the KM Horizon. The applicant reports a drawdown of 0.22 m [0.72 ft] in the closest well screened in the FG Horizon and a drawdown of -0.22 m [-0.72 ft] in the closest well screened in the KM Horizon.

South Cluster HJ Horizon at M-HJ1 (2013) Pumping Test

The pumping test was conducted for approximately 5 days at a pumping rate of 153 l/m [40.5 gpm]. In addition to 3 monitoring wells screened in the HJ Horizon, drawdown was monitored at 2 wells in the FG Horizon, 4 wells in the KM Horizon, and 2 wells screened in the M/N Horizon (same wells included in the KM pumping test at this cluster). Six of the 11 monitoring wells are located in excess of 914 m [3,000 ft] from the pumping well. The applicant reports drawdown at all three wells screened in the HJ Horizon, 2.1 m [6.91 ft] at the monitoring well located 240 m [787 ft] from the pumping well, 0.22 m [0.72 ft] at the monitoring well located 855 m [2,804 ft] from the pumping well and 0.69 m [2.28 ft] at a well located 927.8 m [3,044 ft] from the pumping well. The applicant calculates hydraulic properties for the two of the three wells (the closest and farthest from the pumping well). The properties were slightly higher than those calculated for the KM Horizon tests but similar to those previously reported for pumping tests conducted in the HJ Horizon in the licensed area. The applicant reports a drawdown of 0.22 m [0.73 ft] in the closest well screened in the FG Horizon and a drawdown of 0.009 m [0.03 ft] at the closest well screened in the KM Horizon. The applicant reports measurable drawdown in all other monitoring wells except one well screened in the FG Horizon at a distance of 883.6 m [2,899 ft] from the pumping well.

North Cluster KM Horizon at M-KM9 (2016) Pumping Test

The pumping test was conducted for approximately 2 days at a pumping rate of 84.23 l/m [22.25 gpm]. In addition to 2 monitoring wells screened in the KM Horizon, drawdown was monitored at 2 wells in the L Horizon and 2 wells screened in the N Horizon. Three of the 6 monitoring wells are located in excess of 1067 m [3,500 ft] from the pumping well. The applicant reports drawdown in both wells screened in the L Horizon (0.21 m [0.69 ft] at the monitoring well located 14.6 m [48 ft] from the pumping well and 0.369 m [1.21 ft] at the monitoring well located 59.4 m [195 ft] from the pumping well) and no drawdown at both wells screened in the KM Horizon and both wells screened in the N Horizon. The applicant did not calculate aquifer properties based on this pumping test results because of the lack of drawdown.

North Cluster L Horizon at M-L7 (2016) Pumping Test

The pumping test was conducted for approximately 480 minutes at a pumping rate of 79.9 l/m [21.1 gpm]. The applicant attributes the short duration of the test to excessive drawdown in the pumping well. In addition to 1 monitoring well

screened in the L Horizon, drawdown was monitored at 1 well in the KM Horizon and 1 well screened in the N Horizon. All 3 monitoring wells are located within 61 m [200 ft] of the pumping well. The applicant reports drawdown of 4.56 m [14.95 ft] at the well screened in the L Horizon at 45.7 m [150 ft] from the pumping well and no responses at the wells screened in the KM and N horizons. The applicant calculates aquifer properties for the L Horizon based on the observed drawdown. The calculated properties include transmissivity of approximately 1.1×10^{-5} m²/s [10 ft²/d], hydraulic conductivity of approximately 3.8×10^{-4} cm/s [1.1 ft/d], and storativity of 2.2×10^{-4} .

Central Cluster KM Horizon at M-KM7 (2016) Pumping Test

The pumping test was conducted for approximately 1.2 days at a pumping rate of approximately 90.8 l/m [24 gpm]. In addition to 2 monitoring wells screened in the KM Horizon, drawdown was monitored at 3 wells in the L Horizon and 1 well screened in the M Horizon. Three of the 6 monitoring wells are located in excess of 1067 m [3,500 ft] from the pumping well. The applicant reports no drawdown at all monitoring wells.

Central Cluster L Horizon at M-L9 (2016) Pumping Test

The pumping test was conducted for approximately 435 minutes at a pumping rate of 79.9 l/m [21.1 gpm]. The applicant attributes the short duration of the test to excessive drawdown in the pumping well. In addition to 2 monitoring wells screened in the L Horizon, drawdown was monitored at 3 wells screened in the KM Horizon and 1 well screened in the M/N Horizon. Three monitoring wells are located within 61 m [200 ft] of the pumping well whereas the remaining three wells are located in excess of 1067 m [3,500 ft] from the pumping well. The applicant reports drawdown of 22 m [72 ft] at the well screened in the L Horizon at 36.6 m [120 ft] from the pumping well and no responses at the other well screened in the L Horizon or wells screened in the KM and N horizons. The applicant calculates aquifer properties for the L Horizon based on the observed drawdown. The calculated properties are similar to those reported for the L Horizon test in the North Cluster except the storativity is approximately one order of magnitude less at a value of 3.67×10^{-5} .

South Cluster KM Horizon at M-KM4A (2016) Pumping Test

The pumping test was conducted for approximately 1.7 days at a pumping rate of 86.6 l/m [22.88 gpm]. In addition to 1 monitoring well screened in the KM Horizon, drawdown was monitored at 2 wells in the L Horizon and 1 well screened in the N Horizon. All four monitoring wells are located within 244 m [800 ft] of the pumping well. The applicant reports drawdown of 0.86 m [2.82 ft] at the well screened in the KM Horizon located 243 m [798 ft] from the pumping well and a drawdown of 0.037 m [0.12 ft] at the well screened in the L Horizon located 73.8 m [242 ft] from the pumping well. The applicant reports no responses at the remaining wells. The applicant did not calculate aquifer properties based on this pumping test result; however, the applicant calculated the hydraulic properties for observed drawdown in the KM Horizon for the pumping test conducted at this well during 2013 (see above).

South Cluster L Horizon at M-L11A (2016) Pumping Test

The pumping test was conducted for approximately 1 day at a pumping rate of 51.9 l/m [13.7 gpm]. In addition to 1 monitoring well screened in the L Horizon, drawdown was monitored at 2 wells screened in the KM Horizon and 1 well screened in the N Horizon. All four monitoring wells are located within 243 m [800 ft] of the pumping well. The applicant reports drawdown of 3.52 m [11.54 ft] at the well screened in the L Horizon at 190 m [623 ft] from the pumping well and no responses at wells screened in the KM and N horizons. The applicant calculates aquifer properties for the L Horizon based on the observed drawdown. The calculated properties are similar to those reported for the L Horizon test in the other clusters with a transmissivity approximately 2.5 times that calculated for the North Cluster L Horizon Test and a storativity equal to that calculated for the Central Cluster L Horizon Test.

Based upon the above, and except for two issues identified below, the NRC staff finds that the applicant's descriptions and characterizations of the LCE hydrogeology meet Acceptance Criterion 2.7.3(3) of the SRP by presenting potentiometric mapping, discussing hydraulic parameters and providing an appropriate site conceptual model. The pumping tests conducted for the LCE Amendment, while shorter in duration and included less monitoring wells than the testing in the KM Amendment, provides data on confinement that are consistent with its site conceptual model. Furthermore, the potentiometric head differences for wells in the KM and L horizons supports the potential confinement of the K Shale within the LCE area.

The two issues are: (1) collecting potentiometric head data for the L Horizon wells to establish the seasonal variability; and (2) operating wellfields in the HJ Horizon in areas that are less than fully saturated. The applicant acknowledged that it had less than four quarters of samples from the L Horizon wells and committed to conducting additional sampling (see SER Section 2.6). Because the sample results have not been submitted, the NRC staff will include this commitment as a license condition (see Section 2.6.4). The NRC staff will include including the groundwater elevations with the data to be submitted for this license condition.

The applicant did not provide data or evaluate the impacts of operations in areas in which the HJ Horizon is less than fully saturated. The applicant did not propose to conduct operations in the HJ Horizon where it is not fully saturated and, in response to RAIs, commits to not conducting operations in those areas (LCI, 2017c). Staff will include a license condition for this commitment (see SER Section 2.5.4).

Water Use

The applicant's descriptions of surface water and groundwater uses are identical to the descriptions in the approved license application, as amended, with the following updates:

- Description of water uses by Lost Creek ISR, LLC, for its on-site operations; and
- Report on testing completed on BLM's Battle Spring Draw Well 4451 which identifies its existing depth of 70.1 m [230 ft] based on the recent testing is less than the 274-meter [900-foot] depth reported in the State of Wyoming State Engineer's Office record.

Based on the updated information supplied by the applicant and that previously reviewed by staff for the license application, the NRC staff finds that the applicant provides sufficient

information to evaluate potential risks to nearby water uses by the proposed activities in accordance with Acceptance Criterion 2.7.3(6) of the SRP.

2.5.4 Evaluation Findings

The NRC staff has completed its review of the Amendment. During the review, the NRC staff determined that the applicant has acceptably described the surface water hydrology by providing the following:

- the location of the drainages in and around the license area;
- characterization of the vicinity surface water flows; and
- acceptable erosion protection against the effects of flooding from all drainages in and around the license area.

The NRC staff concludes that applicant has acceptably described the groundwater hydrology by providing the following:

- a description of the regional hydrogeology;
- a description of the overlying aquifer(s), extraction zone(s), and underlying aquifer(s) hydrogeology using potentiometric surface maps with acceptable contour intervals based on an appropriate number of monitoring wells;
- vertical gradients and pumping test data to evaluate the integrity of the confining layers and initially assess hydraulic parameters except as noted below;
- water level data to evaluate the seasonal variability except as noted below; and
- locations of groundwater stock and domestic wells in vicinity of the license area.

The applicant acknowledged that it submitted an insufficient number of samples for the L Horizon wells in the LCE area to establish background quality (see SER Section 2.6.3). The applicant committed to collecting the additional data and the requirement of 10 CFR Part 40 Appendix A Criterion 7 is to collect the data in a year prior to major site construction. Because the data have yet to be submitted, the NRC staff will include a license condition to ensure the data are collected and reported prior to major construction at the LCE area (See SER Section 2.6.4). The license condition will also include the requirement to provide potentiometric head data to document seasonal variability.

The applicant committed to restricting operations in HJ Horizon to areas in which the zone is fully saturated (LCI, 2017c). The NRC staff will include this commitment in the following license condition:

License Condition 10.22

The licensee is restricted from conducting ISR operations in the HJ Horizon in areas in which the HJ Horizon is not fully saturated as depicted on Figure 10 in Attachment OP-2 of the Lost Creek East Amendment Application (ML18017A809).

The applicant requested withdrawal of Mine Unit 3 and Mine Unit 12 from consideration in the KM Amendment. The NRC staff will include this commitment in the following license condition:

License Condition 10.23

The licensee is prohibited from operations in the KM Horizon within the initial licensed area (Mine Unit 3 and Mine Unit 12).

Based on its review of the information provided by the licensee, as supplemented by information to be collected or commitments in the above license conditions, the staff concludes that the information meets the applicable acceptance criteria of SRP Section 2.7.3 and the requirements of 10 CFR 40.41(c).

2.6 Non-Radiological Background Characteristics

This section describes the NRC staff's evaluation of the applicant's characterization of the non-radiological background surface water and groundwater quality within the proposed amendment areas. As reported by the applicant, for the KM Amendment, information on the background surface water and groundwater quality characterization is found in the KM Amendment Environmental Report Section 3.5.1.3 and 3.5.4 and KM Amendment sections 2.7.1.3 and 2.7.4. For the LCE Amendment, the information is found in LCE Amendment Environmental Report Section 3.5 and LCE Amendment sections D6.1.3 and D6.4 for the LCE Amendment. The NRC staff reviewed the documents and determined that the narrative in the environmental report is identical to that in the amendment application (i.e., technical report). Therefore, staff's discussion will be solely on the amendment applications.

2.6.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the characterization of surface water and groundwater quality at the proposed Amendment areas is adequate to meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.6.2 Regulatory Acceptance Criteria

The Amendment was reviewed for compliance with requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the applicable acceptance criterion 2.7.3(4) in SRP Section 2.7.3, "Acceptance Criteria" (NRC, 2003a).

2.6.3 Staff Review and Analysis

The applicable sections reviewed by the NRC staff in the Amendment, other referenced documents and associated SER's are as follows:

Approved License Application SER	2.7.1.2, 2.7.3 2.5
KM and LCE Application	Sections 2.7.1.3, 2.7.4 (KM Amendment) Sections D6.1.3, D6.4 (LCE Amendment)
RAI Responses	RAI-10, RAI-11, RAI-14

Staff compared the characterizations with the prior characterizations of the surface water and groundwater quality in the approved license application, as amended. As discussed below, if the characterizations are identical to the prior characterizations and applicable to the proposed

amendment, then the NRC staff would concluded that the information was adequate without further detailed analysis.

2.6.3.1 Surface Water

For the KM Amendment, the discussions and data presented in Section 2.7.1.3 are identical to the data reported in Section 2.7.1.2 of the approved license application, as amended, except for the following:

- Discussion of the WDEQ Surface Water Classification of 3B has been moved to Section 2.7.1.2.
- Discussion on the lack of a routine or “ad hoc” operational surface water monitoring program was added to the Amendment.

The applicant’s discussion of the lack of a routine operational surface water monitoring program references Section 5.7.8.2 of the approved license application, as amended. In that section, the licensee states that a routine operational surface water monitoring program will not be conducted because of the ephemeral nature of the drainages in the basin. Furthermore, the licensee states that samples will be collected in a drainage during the next precipitation event following a spill, if the spill impacts a drainage.

In the approved application, the NRC staff found the background surface water preoperational and operational monitoring program acceptable. For the lack of a routine operational monitoring program, the NRC staff finds the change acceptable because of the ephemeral nature of the surface water runoff.

For the LCE Amendment, the applicant reports surface water quality sampling conducted during 2013 at sampling locations within the Lost Creek existing licensed area and the LCE area. Due to the limited volumes obtained, the only parameters analyzed were the radionuclides (LCI, 2017a). For staff’s evaluation, see SER Section 2.7.

2.6.3.2 Groundwater

The applicant descriptions of the regional groundwater quality in the KM and LCE Amendments are essentially identical to the narrative in the approved license application, as amended.

The applicant provides new information of the site groundwater. For the KM Amendment, the applicant incorporates by reference information on the groundwater quality in the approved license application, as amended, for the stratigraphic horizons at or above the HJ Horizon. For the KM Horizons and below, the applicant provides data (collected prior to 2009) from the approved license application, as amended, with supplemental data collected in 2010 from one of the baseline wells (MB-4) for the KM Horizon. The applicant includes figures displaying the distribution of three parameters (TDS, uranium and combined radium) in groundwater in the UKM Horizon. The figures are similar to those in the approved license application, as amended, except: (1) the concentration at well MB-4 is added to each figure; and (2) the combined radium concentration at several wells differs slight from the respected value depicted on the figure in the approved application, as amended.

In the KM Amendment, the applicant also presents groundwater quality data from nine wells in the L Horizon (wells KMU-1 through KMU-4, MB-11, MB-12A, MB-13, MB-14 and M-L2), three wells in the M Horizon (wells LC229W, LC606W, M-M1, M-M2 and M-M3), and one well in the N

Horizon (well LC33W).¹⁰ Of the above wells, the applicant reports sampling that occurred less than the recommended four sampling events for six wells (M-L2, LC229W, LC606W, M-M1, M-M3 and LC33W). The applicant provides figures displaying the distribution of three parameters (TDS, uranium and combined radium) in groundwater for the L, M and N horizons as well as piper diagrams.

The applicant concludes that the groundwater quality for the KM Horizon is relatively good with the exception of the presence of radionuclides. The radionuclides include uranium detected at or above EPA's MCL of 0.03 mg/L, combined radium concentrations detected at up to twice EPA's MCL of 5 pCi/L and gross alpha particle activity at up to five times the EPA's MCL of 15 pCi/L.¹¹ The applicant concludes that the groundwater quality for the L, M and N horizons is relatively good with the exception of radionuclides. The radionuclides include combined radium detected at up to eight times EPA's MCL and gross alpha particle activity of up to 10 times EPA's MCL. The applicant states that the elevated concentrations of radionuclides are consistent with the presence of uranium orebodies.

For the LCE Amendment, the applicant provides groundwater quality for the FG, HJ, KM, L and N horizons at three wells (wells M-FG1, M-FG2 and M-FG5), eight wells (wells M-HJ1, M-HJ2A, M-HJ3, M-HJ4, M-HJ5, M-HJ6, M-HJ7D and M-HJ8), eight wells (wells M-KM4A, M-KM5A, M-KM6 through M-KM10, and M-KM11A), three wells (M-L7, M-L9 and M-L11A), and five wells (M-N2, M-N3, M-N4, M-N5A and M-N6). The wells were sampled for four quarters except for the wells that were installed in the L Horizon during 2016. The applicant presents piper diagrams for the groundwater quality in the FG, HJ, KM, L, M, MN and N horizons.¹² The applicant concludes that the groundwater quality in all horizons at the LCE area is a calcium-sulfate to calcium-bicarbonate type which tends to be relatively good with the exception of the presence of radionuclides. The applicant states that the elevated concentrations of the radionuclides are consistent with the presence of uranium orebodies.

Staff reviewed the information provided by the applicant and finds it acceptable because the information is consistent with guidance in the SRP for background characterization except for wells M-N3, M-L7, M-L9 and M-L11A). For well M-N3, the applicant acknowledges that the groundwater quality from that well was not "representative of the aquifer." The NRC staff reviewed the quality and agrees that the levels (specifically pH) are not consistent with expected naturally occurring levels and thus the applicant needs to obtain proper quality for a background prior to major site construction. For wells M-L7, M-L9 and M-L11A, the applicant only submitted results of one quarter of sampling but committed to getting the data during 2017. The applicant has not submitted the 2017 data to NRC. Staff will include a license condition requiring the

¹⁰ In Table 2.7-15, the applicant lists well BLM(4451) as an N Horizon well while it was not discussed in the narrative. The applicant confirmed in the responses to RAIs that BLM's Battle Spring Draw Well No. 4451 (aka BLM(4451)) was shallower than the expected depth for an "N" Horizon well based on recent testing by Lost Creek.

¹¹ The applicant compared the report laboratory detection of gross alpha to the MCL. However, the laboratory measurement was by EPA Method 900 (LCI, 2018a), which would have included the activity due to uranium. For a proper characterization, the EPA MCL is gross alpha particle activity (excluding radon and uranium).

¹² The narrative does not describe a well as M/N wells (i.e., a well screened over multiple horizons). However, on Table D6.2-1, the applicant lists the completion zones as "M/N" for wells M-N2 and M-N3. The well completion report for M-N2 in Attachment D6-2 depicts the well screen straddling the designated "M" and "N" horizons whereas the well completion report for M-N3 depicts the well screen entirely within the "M" horizon.

applicant to complete four quarters of sampling at background wells located within the LCE area.

2.6.4 Evaluation Findings

The applicant described the background surface water and groundwater quality at the Amendment areas by providing appropriate chemical analyses of water samples taken from surface drainages and aquifers within and away from mineralized zones (for discussions of the radionuclides, see SER Section 2.7). The NRC staff finds the applicant's approach to water quality characterization consistent with that previously reviewed for the approved license application, as amended (NRC, 2011a). Furthermore, based on the review described above, the NRC staff concludes that the additional background information provided in the Amendment meets the applicable acceptance criteria of SRP Section 2.7.3, "Acceptance Criteria," and the requirements of 10 CFR Part 40, Appendix A, Criterion 7, provided fulfillment of the following license condition:

License Condition 12.16

Prior to major site construction in the Lost Creek East area, the licensee will complete the background characterization of groundwater at wells M-N3, M-FG2, MHJ1, M-L7, M-L9 and M-L11A. The background characterization for the L Horizon wells includes potentiometric head data to establish the seasonal variability.

2.7 Radiological Background Characteristics

In this SER Section, the NRC staff's evaluation is focused on the applicant's description of the background radiological characteristics at the LCE area. The applicant provides information on the background radiological characteristics of LCE in Section D10, "Background Radiation," of the LCE Amendment and the "Preamble" in the KM Amendment for the Lost Creek licensed area (LCI, 2017a). The collection of site-specific background radiological characterization information is part of the preoperational monitoring program.

Data from the preoperational monitoring program is used to evaluate the potential radiological impact of operations that could result from spills, routine discharges from operations, and other potential releases. Also, the collected preoperational information is used to identify a radiological background for decommissioning, restoration, and reclamation.

2.7.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the preoperational monitoring program provides baseline data in compliance with 10 CFR Part 40, Appendix A, Criterion 7.

2.7.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment was reviewed for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, and using the acceptance criteria presented in SRP Section 2.9.3, "Acceptance Criteria" (NRC, 2003a) and guidance contained in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980). Air monitoring stations are located in a manner consistent with the

principal wind directions, and soil sampling is conducted at both a 5-cm [2-in] depth and 15-cm [6-in] depth for background decommissioning data.

2.7.3 Staff Review and Analysis

The summary of background radiological data collected for LCE was provided in Section D10 of the LCE Technical Report and Section 3.12 of the LCE Environmental Report (LCI, 2017a). The preamble for the KM Amendment incorporates by reference Section 2.9 of the approved license application, as amended.

The applicable sections reviewed by staff in the current and previous applications, previous SER's and related documents are as follows:

Approved License Application	2.6, 2.9
SER	2.6
SER Amendment 4	All
KM and LCE Application	Section D10 (LCE Amendment) Tables D6.1-2, D6.1-3, D10-1, D10-2, and D10-3 Appendix D6 (LCE Amendment) Attachments D10-1 and D10-2 (LCE Amendment)
LCE Environmental Report	Section 3.12
RAI Responses	RAI-11, RAI-13, RAI-18
License SUA-1598	License Condition 12.9

2.7.3.1 Approved Background Radiological Data

In the SER for issuance of License SUA-1598 (NRC, 2011a), the NRC staff found that, except for one element in criteria (2), the background radiological data met the acceptance criteria in SRP Section 2.9.3 (NRC, 2003a) by providing monitoring data that includes sampling frequency, sampling methods, and sampling location and density in accordance with preoperational monitoring guidance provided in Section 1.1 of Regulatory Guide 4.14 (NRC, 1980). The NRC staff found that the applicant provided adequate justification for not conducting radon flux monitoring, analysis of dissolved Ra-226 in surface water samples, and game, crop, and fish sampling during preoperational monitoring. The acceptance criteria element that was not met pertained to the collection of a subset of baseline soil samples. Although the applicant collected representative baseline soil samples, it did not collect soil samples that were co-located with air monitoring stations, as recommended by Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980). Therefore, to completely comply with 10 CFR 40, Appendix A, Criterion 7, the staff imposed License Condition 12.9 requiring subsequent submittal of a radiological monitoring program report that included soil samples co-located with air particulate samples prior to any major site construction.

Following issuance of the license, the licensee collected surface soil samples at five air monitoring stations in the approved monitoring program and submitted a report that summarized the results of soil sampling at those locations (LCI, 2013). Although License Condition 12.9 has not been removed from the license, the NRC staff notes that the licensee met the requirement

for submittal of a radiological monitoring program report that included soil samples co-located with air particulate samples, in accordance with License Condition 12.9 and that the submittal of the data fulfill the guidance. The NRC approved removal of this license condition in Amendment 7 of the license (NRC 2018d).

2.7.3.2 KM Amendment

The “Preamble” section of the KM Amendment (LCI, 2017a) states that Section 2.9, “Background Radiation,” of the approved license application, as amended, is incorporated by reference without change. Also, this section states that a new MILDOS-AREA calculation considers production from mine units located within the Lost Creek licensed area and LCE area. The NRC staff agrees that additional background radiological characterization is not necessary for the KM Amendment because the proposed mine units are located within the Lost Creek licensed area, which was reviewed previously by the NRC staff (NRC, 2011a). The NRC staff considers background radiological characterization information approved by the existing license, as amended, is applicable to the KM Amendment, and therefore meets Acceptance Criterion 2.9.3 of the SRP (NRC, 2003a). The NRC staff evaluation of the new MILDOS-AREA calculations that takes into account the mine unit production schedule for the KM and LCE Amendments is covered in SER section 5.7.7.

2.7.3.3 LCE Amendment

The applicant provided information on background radiological characteristics for LCE in Section D.10, “Background Radiation” of the LCE Amendment (LCI, 2017a). The applicant measured radionuclide concentrations in the following environmental media: air, soil, sediment, groundwater and surface water. The applicant’s measurements of radionuclides in air included both particulate matter radionuclides and gaseous radon-222. The applicant also assessed gamma radiation levels in the LCE area by taking instantaneous measurements of radiation exposure rates in air and quarterly measurements of total radiation exposure. The applicant evaluated the location of monitoring stations for the LCE area (LCI, 2017c), as recommended by Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills” (NRC, 1980).

The NRC staff reviewed the background radiological characteristics described in Section D10 of the LCE Amendment and supplemental information provided by the applicant. The NRC staff review included the following information on background radiological characteristics at the LCE area:

1. Air sampling;
2. Direct radiation monitoring;
3. Soil sampling;
4. Sediment, groundwater, and surface water sampling; and,
5. Updated MILDOS-AREA calculations to aid in the selection of monitoring station locations.

2.7.3.3.1 Air Sampling (Particulate and Radon-222)

As part of its preoperational monitoring program, the applicant sampled particulate matter radionuclides (uranium, thorium-230, radium-226 and lead-210) and radon-222 at or near the LCE site boundary. The applicant shows locations of the radon and air particulate samplers in Figure D4-6, “Radon, Passive Gamma and Radiological Air Particulate Sampling Locations” of

the LCE Amendment (LCI, 2017a). The sampling method (e.g., description of air sampling equipment), sampling locations, and radiological background results for the Lost Creek licensed area (LCI, 2010) were previously reviewed and found acceptable by the NRC staff (NRC, 2011a).

Air particulate samplers HV-1, HV-2, HV-3, HV-4, HV-5, and HV-6 are co-located with radon track-etch detectors PR-1, PR-5, PR-2, PR-10, PR-3 and PR-13, respectively. As shown in Figure D4-6, "Radon, Passive Gamma and Radiological Air Particulate Sampling Locations," the applicant's air samplers for the LCE area were located as follows:

- HV-1/PR-1: Outside the LCE area, 18 km [11 mi] northeast of the LCE area
- HV-2/PR-5: Inside the Lost Creek licensed area, near the northern boundary
- HV-3/PR-2: At the southwest corner of the Lost Creek licensed area
- HV-4/PR-10: At the western boundary of the LCE area / eastern boundary of the Lost Creek licensed area
- HV-5/PR-3: At the northwest corner of the Lost Creek licensed area
- HV-6/PR-13: At the eastern boundary of the LCE area

According to the applicant (LCI, 2017c), the locations of these monitoring stations were selected based on the recommendations in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980). To evaluate the locations of the monitoring stations, the NRC staff examined the wind roses presented in Figure D4-3, "Wind Speed and Wind Direction at Lost Creek," in Section D4, "Meteorology," of the LCE Amendment (LCI, 2017a), the meteorological data set approved by Amendment 6 (NRC, 2018b), and a joint frequency distribution in Appendix B, "Lost Creek Joint Frequency Distribution (2012-2014)," of Lost Creek letter dated March 4, 2016 (LCI, 2016e). The wind roses and joint frequency distribution are from the approved meteorological data set acquired from the on-site meteorological station. The wind roses and joint frequency distribution indicate the predominant wind directions are from the west to south-southwest (i.e., 46.8% of the time, as compared to <5.9% from any other wind direction), with an average annual wind speed of approximately 5 m/s [16 ft/s]. The predominant atmospheric stability category is Class D (i.e., 60.1% of the time, as compared to <9.2% from any other atmospheric stability category), which is indicative of relatively stable atmospheric conditions.

Based on local meteorological conditions, three monitoring stations are located upwind of the LCE area, near the north (HV-2/PR-5), northwest (HV-5/PR-3), and west (HV-4/PR-10) site boundaries. One monitoring station is located downwind of the LCE area, at the eastern site boundary (HV-6/PR-13). A fifth monitoring station (HV-1/PR-1) is located approximately 18 km [11 mi] from the northeast boundary of the LCE area, which is approximately 24 km [15 mi] from central processing plant, in the town of Bairoil, Wyoming. According to the applicant, air monitoring station HV-1/PR-1 is at the location of the nearest resident downwind from the LCE area (LCI, 2017c). A sixth monitoring station (HV-3/PR-2) was installed upwind from the LCE area, at the southwest corner of the Lost Creek licensed area, to serve as a control or background location for the Lost Creek licensed area and the LCE area. It is located generally between the nearby Sweetwater Uranium Mill guard trailer, and the southern boundary of the Lost Creek licensed area and LCE area. The Sweetwater Uranium Mill is located upwind of the Lost Creek licensed area and LCE area, and within 10 km [6 mi] of the nearest wellfield of the Lost Creek licensed area. Winds from the northeast, toward the Sweetwater Uranium Mill guard trailer from the LCE area, occur infrequently (i.e., 4.9%) on an annual basis. The NRC staff finds that the location of monitoring station HV-3/PR-2 is located appropriately for sampling airborne

particulates and radon from the Lost Creek licensed area and the LCE area when winds are infrequently from the northeast direction.

The NRC staff finds that the locations of these monitoring stations acceptable because they meet the criteria in Regulatory Position C.1.1.1, "Air Samples," of Regulatory Guide 4.14, for a minimum of three locations at or near the site boundary, one location near a residence, and one remote location representing background conditions.

The NRC staff evaluated the preoperational sample results from air monitoring station HV-6/PR-13, which the applicant provided in Section D10 of the LCE Amendment (LCI, 2017a). The applicant reported particulate matter sample results and radon-222 concentrations for five quarters (October 2012 through March 2014) in Table D10-2, "High Volume Air Sampling Results," and Table D10-3, "Radon Track Etch Cup Results." The particulate matter samples were assayed for natural uranium, thorium-230, radium-226, and lead-210. The radon track etch samples were assayed for radon-222. In response to the NRC staff's RAI-11 (NRC, 2017d), the applicant provided updated information on the minimum detectable activity of air sampling results for natural uranium listed in Table D10-2 (LCI, 2017c).

The NRC staff reviewed particulate matter samples results and radon-222 concentrations acquired from the five monitoring stations included in the operational monitoring program. For each year of operation, the radionuclide concentrations in air particulate samples were comparable to background radiation levels. Gaseous radon-222 was measured using track etch detectors, which showed that radon-222 concentrations in air were consistent with background levels. Overall, the data acquired from the six air monitoring stations did not indicate a trend of increasing radiation levels.

The NRC staff found the number of air samples and locations of the monitoring stations acceptable because it is consistent with Regulatory Position C.1.1.1, "Air Samples," of Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980), which states the minimum preoperational samples should be four quarters at three locations at or near the site boundary, one location near a residence or occupiable structure, and another at a remote location that represents background. Based on the review described above, the NRC staff concludes that the information provided in the LCE Amendment meets Acceptance Criterion 2.9.3 of the SRP (NRC, 2003a).

2.7.3.3.2 Radon Flux Monitoring

Regulatory Guide 4.14 (NRC, 1980) recommends that radon flux measurements be conducted at eight locations within 1.5 km [0.9 m]) of the site. Radon flux measurements evaluate radon emitted per unit area per time, such as radon emitted from a tailings impoundment. For the Lost Creek licensed area, the NRC staff previously concluded that the applicant is not required to collect radon flux measurements to comply with 10 CFR Part 40, Appendix A, Criterion 7 because of the lack of a tailings impoundment and that any residues that may accumulate in the site's liquid waste storage ponds will be disposed offsite in compliance with regulatory requirements (NRC, 2011a). Similarly for the LCE area, the NRC staff concludes that radon flux measurements are not required because there are no tailing impoundments or liquid waste storage ponds planned at the LCE area.

2.7.3.3.3 Vegetation, Food, and Fish Sampling

Regulatory Position C.1.1.3, "Vegetation, Food and Fish Samples," in Regulatory Guide 4.14

recommends the collection of three vegetation samples, three food samples of each type (crops, livestock, etc.) within 3 km [1.9 mi] of the site, and fish samples from each body of water. The samples should be analyzed for natural uranium, radium-226, thorium-230 and lead-210 (NRC, 1980). As noted in the NRC's SER for the Lost Creek licensed area (NRC, 2011a), the applicant developed a background sampling program that is modified from the guidance in Regulatory Guide 4.14. For the modified background sampling program, the NRC staff found it was not necessary to obtain samples of fish, crop, or game animals in the Lost Creek licensed area (NRC, 2011a).

Regarding preoperational vegetation sampling, Regulatory Position C.1.1.3 in Regulatory Guide 4.14 (NRC, 1980) recommends sampling of forage vegetation in three sectors having the highest predicted airborne radionuclide concentration due to milling operations. The NRC staff found that the preoperational vegetation sampling for the Lost Creek licensed area was acceptable, based on sampling vegetation from seven locations predicted to have the highest airborne radionuclide concentrations due to milling operations, according to MILDOS-AREA calculations (NRC, 2011a). For the LCE area, the applicant did not collect vegetation samples because the applicant states that the highest predicted airborne radionuclide concentrations are expected to be in the same location that was analyzed for the Lost Creek licensed area, which is the immediate vicinity of the central processing plant (LCI, 2017c). However, the applicant did not compare the results of MILDOS-AREA modeling performed for the Lost Creek licensed area (LCI, 2010) with those performed for the LCE area (LCI, 2018a) to determine whether there are changes in the locations of the highest predicted airborne radionuclide concentration due to operations. Although the applicant did not provide this information, the applicant has committed to perform a comparison of MILDOS-AREA modeling for the Lost Creek licensed area and LCE area and collect additional vegetation samples if the results of the comparison show a change in the location of the highest predicted airborne radionuclide concentration (LCI, 2018a, 2018d). The NRC staff finds the applicant's proposal of collecting additional vegetation samples consistent with Regulatory Guide 4.14 acceptable, if the revised MILDOS-AREA modeling for the LCE Amendment shows a change in the location of the highest predicted airborne radionuclide concentration. The NRC staff will include these commitments as a license condition, as discussed in Section 2.7.4.

Regarding food sampling for the Lost Creek licensed area, the NRC staff found that the collection and analysis of preoperational beef samples was consistent with the food sampling recommended in Regulatory Guide 4.14 (NRC, 2011a). For the LCE area, Section D.1.2, "Wildlife Habitat and Hunting" of the LCE Amendment states that the Wyoming Game and Fish Department hunting areas for antelope, deer, elk, and mountain lion are included in the LCE area (LCI, 2017a). The applicant stated that BLM and State of Wyoming lands surrounding LCE are open to hunting, and although there has been a slight increase in elk and pronghorn in the region, there is little hunting nearby due to a lack of game animals. The applicant also stated that beef represents a better food sample and more likely to be in the pathway-to-man than game wildlife (LCI, 2018d). The NRC staff previously concluded that the justification for not collecting game animals in the Lost Creek licensed area was acceptable. This remains acceptable for the LCE Amendment because neither large nor small game are hunted to any extent in the LCE area, and that livestock samples are better food samples and more likely to be in the pathway-to-man.

In 2008 and 2009, the applicant collected samples of bone, liver, kidney, and meat (muscle tissue) from cattle with access to grazing fodder within 3 km [1.9 m]) of the central processing plant, and analyzed the samples for natural uranium, radium-226, thorium-230, lead-210, and

polonium-210 (LCI, 2010). The NRC staff found that the applicant collected and analyzed preoperational beef samples consistent with the food sampling recommended in Regulatory Guide 4.14 because LCI collected more than three livestock food samples. The NRC staff concluded that the applicant collected vegetation that could also be foraged by livestock or game that may be consumed by humans, and therefore, potentially in the pathway-to-man. The NRC staff found the applicant's baseline livestock sampling acceptable and consistent with acceptance criterion (1) in SRP Section 2.9 (NRC, 2011). This remains acceptable for the LCE Amendment because there has not been a change in cattle grazing or wildlife at the Lost Creek licensed area or LCE area since the previous sampling and analyses were conducted (LCI, 2018d).

The applicant states in Section D9-4.10, "Fish and Aquatic Life," of the LCE Amendment, that there are no fish or other aquatic life known to occur in LCE (LCI, 2017a). Also, the applicant confirmed it did not collect preoperational fish samples because there are no fish in the LCE area (LCI, 2017b). In Section D.1.1, "Rangeland Grazing," of the LCE Amendment, the applicant states there is no crop production in the LCE area or within 3.2 km [2 mi] of the LCE area (LCI, 2017a). The NRC staff previously concluded that the justification for not collecting fish and crop samples in the Lost Creek licensed area was acceptable. This remains acceptable for the LCE Amendment because there remain no crop land nor nearby surface waters that contain fish or other aquatic life in the LCE area.

The NRC staff concludes that the preoperational food sampling conducted for the Lost Creek licensed area is applicable to the LCE Amendment, and therefore meets Acceptance Criterion 2.9.3 of the SRP (NRC, 2003a).

2.7.3.3.4 Direct Radiation Monitoring

Regulatory Guide 4.14 recommends that gamma radiation measurements should be made with passive integrating devices, pressurized ion chambers, or properly calibrated portable survey instruments. The NRC previously evaluated the licensee's methods for direct radiation monitoring (LCI, 2010) and found these methods acceptable (NRC, 2011a). In Section D10, "Background Radiological Characteristics" of the LCE Amendment (LCI, 2017a), the applicant summarized the characterization of background radiation in the LCE area, which consisted of two components. The first component was ambient gamma dose rate monitoring using optically stimulated luminescence dosimeters (OSLs), a type of passive integrating device that is recommended in Regulatory Position C.1.1.5, "Direct radiation," in Regulatory Guide 4.14. (NRC, 1980). The applicant measured pre-operational ambient gamma dose rates at six locations shown in Figure D4-6, "Radon, Passive Gamma and Radiological Air Particulate Sampling Locations," of the LCE Amendment (LCI, 2017a), which are the same locations as the air monitoring stations discussed in SER section 2.7.3.3.1. Table D10.1, "Direct Gamma Using OSL Badges," of the LCE Amendment (LCI, 2017a) summarizes ambient gamma dose rates measured at location HV-6.PR-13. The dose rates ranged from 15 mrem per quarter to 30 mrem per quarter from October 2012 to March 2014.

The NRC staff evaluated direct radiation measurements acquired from the five other monitoring stations in its analysis of the operational monitoring program. For each year of operation, measurements of direct radiation were made at each monitoring station with either a passive radiation dosimetry badge or a radiological survey meter with a sodium iodide (NaI) detector, and were found to be comparable with background radiation levels. The dose rates typically ranged from 10 mrem per quarter to 30 mrem per quarter from years 2012 to 2017. Direct radiation measurements made at air monitoring station HV-4/PR-10, at the western boundary of

the LCE area and eastern boundary of the Lost Creek licensed area, were consistently slightly higher than direct radiation measurements acquired at the other monitoring stations, ranging from 19 mrem per quarter to 44 mrem per quarter. The applicant attributes the slightly higher readings at monitoring station HV-4/PR-10 to mineralization trends in the area (LCI, 2018e).

The second component to characterize preoperational gamma radiation levels in the LCE area used an alternative approach to the direct radiation survey method described in Regulatory Position C.1.1.5, "Direct Radiation," in Regulatory Guide 4.14 (NRC, 1980), which recommends 80 gamma exposure rate measurements in a radial grid pattern. Attachment D10-1, "Baseline Radiological Survey Report," of the LCE Technical Report (LCI, 2017a) describes the alternative survey method used by the applicant to characterize background radiation levels during year 2012. The applicant acquired 126,229 gamma exposure rate measurements over land surfaces using Ludlum 44-10 two-inch NaI detectors with 2350-1 dataloggers, paired to a global positioning system (GPS), and installed on off-highway vehicles (OHVs). The applicant cross-calibrated the NaI detectors with high-pressure ionization chambers (HPICs) to allow a comparison of preoperational data with data obtained later without relying on identical NaI detectors. This alternative survey method is similar to the survey method the NRC staff found acceptable for preoperational characterization of the Lost Creek licensed area the applicant conducted in year 2006 (NRC, 2011a).

The applicant provided gamma exposure rate maps, based on NaI detector measurements, in Figure 9, "Lost Creek East Gamma Exposure Rate Map," and Figure 10, "Lost Creek East Kriged Gamma Exposure Rate Map," in Attachment D10-1 of the LCE Technical Report (LCI, 2017a). The applicant correlated NaI detector measurements acquired at the LCE area in 2012 with Lost Creek licensed area survey data acquired from NaI and HPIC radiation detectors in 2006. HPIC-equivalent results are shown in Figure 11, "Lost Creek East HPIC Equivalent Kriged Gamma Exposure Rate Map," of the Technical Report (LCI, 2017a). The applicant converted the 126,299 gamma exposure rate measurements to estimated radium-226 soil concentrations, which are shown in Figure 12, "Lost Creek East Kriged Ra-226 Soil Concentration Map," in Attachment D10-1 of the LCE Amendment (LCI, 2017a).

Although the applicant used the same NaI radiation detectors and data loggers for the 2006 and 2012 preoperational characterization surveys conducted at the Lost Creek licensed area and LCE area, respectively, the NaI detectors were installed in a different configuration on the OHVs for the LCE area survey. The change in installation geometry of the NaI detectors led to differences in instrument response between the 2006 and 2012 surveys. In response to NRC staff RAI-11 (NRC, 2017d), the applicant stated that the 2012 survey did not include collection and analysis of surface soil samples, subsurface soil samples, sediment samples or cross-calibrations between NaI and HPIC measurements acquired in the LCE area (LCI, 2018a). The applicant analyzed results of surveys performed at the same 2.2-hectare (5.6-ac) land area located in the eastern area of the Lost Creek licensed area, near the western boundary of the LCE area, to normalize the results of the two surveys. The applicant analyzed NaI detector responses at the same location and determined that the 2006 measurements were 13.8% higher than the 2012 measurements. The applicant attributes the difference between the two data sets to changes in the installation geometry of the NaI detectors on the OHVs, including a shorter distance between the NaI detector and ground surface, the orientation of the NaI detectors, and shielding of the OHV in the NaI detector field of view.

The applicant has committed to review the 2012 survey data to identify locations for collecting additional soil samples to further characterize the preoperational radiological background in the LCE area (LCI, 2018a). Also, the applicant has committed to comparing the results of the

additional soil sampling and analyses to the results obtained from the OHV gamma scan survey (LCI, 2018d). The NRC staff finds the applicant's analysis of the differences in exposure rate measurements, combined with the applicant's proposed comparison of OHV gamma survey scan data with additional preoperational soil sampling results, acceptable for the purpose of characterizing preoperational gamma exposure rates in the LCE area. The NRC staff will include these commitments in a license condition, as discussed in SER Section 2.7.4.

The NRC staff finds that the applicant collected a large number of samples (i.e., 126,229) during the OHV gamma survey, exceeding the 80 samples recommended in Regulatory Guide 4.14 (NRC, 1980). Also, the sample devices (i.e., NaI detectors) are of a type approved for this purpose in Regulatory Guide 4.14 (NRC, 1980). The applicant collected a sufficient number of gamma survey measurements to characterize the LCE area and thereby demonstrate compliance with establishing baseline direct radiation readings within the LCE area. Based on its review of the information provided by the licensee, as supplemented by information to be collected or commitments included in the above license condition, the staff accepts the applicant's characterization of direct radiation in the LCE area.

Regarding the extrapolation of gamma exposure rates to estimate radium-226 concentrations in surface soil, the NRC staff finds the applicant's analysis for the LCE area consistent with the NRC staff's previous analysis for the Lost Creek licensed area (NRC, 2011a). Also, the NRC staff finds that the applicant provided an analysis of gamma exposure rates in Attachment D10-1, "Baseline Radiological Survey Report," of the LCE Amendment (LCI, 2017a), but did not provide information on correlations between direct gamma measurements using NaI detectors with natural uranium, thorium-230 or lead-210 in surface or subsurface soils. The NRC staff's evaluation of the applicant's characterization of background concentrations of natural uranium, thorium-230 and lead-210 in soil is provided in the next section of this SER.

2.7.3.3.5 Soil Sampling

the SRP, Acceptance Criterion 2.9.3(2), states: "Soil sampling is conducted at both a 5-cm (2-inch) depth as described in Regulatory Guide 4.14, Section 1.1.4 (NRC, 1980) and 15-cm (6-inch) depth for background decommissioning data." Regulatory Position C.1.1.4, "Soil and Sediment Samples," in Regulatory Guide 4.14 recommends the collection of 40 surface soil samples in a radial pattern, plus one surface sample at each of five air sample locations. All surface soil samples should be analyzed for radium-226, and ten percent of surface soil samples should be analyzed for natural uranium, thorium-230 and lead-210. Also, Regulatory Guide 4.14 recommends the collection of 5 subsurface soil samples to a depth of one meter, with all samples analyzed for radium-226 and one sample analyzed for natural uranium, thorium-230 and lead-210.

The NRC staff evaluated the results of annual soil sampling at the locations of the air monitoring stations that were used for preoperational characterization of the LCE area. Beginning in 2014, soil sampling was conducted annually at each of the air monitoring stations, except for monitoring station HV-6/PR-13, which was sampled once in 2016 (LCI, 2018d). The NRC staff found the applicant's collection of soil samples at air monitoring stations consistent with preoperational monitoring program guidance contained in Regulatory Position C.1.1.4 in Regulatory Guide 4.14 (NRC, 1980). Also, the NRC staff found that radionuclide concentrations in soil samples at all air monitoring stations were comparable to background radiation levels.

Section 2.9.1 of the original Lost Creek Technical Report describes soil sampling conducted in support of the preoperational monitoring program for the Lost Creek licensed area (LCI, 2007).

Information on soil sampling at 5-cm [2-in], 15-cm [6-in], or 1-meter [39-in] depths within the LCE area is not included in the LCE Amendment (LCI, 2017a). Also, as noted above, the applicant's analysis of gamma exposure rates in Attachment D10-1, "Baseline Radiological Survey Report," of the LCE Amendment (LCI, 2017a) did not correlate direct gamma measurements using NaI or HPIC detectors with natural uranium, thorium-230 or lead-210 in surface or subsurface soils for the LCE area.

In response to the NRC staff's RAI-11 (NRC, 2017d), the applicant proposed an alternative preoperational soil sampling program for the LCE area that consists of the following sample collection and analyses, taking into account the results of the gamma scans with OHVs acquired during year 2012 (LCI, 2018a). In Figure 6, "Proposed Soil Sample Locations," the applicant identified locations for additional soil sampling throughout the LCE area. The applicant proposes to collect 14 surface soil samples at locations of elevated naturally occurring radioactivity levels, and three surface soils samples at locations of lower naturally occurring radioactivity levels, based on gamma radiation measurements acquired from the 2012 surveys. Five of the 14 surface soil samples would be analyzed for radium-226, natural uranium, thorium-230 and lead-210, and 11 surface soil samples would be analyzed for radium-226 only. The NRC staff finds that the proposed number of surface soils samples to be collected and analyzed for radium-226, natural uranium, thorium-230 and lead-210 (a total of five surface soil samples) is higher than the four samples recommended in Regulatory Guide 4.14. The NRC staff finds that the proposed number of surface soils samples to be collected and analyzed for radium-226 only (a total of 17 surface soil samples) is lower than the 40 surface soil samples recommended in Regulatory Guide 4.14. The NRC staff considers the reduced number of surface soils collected and analyzed for radium-226 acceptable, given the very large number of measurements that were collected and correlated to radium-226 concentrations in surface soils during the 2012 survey of the LCE area.

The applicant proposed to collect five subsurface (1-meter [39-in] depth) soils samples at locations within the LCE area, as shown in Figure 6, "Proposed Soil Sample Locations." Two subsurface soils would be analyzed for radium-226, natural uranium, thorium-230 and lead-210, and three samples would be analyzed for radium-226 only. The NRC staff finds that the total number of proposed subsurface soil samples is consistent with Regulatory Guide 4.14, and the analyses of two subsurface soils for radium-226, natural uranium, thorium-230 and lead-210 is higher than the one sample recommended for the collection and analysis of subsurface soil samples. The NRC staff finds the applicant's proposed collection and analysis of additional surface and subsurface soil samples from specific locations, based on the applicant's analysis of the OHV gamma survey data, acceptable because it meets Regulatory Guide 4.14 (NRC, 1980).

The NRC staff finds that the applicant has not provided complete baseline soil sampling data for the LCE area, in accordance with Acceptance Criterion 2.9.3(2) of the SRP (NRC, 2003a). As noted in this section and SER Section 2.7.3.3.4, the applicant has committed to review the 2012 OHV gamma survey data to identify locations for collecting additional soil samples to further characterize the preoperational radiological background in the LCE area (LCI, 2018a), and then compare the results of the soil sample analyses to the results obtained from the OHV gamma scan survey (LCI, 2018d). The NRC staff will include these commitments in a license condition, as discussed in Section 2.7.4.

2.7.3.3.6 Sediment Sampling

Regulatory Position C.1.1.4, "Soil and Sediment Samples," in Regulatory Guide 4.14 (NRC, 1980) recommends sediment sampling at two locations in each surface water location (e.g., streams, rivers, drainages) crossing the site boundary, and any offsite areas that may be subject to direct runoff from potentially contaminated areas. For the Lost Creek licensed area, the applicant collected and analyzed sediments at upstream and downstream permit boundaries of the Lost Creek licensed area and at the Crooked Well Reservoir, which was found to be acceptable in the SER for the Lost Creek licensed area (NRC, 2011a). For the LCE Amendment, the applicant installed four additional storm water and snow melt samplers to capture runoff as it enters the LCE area from the upstream side, and four additional samplers to capture runoff at the downstream LCE area boundary. According to the applicant, the sampling locations were selected based on their topographic potential to concentrate ephemeral surface flow (LCI, 2017a). The location of the samplers are shown in Figure D6.1-3, "Storm Water and Snow Melt Sample Locations," of the LCE Amendment (LCI, 2017a). In response to the NRC staff RAI-11 (NRC, 2017d), the applicant committed to collecting two rounds of sediment samples in years 2017 and 2018 from surface water sample locations within the LCE area, as shown in Figure D6.1-3 (LCI, 2017c). The NRC staff finds the applicant's proposed number of sediment samples and the sediment sample collection times acceptable because they meet the guidance in Regulatory Guide 4.14 (NRC, 1980).

The applicant states that there are two ponds located with LCE (LCI, 2017c). The first pond is located at the northwest-southeast quarter of Section 10, T25N R92W, and is fed by BLM Boundary Well No. 4775. The applicant states that sediment sampling from this pond is not planned because there are no wellfields, pipelines or other infrastructure that could drain into this pond, and it is constructed on a hillside with very little drainage area. The second pond is located at the northeast-northwest quarter of Section 21, T25N R92W, and is fed by a small drainage channel and BLM Well No. 4451. The applicant stated that sediment samples were collected from this location in year 2017, and an additional sample will be collected in year 2018 (LCI, 2018a). The applicant stated that it will perform an additional round of sediment sampling at a pond located at the northeast-northwest quarter of Section 21, T25N R92W, and measure baseline radionuclide concentrations of uranium, lead-210, radium-226, and thorium-230, in accordance with guidance in Regulatory Guide 4.14 (NRC, 1980).

The NRC staff finds the applicant's proposed preoperational sediment sampling program acceptable because the applicant plans to collect additional sediment samples upstream and downstream of proposed wellfields in ephemeral streams inside the LCE area, and submit a report to the NRC that documents the additional round of sediment sampling. The submittal of a report that documents the results of the applicant's proposed sediment sampling program will be included in a license condition, as discussed in Section 2.7.4.

2.7.3.3.7 Groundwater Sampling

The NRC staff's evaluation of the licensee's assessment of groundwater and surface water quality in background samples is provided in SER Section 2.5. For this section, the NRC staff evaluated the licensee's description of background radiological groundwater sample locations, frequency, and types of radiological analyses, as described in Section 2.78.4 of the KM Amendment and Section D6.4 of the LCE Amendment.

The applicable Regulatory Guide 4.14 guidance for pre-operational (background) radiological groundwater characterization is focused on samples collected downgradient of mill tailings

disposal areas and does not specifically address ISR facilities. However, the applicant characterized groundwater from 22 on-site wells throughout the Lost Creek licensed area (seven wells in the UKM Horizon, nine wells in the M Horizon and six wells in the M or N Horizon), and 26 on-site wells throughout the LCE area (three wells in the FG, seven wells in the HJ Horizon, eight wells in the KM Horizon, three wells in the L Horizon, and five wells in the N Horizon). The licensee collected two to five samples from each well between 2009 and 2016, generally on a quarterly basis for each well. The parameters analyzed consist of radium-226, radium-228, gross alpha, gross beta, and natural uranium, and for samples from the LCE area, polonium-210, lead-210 and thorium-230.

The applicant has collected background samples from four BLM stock water wells located within 2 km [1.2 mi] of the Lost Creek licensed area, as part of the approved license application, as amended. The licensee has been collecting samples for the wells as part of the operational monitoring program. No additional wells are located within 2 km [1.2 mi] of the LCE area.

The NRC staff finds the types of radiological analyses performed for these samples acceptable because natural uranium and radium isotopes are the primary soluble contaminants resulting from operation of an ISR wellfield, and gross alpha and gross beta analyses establish overall radiological conditions. The distribution of wells both horizontally and vertically, yield representative samples of the subsurface horizon. However, the applicant failed to collect four quarterly samples from the following: Lost Creek licensed area (M-L2, LC229W, LC606W, M-M1, M-M3 and LC33W); LCE area (M-FG2, MHJ1, M-N3, M-L7, M-L9 and M-L11A). Because the applicant withdrew the KM mine units in the Lost Creek licensed area, the NRC staff will include a license condition requiring completion of the sampling at wells M-FG2, MHJ1, M-N3, M-L7, M-L9 and M-L11A (see SER Section 2.6.4)

2.7.3.3.8 Surface Water Sampling

The NRC staff's evaluation of the applicant's assessment of surface water quality in pre-operational samples is provided in SER Section 2.6.4. For this section, the NRC staff evaluated the applicant's description of background radiological surface water sample locations, frequency, and types of analyses. Section C.1.1.2, "Water Samples," in Regulatory Guide 4.14 (NRC, 1980) recommends surface water sampling at site locations that include large permanent onsite water impoundments, such as a pond or lake, offsite impoundments that could be subject to direct surface drainage from potentially contaminated areas, surface waters, drainage systems crossing the site boundary, and surface waters that could be subject to drainage from potentially contaminated areas. Surface water samples are to be collected as a grab sample on a monthly and quarterly basis for water impoundments and drainage systems, respectively, and analyzed for suspended and dissolved natural uranium, radium-226, thorium-230, lead-210 and polonium-210 at specific intervals.

In Section D6-1, "Surface Water," of the LCE Amendment (LCI, 2017a), the applicant describes surface water drainage characteristics at the LCE area. The applicant states that annual runoff is very low due to a high infiltration capacity and low annual precipitation, and that channels are dry for the majority of the year except during spring snowmelt, when soil moisture is variable and at a maximum for the year. According to information contained in Section D6-1 of the LCE Amendment (LCI, 2017a), insufficient surface water was available to conduct a complete analysis for all radionuclides recommended in Regulatory Guide 4.14 (NRC, 1980). The applicant states that surface water runoff events are relatively rare, short-lived and usually contain small quantities of water (LCI, 2017c).

As discussed in SER Section 2.7.3.3.6, the applicant installed eight storm water and snow melt samplers to capture runoff as it enters and leaves the LCE area. The applicant states that the sampler locations were chosen based on their topographic potential to concentrate ephemeral surface flow, and are shown in Figure D6.1-3, "Storm Water and Snow Melt Sample Locations," of the LCE Technical Report (LCI, 2017a). The results of storm water and snow melt sampling during year 2013 from six of the eight samplers are summarized in Table D6.1-3, "2013 Water Quality Results for Storm Water/Spring Snow Melt Samplers," of the LCE Amendment (LCI, 2017a). The radionuclides analyzed in surface water samples include natural uranium, radium-226, and thorium-230, but not lead-210. The applicant states there was an insufficient quantity of water collected to analyze for lead-210, but the applicant will attempt to collect surface water samples during year 2018 with sufficient quantity to include lead-210 in the analyses (LCI, 2017c).

The results of the surface water sample analyses show that dissolved uranium was present in only one sample at a very low concentration near the detection limit, and suspended uranium was detected in six of eight samples at concentrations ranging from 0.024 to 0.106 mg/L. Dissolved radium-226 and thorium-230 were detected in all samples, ranging from 0.11 to 5.1 pCi/L, and 0.08 to 0.4 pCi/L, respectively. Suspended radium-226 and thorium-230 were present in all samples, ranging from 0.001 to 105 pCi/L and 0.006 to 47.8 pCi/L, respectively. The applicant did not provide an explanation of the variability of the sample results.

The NRC staff finds the results meets the guidance in Regulatory Guide 4.14 because of the ephemeral nature of the streams. The NRC staff acknowledges that the surface water samples of good quality were collected during the spring and likely represents spring run-off. The samples collected in autumn had poorer water quality, reflecting lower water flows and possibly high sediment load. Based on this variability, the applicant will have difficulty in establishing a background radiological baseline for an analysis of future impacts.

The applicant stated that it did not attempt to collect samples from the discharge of stock ponds since the only stock pond that could potentially be affected by operations is located adjacent to BLM Battle Spring Draw Well No. 4451. The applicant stated that storm water and snow melt sampling station SS-8 is located downstream of this stock pond (LCI, 2017c). The water in this stock pond was sampled and the results were added to Attachment D6-3 of the LCE Amendment (LCI, 2017a). Because surface water in the stock pond near station SS-8 is only direct flow following significant storm/snow melt event, the NRC staff considers the pond not to meet the description of a "large permanent onsite water impoundment" and thus finds not sampling that pond by the applicant reasonable.

Based on the information provided in the LCE Amendment and supplemental information provided by the applicant, the NRC staff finds that the surface water sampling is consistent with Regulatory Position C.1.1.2 in Regulatory Guide 4.14 (NRC, 1980), and the preoperational surface water sampling and analysis acceptable.

2.7.4 Evaluation Findings

Staff reviewed the background radiological characteristics of the LCE area in accordance with applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, and the acceptance criteria presented in SRP Section 2.9.3, "Acceptance Criteria" (NRC, 2003a) and guidance contained in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980).

Except as noted below, the applicant has acceptably established background radiological characteristics in the LCE area by providing monitoring programs that include: (i) radionuclides monitored, sampling frequency, and methods, location, and density; (ii) air monitoring stations located consistent with the prevailing wind directions; and (iii) time periods for preoperational monitoring that allow for 12 consecutive months of sampling. The applicant has acceptably established the background radiological characteristics of ground water and surface water quality by providing ground water and surface water monitoring programs to determine background radiological characteristics that include radionuclides monitored, sampling frequency, and methods, location, and spatial coverage of the license area. The applicant has acceptably collected soil samples at the locations of air monitoring stations, and has committed to performing additional sampling of surface and subsurface soils, and comparing soils sample results with OHV scan surveys results as an additional quality assurance measure of the direct radiation surveys conducted in the LCE area. The applicant has also committed to collecting additional sediment samples and, based on a comparison of results of MILDOS-AREA modeling for the Lost Creek licensed area and LCE area, additional vegetation samples if the comparison shows a change in the location of the highest predicted airborne radionuclide concentration due to operations.

Based on the information provided by the applicant, and the detailed review conducted by the staff as indicated in SER Section 2.7.3, the staff concludes that the information is consistent with the applicable acceptance criteria of SRP Section 2.9.3 and the requirements of 10 CFR 40, Appendix A, Criterion 7, except for following items:

License Condition 12.17

Prior to major site construction in the Lost Creek East area, the licensee will submit to the NRC one or more radiological environmental monitoring program reports that address the following:

- (1) Results of additional preoperational surface and subsurface soil sampling, and a comparison of the surface and subsurface soil sampling results to the OHV scan surveys results conducted in year 2012 at the Lost Creek East area.
- (2) A comparison of the results of MILDOS-AREA modeling for the Lost Creek licensed area and Lost Creek East area. If the comparison shows a change in the location of the highest predicted airborne radionuclide concentration due to milling operations, the licensee shall collect additional vegetation samples consistent with Regulatory Guide 4.14.
- (3) Results of additional preoperational sediment sampling at a pond located at the northeast-northwest quarter of Section 21, T25N R92W. The sediment samples shall be collected and analyzed for radionuclide concentrations of uranium, lead-210, radium-226, and thorium-230 consistent with Regulatory Guide 4.14.

For groundwater samples, the NRC staff has included a license condition in SER Section 2.6.4.

3.0 DESCRIPTION OF PROPOSED FACILITY

The NRC staff evaluated the applicant's description of its in situ recovery (ISR) process and equipment (SER Section 3.1), equipment used and materials processed in the processing cycle (SER Section 3.2), and instrumentation and control systems (SER Section 3.3) for the Lost Creek facility as presented in its KM Horizon Amendment and LCE Amendment (LCI, 2017a).

3.1 In Situ Recovery Process and Equipment

This section describes the NRC staff's evaluation of the applicant's description of the in situ recovery process and equipment. The applicant provided information on ISR process and equipment in section OP 2.5.2.1 and Attachment D5 of the LCE Amendment and Section 3.4 of the LCE Environmental Report (LCI, 2017a).

3.1.1 Regulatory Requirements

The staff determines if the applicant demonstrated that the in situ recovery process and equipment used during operations carried out as part of the proposed activities for the Amendment application meet requirements of 10 CFR 40.32(c), 10 CFR 40.32(d), 10 CFR 40.41(c) and Criteria 2, 5A, 5B and 13 of Appendix A to 10 CFR Part 40.

3.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 3.1.3, "Acceptance Criteria" (NRC, 2003a).

3.1.3 Staff Review and Analysis

The applicant's discussions on the proposed in situ recovery process and equipment are presented in the Operations Plan Section 2.5.2.1, LCE Environmental Report Section 3.4 and LCE Amendment Attachment D5. Except for the additional mine units and changes to the excursion monitoring program due to overlapping HJ and KM horizon mine units, the applicant states that Amendment includes no changes to the currently approved in situ recovery process and equipment and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2017a). The applicable sections reviewed by the NRC staff in the Application, other referenced documents and associated SER's are as follows:

Approved License Application	Section 3.1
SER	Section 3.1
Dryer Amendment Application	all
SER Amendment 1	all
KM and LCE Application	OP 2.5.2.1 (LCE Amendment) Attachment D5 (LCE Amendment)
LCE Environmental Report	Section 3.4
RAI Responses	RAI-3, RAI-4, RAI-7, RAI-8, RAI-16

For those sections that incorporate by reference the approved license application, as amended, the NRC staff verified that the prior descriptions on the in situ recovery process and equipment are applicable to the proposed activities. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. Therefore, except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

The aspects of the in situ recovery processes and equipment that are changed from the approved license application, as amended, consist of the following:

- Number of mine units;
- Proposed operating plans and schedules;
- Downhole pressures;
- Excursion monitoring where mine units in the HJ and KM horizons overlap; and
- Collective Drawdown Impacts.

Number of Mine Units

In 2011, Lost Creek initially proposed six mine units in the HJ Horizon within the existing licensed area in the license application (see Figure 2.1-1 of LCI, 2008a). During staff's review of that application, Lost Creek had developed the monitoring network for Mine Unit 1 (LCI, 2009a). The developed area of Mine Unit 1 incorporated all or parts of three of the six initially proposed mine units. As a result, WDEQ requested that the number of mine units be reduced to three mine units reflecting then current conditions of Mine Unit 1.¹³ The mine units that are licensed or part of the Amendment are as follows:

Mine Unit	Horizon	Location	Status
1	HJ	Existing Licensed Area	Licensed – currently in operation
2	HJ	Existing Licensed Area	Licensed – currently in operation
3	KM	Existing Licensed Area	Withdrawn from KM Amendment
4	HJ	Existing Licensed Area	Licensed as part of MU-2 but expanded by KM Amendment
5	HJ	Existing Licensed Area	Licensed but expanded by KM Amendment KM Amendment
7	HJ	LCE	LCE Amendment
8	KM	LCE	LCE Amendment
9	HJ	LCE	LCE Amendment
10	KM	LCE	LCE Amendment
11	KM	LCE	LCE Amendment
12	KM	Existing Licensed Area	Withdrawn from KM Amendment

¹³ The three mine units are depicted on the June 29, 2011 Figure II-1 “Proposed HJ Aquifer Exemption” map (ML13189A230). Mine Unit 2 is located west, and Mine Unit 3 is located east of Mine Unit 1. The mine units encompass the trend depicted on Figure 2.1-1 (LCI, 2008a) but Mine Unit 2 is slightly wider and extends approximately to the western boundary of the licensed area.

Source: LCI, 2017c

Mine Unit 3 and Mine Unit 12 are withdrawn from consideration by the applicant (LCI, 2018c)

Staff reviewed the geometry (location, size, thickness and depths) and geochemistry for the proposed mine units and finds that the applicant has provided sufficient detail to characterize them. Furthermore, staff finds that the proposed mine units are consistent with the existing mine units at the Lost Creek property and mine units/wellfields at the sites of other licensees in which ISR operations have been conducted safely and protectively of human health and the environment. Therefore, staff finds the applicant has met requirements of Acceptance Criterion 3.1.3(1) of the SRP.

Proposed Operating Plans and Schedules

The applicant does not propose changing the existing operations at a specific mine unit (i.e., production unit designs, pressures, lixiviant composition, inspections, generated wastes and restoration) including production rates. However, because the number of mine units has increased, the scheduled life of the project increases should all other operating parameters remain constant. The applicant proposes a revised schedule to include all mine units (see Amendment Figure OP-4a).

The schedules for construction, startup, and duration of operations for the various mine units are based on timing for NRC's approval of the Amendment. For the existing license area, the construction and operation of the wellfields can begin immediately after approval. For the LCE area, construction of the access roads and pipelines may start immediately after approval. The operation of the first wellfield in the LCE area is scheduled to begin in Year 3 after approval. Using 2017 as the baseline year, that would mean operations of the first wellfield in the LCE area will begin in 2020.

Lost Creek's proposed schedule for an individual wellfield consists of two years for wellfield development, one to two years of production, one to two years of restoration, one year of stability monitoring, and one to one-and-one-half years of regulatory approval and surface reclamation. The production of individual wellfields will be staggered (or phased). As a result, completion of surface reclamation of the final wellfield is estimated at relative year 16 (year 2033 using 2017 as the baseline year). This extends the life of the mine from six to eight years beyond the current estimate for the existing licensed area.

The schedule includes plans that extend the life of the plant/operations beyond the expiration date for the existing license (i.e., August 2021). The applicant committed to submit a timely renewal of its license at the appropriate time (LCI, 2017c).

The staff reviewed the applicant's schedule and finds it meets Acceptance Criteria 3.1.4(6) because the schedule is based on the existing equipment, flow rates and staff's experience with the life of wellfields at many ISR facilities which have operated safely and protectively of human health and the environment. As discussed in SER Section 4.0, the proposed water balances would provide adequate capacity during the life of the proposed activities.

Downhole Pressures

The Amendment includes vertical expansion to a stratigraphically deeper horizon (i.e., L Horizon) below the current KM Horizon. Based on depths to the bottom of the HJ and KM horizons (LCI, 2018b), the increase in depths is approximately 21 m [70 ft] (750 ft minus 680 ft)

and 33.5 m [110 f]) (610 ft minus 500 ft) at the existing license area and LCE area, respectively (LCI, 2018b). The increase in depth is within range for well materials used safely by the applicant and other licensees at other licensed facilities and the pressure range of the PVC piping and operating pressure of 150 psi documented in the approved license application, as amended. Staff finds that the proposed depths meets Acceptance Criterion 3.1.4(5)(a) of the SRP.

Excursion Monitoring where Mine Units in the HJ and KM Horizons Overlap

The applicant proposes a modification to the excursion monitoring program where mine units in the HJ and KM Horizons overlap. The applicant states that, in the areas of overlap, its preference is to conduct operations in the deeper KM Horizon first, unless operations have been conducted already in the HJ Horizon (Section OP 3.2.2.4, LCI, 2017a). The applicant then states that regardless of the order of production, the well placement for the overlying and underlying aquifers would follow the normal excursion monitoring program (i.e, for the HJ Horizon, the overlying monitoring wells will be installed in the lower FG Horizon and the underlying wells will be installed in the upper KM Horizon, and for the KM Horizon, the overlying wells will be installed in the lower HJ Horizon and the underlying wells will be installed in the L Horizon).

In Section 3.6.4 of the LCE Application (LCI, 2017a), the applicant expanded its discussion of the excursion monitoring program in areas where the wellfields in the HJ and KM horizons overlap (LCI, 2017c). The discussions provide several scenarios:

Mine Unit at which Operations First Conducted	Mine Unit Under Operation	Were Restoration of Mine Unit subject to operations Restored?	Proposed Monitoring	
			Overlying Unit	Underlying Unit
KM	KM	N/A	Lower HJ	L
	HJ	No	Lower FG	L
	HJ	Yes	Lower HJ	L
HJ	HJ	N/A	Lower FG	Upper KM
	KM	No	(?)	L
	KM	Yes	HJ & FG	L

The applicant further elaborates on the complexity of the excursion monitoring program including (1) monitoring in areas that do and do not overlap, or (2) drilling through the HJ Horizon which has undergone operations but is not fully restored. In the case of the latter (i.e., drilling through the HJ Horizon which has undergone operations but is not restored), the applicant discusses additional protocols to the excursion monitoring program that include:

- Using clay-based drilling fluids to limit fluid migration to and from the drill hole;
- Flushing fluids that migrate from the HJ Horizon through the drill hole to the surface and allow the fluids to be evaporated, transferred to another mud pit or disposed of in the existing “holding” ponds; and
- Capturing cuttings in a lined mud pit and evaluating the soils relative to the approved release limit.

The NRC staff reviewed the applicant's information and finds it satisfactory for reasons discussed below with the additional clarifications and license conditions. First, based on the applicant's description, a rationale for conducting operations first in the deeper KM Horizon is to avoid drilling through the HJ Horizon, which would contain "liquid" licensed material if operations were first conducted in that horizon. The applicant addressed this concern in part (staff's review is below). Although the applicant proposes to conduct operations in the deeper KM Horizon, the applicant proposes flexibility in its operations and all options are possible.

Conducting operations first in the deeper KM Horizon has additional effects that the applicant did not discuss. First, the applicant did not specify whether or not the same production wells will be recompleted for use in both horizons or if that was possible. Consequently, for a conservative analysis, staff assumes that twice the number of drill holes would penetrate the HJ and shallower horizons (i.e., production wells in the HJ Horizon, and production wells in the KM Horizon). Because faulty wells or improperly abandoned drill holes provide conduits for the potential migration of fluids (MacKin et al., 2001), doubling the number of wells would similarly increase that potential. In this case where the KM Horizon is first subject to operations, the NRC staff finds that subsequent operations in the HJ Horizon would greatly increase the likelihood of an excursion to the overlying aquifer because fluids under higher pressures would directly encounter the drill holes. Therefore, in the case of HJ Horizon operations conducted after the KM Horizon operations, the NRC staff finds that increasing the density of wells in the overlying FG Horizon from one well per four acres to one well per two acres is appropriate and will include a revised license condition with this requirement. In the case of the KM Horizon subject to operations after the HJ Horizon, the fluids in the KM Horizon would not be affected by an increase in number of drill holes in the HJ Horizon. Staff finds that approved density of one well per four acres in the overlying well is appropriate in this situation.

Second, based on the LCE Amendment Site Plan (OP-2a&b), the proposed wellfields do not consist of a single contiguous patterned area but consist of segmented patterned areas. As a result, the area in which the pattern areas in each horizon overlap is a low percentage of the wellfield area; most overlap that occurs in the exempted zones of the two horizons, as defined by the perimeter well rings, consist of a production area in one horizon that is not overlain by a production area in the other horizon. In this case, the number of drill holes through the HJ Horizon is not a concern nor is drilling through the HJ Horizon with licensed material. However, the concern is that the immediately overlying (underlying) aquifer for the KM (HJ) Horizon is within the exempted aquifer of the other unit where monitoring wells are not commonly installed. The quality at that location may be affected by the operations of the first mine units and thus the baseline quality established prior to operations of the first unit. Staff will include as a license condition the applicant's proposed procedure and staff's modification to collect background samples prior to the operation of the first unit.

Third and finally, the applicant's discussions on the handling of cuttings and fluids during drilling a well/exploratory drill hole that penetrates to the KM Horizon through the HJ Horizon that had been affected by operations (if the HJ Horizon were to be subject to operations first) needs to be limited. The applicant proposes to capture the cuttings in a lined pit, determine if the concentrations meet the approved released limits and bury in the cuttings in place with at least 0.9 m [3 ft] of overburden. While staff agrees that the applicant's proposed procedures for the disposition of the cuttings from such a drill hole because they are consistent with best management practices, NRC's has no jurisdiction of the disposition of the cuttings themselves because the orebody is exempt for the definition of byproduct material in section 10 CFR 50.4.

Disposition of the fluids that are affected by operations falls under NRC's jurisdiction for disposal of byproduct material. One of the methods proposed by the applicant for the disposal of such fluids is to the "holding" ponds (the NRC staff interprets holding ponds as the surface impoundments). The surface impoundments are part of the licensee's approved wastewater treatment and disposal facilities. Disposal of the fluids through the collection in a designated tanker and transport to the surface impounds for disposal, which is currently approved for swabbing water from a production well, is part of the approved wastewater treatment process and is thus acceptable.

The other method proposed by the applicant for disposal of the affected fluids consists of evaporation in the on-site mudpits. The on-site disposal in the mudpit by evaporation is not a currently approved disposal method. Although NRC staff has estimated a low dose based on a hypothetical mud pit scenario, the definition of byproduct material does not include "de minimis" quantities and that the disposal by evaporation in the mud pit, as proposed by the applicant, is not authorized by regulations. The applicant would be required to evaluate the on-site disposal pursuant to requirements of 10 CFR 20.2002 "Method for obtaining approval of proposed disposal procedures". Because the applicant has not submitted that information, the NRC staff cannot approve this method of disposal. The NRC staff will include a license condition limiting the disposal to the surface impoundments as documented in SER Section 3.1.4.

Therefore, based upon its review discussed above, the NRC staff finds that the applicant's proposed changes to the excursion monitoring program along with the license condition listed in SER Section 3.1.4 meets the acceptance criterion 3.1.3(3) of the SRP.

Collective Drawdown Impacts

In Appendix OP-2 of its response to NRC's clarifying comments on the prior RAI responses (LCI, 2018a), the applicant provided results of the modeling effort to estimated collective drawdown within the HJ and KM horizons based on the projected life of operations. The modeling effort was based on MODFLOW-SURFACT code (Hydrogeologic, 2006). That code was used because of the potential variable saturated conditions of the HJ Horizon in the eastern area of the LCE. The model was developed to estimate drawdown to area resources. The applicant reports that the maximum drawdown of 1.5 m [5 ft] in the HJ Horizon extends approximately 2.9 m [9.5 ft] southwest of the licensed area, and a maximum drawdown of 1.5 m [5 ft] in the KM Horizon extends approximately 8 km (5 mi) southwest of the licensed area. The applicant also reported that a maximum drawdown of approximately 16.7 m [55 ft] at selected locations along the existing and proposed license boundary.

Staff reviewed the applicant's model and finds the model setup, parameters used, and calibration were sufficient to meet the data quality objectives (i.e., calculate the collective drawdown from the proposed operations in the respective HJ and KM horizons). Furthermore, the NRC staff verified the modeling results from the electronic files submitted by the applicant. The NRC staff analyzed the results for impacts of drawdown at the wellfield. The maximum drawdown at the perimeter ring for the HJ Horizon mine units was 39.6 m [130 ft] and for the KM Horizon mine units was 12.1 m [40 ft]. The large drawdown was attributed to the easternmost HJ Horizon mine unit nearest the outcropping/recharge areas. Despite the large drawdown, the mine unit remained fully saturated as was depicted on Figure 10 in Attachment OP-2 of the LCE Amendment (LCI, 2018a). The NRC staff will include a license condition that prohibits the applicant from conducting operations in the less-than-fully saturated portions of the HJ Horizon (see SER Section 2.5.4).

3.1.4 Evaluation Findings

The NRC staff has completed its review of the in situ recovery process and equipment included in the Amendment. Many aspects of those processes and equipment remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

For those aspects that are changed, the NRC staff finds that the proposed changes are consistent with the applicable acceptance criteria in Section 3.1.3 of the SRP (NRC, 2003a), with the following proposed new or revised license conditions:

License Condition 10.24

For drill holes through the HJ Horizon mine unit pattern area for which restoration has not been approved, the licensee will dispose of waste drilling fluids to the existing waste water system (i.e, surface impoundments)

License Condition 11.5

Excursion Monitoring. Monitoring for excursions shall occur twice monthly (semi-monthly) and at least 10 days apart for all wells installed under LC 11.3 (B) and (C) at all wellfields. If, for any well during a semi-monthly sampling event, the concentrations of any two excursion indicator parameters exceed their respective UCL or any one excursion indicator parameter exceeds its UCL by 20 percent, then the excursion criterion is exceeded and a verification sample shall be taken from that well within 48 hours after results of the first analyses are received. If the verification sample confirms that the excursion criterion is exceeded, then the well is placed on excursion status. If the verification sample does not confirm that the excursion criterion is exceeded, a third sample shall be taken within 48 hours after the verification sampling. If the third sample shows that the excursion criterion is exceeded, the well is placed on excursion status. If the third sample does not show that the excursion criterion is exceeded, the first sample shall be considered to be an error and routine excursion monitoring is resumed (the well is not placed on excursion status).

Upon confirmation of an excursion, the licensee shall notify NRC, as discussed below, implement corrective action, and increase the sampling frequency for the excursion indicator parameters at the well on excursion status to at least once every 7 days. Corrective actions for confirmed excursions may be, but are not limited to, those described in Section 5.7.8.2 of the approved license application. An excursion is considered corrected when concentrations of all indicator parameters are below the concentration levels defining the excursion for three consecutive weekly samples.

If an excursion is not corrected within 60 days of confirmation, the licensee shall either (a) terminate injection of lixiviant within the wellfield until an excursion is

corrected; or (b) increase the surety in an amount to cover the full third-party cost of correcting and cleaning up the excursion. The surety increase shall remain in force until the NRC has verified that the excursion has been corrected and cleaned up. The written 60-day excursion report shall identify which course of action the licensee is taking. Under no circumstances does this condition eliminate the requirement that the licensee must remediate the excursion to meet ground-water protection standards as required by LC 10.7 for all constituents established per LC 11.3.

The licensee shall notify the NRC Project Manager (PM) by telephone or email within 24 hours of confirming a lixiviant excursion, and by letter within 7 days from the time the excursion is confirmed, pursuant to LC 11.6 and 9.3. A written report describing the excursion event, corrective actions taken, and the corrective action results shall be submitted to the NRC within 60 days of the excursion confirmation. For all wells that remain on excursion after 60 days, the licensee shall submit a report as discussed in LC 11.1(A).

In areas where mine units in the HJ and KM horizons overlap, the licensee will modify the excursion monitoring program in the overlying and underlying aquifers beyond the standard requirements as follows:

- (1) For areas in which the pattern areas in the two mine units directly overlie each other, the licensee will:
 - (a) install at least one baseline well in each mine unit prior to the injection of lixiviant in either mine unit that will serve to establish the Commission-approved background for each respective mine unit or as an overlying/underlying unit trend well for the excursion monitoring program
 - (b) if operations of the KM Horizon are conducted prior to the HJ Horizon, for the HJ Horizon mine unit, the excursion monitoring program will include overlying monitoring wells in the Lower FG Horizon at a minimum density of one well per two acres and underlying monitoring wells in the upper L Horizon at a minimum density of one well per four acres
 - (c) if operations in the HJ Horizon are conducted prior to the KM Horizon, for the KM Horizon mine unit, the monitoring program will include overlying monitoring wells in the Lower FG Horizon at a minimum density of one well per four acres and underlying monitoring wells the upper L Horizon at a minimum density of one well per four acres.
 - (d) depending upon the state of operations (active restoration, stability monitoring or approved restoration), monitor the trend wells installed in
 - (a) to establish impacts to the exempted aquifer as follows:
 1. if the non-operational horizon is undergoing active restoration, monitor the fluids in a trend well for restoration success using the parameters TDS (or SC), uranium, and alkalinity, at a minimum frequency of one sample per 60 days
 2. if the non-operational horizon is undergoing stability monitoring or the restoration has been approved, monitor the fluids as an excursion monitoring well for the excursion monitoring parameters based on the trend well background concentrations at the normal monitoring frequency (i.e., a sample semi-monthly or 60 days).

- (2) For areas within the perimeter well ring in which the pattern areas in the two mine units do not directly overlie each other, the licensee will install a baseline well in the mine unit with the pattern area and a well in the other horizon (lower HJ or upper KM horizon) that will be used as an overlying (or underlying) excursion monitoring well at a minimum density of one well per four acres

Therefore, the NRC staff concludes that the proposed in situ recovery process and equipment are acceptable and in compliance with requirements and specifications in Part 40 Appendix A (specifically Criterion 5A and 5B), 10 CFR 40.32(c), requiring the applicant's proposed equipment, facilities and procedures to be adequate to protect health and minimize danger to life or property, 10 CFR 40.32(d), requiring an issuance of a license that will not be adverse to the common defense and security or to the health and safety of the public, and 10 CFR 40.41(c) requiring a licensee to confine his possession of source or byproduct material to the locations and purposes authorized in a license. Because the applicant is not proposing new disposal facilities or changes to the parameters included in a monitoring program, Criteria 2, and 13 of Appendix A to 10 CFR Part 40 are not applicable.

3.2 Equipment Used and Materials Processed in the Processing Cycle

This section describes the NRC staff's evaluation of the applicant's description of the equipment used and materials processed in the processing cycle. The processing cycle includes piping to and from the wellfields, processes to convert the dissolved uranium in the lixiviant to yellowcake, and on-site chemical storage with the focus on effects of the processing cycle on the radiation health and safety and the environment. The applicant provided information on the equipment and materials in sections OP 2.9, 2.12.2, and 3.1 through 3.6, and Plates OP-2a and OP-2b of the LCE Amendment (LCI, 2017a).

3.2.1 Regulatory Requirements

The staff determines if the applicant demonstrated that the equipment used and materials processed in the processing cycle during operations carried out as part of the proposed activities for the Amendment application meet requirements of 10 CFR 40.32(c), 10 CFR 40.32(d) and 10 CFR 40.41(c).

3.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 3.2.3, "Acceptance Criteria" (NRC, 2003a).

3.2.3 Staff Review and Analysis

The applicant's discussions on the proposed equipment used and materials processed in the processing cycle are presented in the Operations Plan sections 2.9, 2.12.2 and 3.1 through 3.6 and plates OP-2a and OP-2b (LCI, 2017a,c). Other than the requested increase in annual production of yellowcake, production surface disturbance areas and infrastructure (e.g., underground piping) for the new wellfields and potentially three new Class I disposal wells, the applicant states that Amendment includes no changes to the currently approved equipment used and materials processed in the processing cycle and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2017a). The

applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application SER	Section 3.2 Section 3.2
Dryer Amendment Application SER Amendment 1	all all
Class V Amendment Application SER Amendment 5	all all
KM and LCE Application	Preamble, OP 2.6, 2.9, 2.12.1 and 3.1 through 3.6 Figures OP-2a and OP-2b (LCE Amendment)
License SUA-1598	License Condition 10.2

For those sections that incorporate by reference the approved application, as amended, the NRC staff verified that the prior descriptions on the equipment used and materials processed in the processing cycle are applicable to the proposed activities. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. Therefore, except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

The aspects of the equipment used and materials used in the processing cycle that are changed from the approved license application, as amended, consist of the following:

- Increase in linear footage of underground piping
- Yellowcake slurry
- Increasing the maximum annual production
- Increasing the percentage of toll milling
- Filters in the header houses
- Three additional deep disposal wells

Increase in Linear Footage of Underground Piping

The amendment application states that lixiviant from the proposed wellfields will be conveyed through underground piping to the existing Central Processing Plant for processing. Staff's review of the changes in the piping lengths is discussed in SER Section 2.1.3.

Yellowcake Slurry and Dryers

The applicant states it will use the existing equipment and processes that have been approved for use at the central processing plant (i.e., ionic exchange resin, elution, precipitation and drying as yellowcake). NRC's evaluation of the equipment and processes at the central processing plant is documented in the Safety Evaluation Report for the approved license application (NRC, 2011a) as well as subsequent amendments to License SUA-1598, specifically

the addition of dryers, increase the annual product to 2 million pounds [0.91 million kg] and on-site disposal of treated waste water through Class V facilities (NRC, 2013a; 2016c), and changes implemented by the licensee through its SERP (see Appendix A). The NRC staff has determined that those previously approved equipment and processes at the central processing plant do not require reexamination for this application. The NRC staff based this determination on the fact that the same equipment will be used, on a review of historical records which demonstrate that the operations are protective of human health and safety and the environment and that no unreviewed safety-related concerns have been identified.

Increase in Maximum Annual Production of Yellowcake

The applicant proposes to increase the maximum annual production of yellowcake from 2.0 to 2.2 million pounds [0.91 to 1.0 million kg] per year. In the Preamble for the KM Amendment and Section OP 2.1 of the LCE Amendment (LCI, 2017a,c), the applicant does not provide justification for the increase except that the proposed schedule is based on the increase in on-site yellowcake production from 1.0 to 1.2 million pounds [0.46 to 0.54 million kg] per year. Although not documented in the Application, during previous inspections, the licensee had discussed with NRC staff its preference for an annual production planning base on natural uranium concentrations rather than yellowcake production. The difference is that yellowcake contains oxygen, water and minor impurities. Typically, natural uranium is approximately 85 percent of the yellowcake. Planning for 1.0 million pounds [0.46 million kg] of natural uranium would yield 1.2 million pounds [0.54 million kg] of yellowcake.

The applicant stated that the plant's design is sufficient to handle the slight increase maximum annual yellowcake production.

The NRC staff finds the proposed increase in annual yellowcake production acceptable because the increase is nominal, representing a 10 percent increase, which is within the expected range of capacity for the processing equipment designed for a two million pounds per year. The applicant is not proposing increasing the maximum daily production flow rate of 6000 gallons per minute; the increase is attributed to an increase in uranium concentrations in the pregnant lixiviant (i.e., head grade). This is due in part to the increase efficiency of the Lost Creek operations to leach uranium from the ore body.

The increase in annual yellowcake production rate may increase the effluent releases, primarily to the atmosphere, and an increase in the number of trucks transporting yellowcake from the site. The NRC staff reviewed the air effluent impacts in SER Section 5.7.7.3, and the number of trucks in SER Section 7.0.

The NRC staff also compared Lost Creek's proposed production rates with those for the existing NRC-license facilities that have been approved and many which have operated safely since 1980. The range in maximum daily production rate ranged from 3,000 to 20,000 gallons per minute, and the maximum annual yellowcake production rate ranged from 1.0 to 5.5 million pounds. Most of the other NRC-licensed facilities included toll milling as part of the maximum annual yellowcake production rate but, unlike the Lost Creek facilities, did not limit the on-site production. The applicant's existing maximum daily production rate and proposed increase in maximum annual yellowcake production are within the range of acceptable rates.

Increase Toll Milling

The proposal includes a request to increase toll milling from 1.0 million pounds [0.46 million kg] of yellow cake per year, which is 50 percent of the current total maximum annual production of yellowcake, to 100 percent of the total maximum annual production of yellowcake. The increase in toll milling would result in an increase in truck traffic, which is evaluated in SER Section 7.0.

Filters

The applicant has modified the ISR process equipment by including filters on the production line in the header houses. The filters remove sediment load from the lixiviant which had been affecting the efficiency of the recovery process. The filters need to be changed when filled with sediment. The sediment collected on the filters contains radionuclides.

The handling and approval of the filter installation was evaluated by the licensee's SERP.

The NRC staff finds that the change to include filters in the header houses was properly evaluated.

Three additional deep disposal wells

The applicant's proposal includes the possibility of three additional Class I deep disposal wells. The NRC staff evaluated this potential in SER Section 4.0.

3.2.4 Evaluation Findings

The NRC staff has completed its review of the equipment used and materials processed in the processing cycle included in this Amendment application. Many aspects of those processes and equipment remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

For those aspects that are changed, the NRC staff finds that the proposed changes are consistent with the applicable acceptance criteria in Section 3.1.3 of the SRP (NRC, 2003a). As request, the NRC staff will revise the license condition 10.2 to the following:

License Condition 10.2

Facility Throughput. The Lost Creek processing facility throughput shall not exceed an average daily flow rate equivalent to 6,000 gallons per minute or a maximum instantaneous flow rate of 6,300 gallons per minute, excluding restoration flow. The annual production of yellowcake slurry and/or dried yellowcake shall not exceed 2.2 million pounds equivalent of dried yellowcake product.

Therefore, the NRC Staff concludes that the proposed in situ recovery process and equipment are acceptable and in compliance with requirements and specifications in 10 CFR 40.32(c),

requiring the applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property, 10 CFR 40.32(d), requiring that issuance of the license that will not be inimical to the common defense and security or to the health and safety of the public, and 10 CFR 40.41(c) requiring the licensee to maintain control of licensed and byproduct material.

3.3 Instrumentation and Control

This section describes the NRC staff's evaluation of the applicant's description of the proposed process instrumentation and controls and the radiation safety sampling and monitoring instrumentation. The applicant provided information on the process instrumentation and controls in sections OP 4.0 through OP 4.5 of the LCE Amendment (LCI, 2017a).

3.3.1 Regulatory Requirements

The staff determines if the applicant demonstrated that the proposed process instrumentation and controls used during operations carried out as part of the proposed activities for the Amendment application meet requirements of 10 CFR 40.32(c), 10 CFR 40.32(d) and 10 CFR 40.41(c).

3.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 3.1.3, "Acceptance Criteria" (NRC, 2003a).

3.3.3 Staff Review and Analysis

The applicant's discussions on the proposed process instrumentation and controls are presented in the Operations Plan sections 4.0 through 4.5 (LCI, 2017a,c). The applicant states that Amendment includes no changes to the currently approved equipment used and materials processed in the processing cycle and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2008a). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	Section 3.3
SER	Section 3.3
Dryer Amendment Application	all
SER Amendment 1	all
KM and LCE Application	Section OP 4.0 through OP 4.5 (LCE Amendment)

For those sections that incorporate by reference the approved application, as amended, the NRC staff verified that the prior descriptions on the equipment used and materials processed in the processing cycle are applicable to the proposed activities. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. Therefore, except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and

the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

The staff finds that all aspects of the process instrumentation and controls are unchanged from the approved license application, as amended.

3.3.4 Evaluation Findings

The NRC staff has completed its review of the process instrumentation and controls included in this Amendment application. Staff finds that the proposed process instrumentation and controls remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Therefore, the NRC Staff concludes that the proposed in situ recovery process and equipment are acceptable and in compliance with requirements and specifications in 10 CFR 40.32(c), requiring the applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property, 10 CFR 40.32(d), requiring that issuance of the license that will not be inimical to the common defense and security or to the health and safety of the public, and 10 CFR 40.41(c) requiring the licensee to maintain control of licensed and byproduct material.

4.0 EFFLUENT CONTROL SYSTEMS

In this SER Section, the NRC staff's evaluation is focused on the applicant's description of its effluent control systems, including the ventilation, filtration, and confinement systems used to control the release of gaseous and particulate radioactive materials to the atmosphere (SER Section 4.1) and liquids (surface water and groundwater) (SER Section 4.2), and its management and control of wastes in solid form (SER Section 4.2). The descriptions of the control systems within the Amendment are found in the LCE Operation Plan.

4.1 Gaseous and Airborne Particulates

4.1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed management controls of gaseous and particulate radioactive materials meet the requirements of 10 CFR 20.1101, 20.1201, 20.1301, 20.1302 and Criterion 8 of Appendix A to 10 CFR Part 40. Criterion 8 states, "Milling operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. The primary means of accomplishing this must be by means of emission controls." Although Criterion 8 focuses on effluent releases from a yellowcake dryer and tailings, it does not exclude radon releases from ISRs. The licensee must also demonstrate that releases of gaseous and airborne particulates comply with other relevant sections of 10 CFR Part 20 and 10 CFR Part 40.

4.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40, using the acceptance criteria presented in SRP Section 4.1.3 (NRC, 2003a).

4.1.3 Staff Review and Analysis

The applicant's discussions on gaseous and airborne particulates emission controls are presented in the Operations Plan sections 5.0 and 5.1 (LCI, 2017a). The applicant states that no changes to the effluent control systems are being proposed, and references Section 4.1 of the approved license application, as amended (LCI, 2008, 2010).

Effluent controls for gaseous and airborne particulates are those required for radon-222 (radon), radon progeny, and radionuclide particulate matter emissions resulting from wellfield installation, operation and recovery within the LCE area. The applicant proposes to install new wellfields in the LCE area and process lixiviant from these wellfields at the existing central processing plant in the Lost Creek licensed area. Therefore, the potential radionuclide emissions are radon and radon progeny from both the LCE wellfields and central processing plant resulting from installation, operation and recovery of wellfields in the LCE area, and radionuclide particulate matter emissions resulting from processing of LCE area lixiviant at the existing central processing plant.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SERs are as follows:

Approved License Application	4.0 & 4.1
SER	4.1
Dryer Amendment Application	all
SER Amendment 1	all
SER Amendment 5	all
KM and LCE Application	OP 5.0 – OP 5.1 Attachment D10-2
RAI Responses	RAI-7, RAI-13

The applicant did not propose changes to Section 4.1, “Gaseous and Airborne Particulates,” of the approved license application, as amended. For the approved license application, as amended (NRC, 2011a), the NRC staff determined that areas of review and acceptance criteria in SRP Section 5.7.1, “Effluent Control Techniques,” were addressed in SER section 4.1 in support of the initial license. For the LCE area, the NRC staff’s review of effluent control techniques is addressed in this section of the SER. The applicant states in Operations Plan Section 5.0, “Effluent Control Systems,” that there are no changes to the currently approved effluent control systems and that emissions from the central processing plant are not expected to change, and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2017). The performance specifications for the approved effluent controls systems have not changed.

The applicant states that it will use the same effluent control systems for gaseous and airborne particulates at the LCE area as are already in use at the Lost Creek licensed area.

The minor changes as identified by the applicant are the addition of the Class V wells, possibly three additional Class I wells in the LCE area, the dryer as Amendment 1, and additional sources of radon by increasing the number of wellfields (LCI, 2017b).

The NRC staff evaluated the effluent control systems for airborne releases of radioactive materials from the rotary vacuum dryer units in the SER for Amendment 1 (NRC, 2013a). In that SER, the NRC staff found the systems met SRP Section 4.1.3 (NRC, 2003a). The NRC staff approval was based, in part, on the addition of LC 10.18 to the license, which requires maintenance of effluent control systems and provisions in the event the effluent control system malfunctions. The NRC staff evaluated the effluent control systems for airborne releases of radioactive materials from the Class V wells in the SER for Amendment 5 (NRC, 2016c). The NRC staff found that the proposed treatment system will not result in any new air or liquid effluents, and that the effluent control system is sufficient for ensuring public dose limits are met.

The NRC staff finds that use of the approved effluent control systems for gaseous and airborne particulates at the LCE area is acceptable because the new wellfields in the LCE area are similar to the wellfields already authorized. Similarly, the applicant is proposing to continue using the same effluent control systems at the central processing plant for lixiviant from the LCE area. This is acceptable because the lixiviant from the LCE area will be chemically similar to the lixiviant approved for use at the Lost Creek licensed area.

For those aspects that remain unchanged, the NRC staff's evaluation consists of verifying that the proposed activities are consistent with the previously approved plans, evaluating the historic site operations to determine that the facility has operated in a safe manner, identifying any un-reviewed safety-related issues, and ensuring the plans will be followed in the future in accordance with Appendix A of the SRP (NRC, 2003a). For those changes identified by the applicant as well as other changes identified by the NRC staff, the NRC staff's evaluation was performed in accordance with guidance found in Section 4 of the SRP (NRC, 2003a).

The NRC staff reviewed the history of operations including the effluent monitoring reports. The NRC staff has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion. Also, the NRC staff has not identified any un-reviewed safety-related concerns pertaining to the licensee's equipment and procedures for responding to and mitigating the consequences of accidents. The NRC staff finds the applicant's effluent control systems consistent with acceptance criteria (2) of SRP Section 4.1.3 and (4) of SRP Section 5.7.1.3 because there are not changes to both the approved airborne effluent control systems and its performance specifications for operation, respectively.

Two changes to the effluent that were not previously reviewed are the additional sources of radon by the additional wellfields and the possibly additional three Class I wells. Regarding the additional sources of radon by increasing the number of wellfields in the LCE area, the NRC staff review is discussed in SER Section 5.7.7. Regarding the possibly additional three Class I wells, the NRC staff review is discussed in SER Section 4.2. Based on those reviews, staff finds that the changes are consistent with acceptance criteria in SRP Section 4.1.3.

4.1.4 Evaluation Findings

The NRC staff has completed its review of the effluent controls for gaseous and particulate radiological matter in the Amendment in accordance with Sections 4.1.3 and 5.7.1.3 of the SRP (NRC, 2003a). Many aspects of those controls remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

For that aspects that changed (i.e., additional effluent (radon) directly from the new wellfields and possibly three additional Class I wells), the NRC staff finds that the proposed changes are consistent with the applicable acceptance criteria in sections 4.1.3, 4.2.3 and 5.7.1.3 of the SRP (NRC, 2003a) because the same effluent controls and procedures will be used for both the Lost Creek licensed area and LCE area.

Therefore, the NRC staff concludes that the proposed effluent controls on gaseous and particulate radiological materials released to the atmosphere are acceptable and in compliance with requirements and specifications in 10 CFR 20.1101, which requires that an acceptable radiation protection program that achieves as low as is reasonably achievable goals is in place

and that a constraint on air emissions, excluding radon and its progeny, will be established to limit doses from these emissions; 10 CFR 20.1201, which defines the allowable occupational dose limits for adults; 10 CFR 20.1301, which defines dose limits allowable for individual members of the public; 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluent releases.

The related reviews of the 10 CFR Part 20 radiological aspects of the effluent control systems for gaseous and airborne radionuclides in accordance with SRP Sections 5.0, “Operations;” and 7.0, “Environmental Effects” are addressed elsewhere in this SER.

4.2 Liquid and Solids

This section describes the NRC staff’s evaluation of the applicant’s description of the design of effluent control systems for liquids, and the management and control of solid wastes.

4.2.1 Regulatory Requirements

For liquid effluents, the applicant must demonstrate compliance with 10 CFR 20.1301; 10 CFR 20.2002, “Method for Obtaining Approval of Proposed Disposal Procedures”; and 10 CFR 20.2007, “Compliance with Environmental and Health Protection Regulations.”

For solid wastes, the applicant must demonstrate compliance with 10 CFR Part 40, Appendix A, Criterion 2.

4.2.2 Regulatory Acceptance Criteria

The Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria outlined in SRP Section 4.2.3 (NRC, 2003a).

4.2.3 Staff Review and Analysis

4.2.3.1 Liquid Waste

The discussions on liquid wastes are presented in the Operations Plan Section OP 5.2. The applicant states that amendment includes no changes to the currently approved effluent control methods and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2017). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER’s are as follows:

Approved License Application	4.2
SER	4.2
Class V Amendment Application	all
SER Amendment 5	all
KM and LCE Application	Table ADJ-1 (LCE Amendment) OP 5.2 (LCE Amendment) Figures OP-5a through OP-5f (LCE Amendment)

For those sections that incorporate by reference the approved application, as amended, the NRC staff verified that the prior descriptions on the liquid wastes are applicable to the proposed activities. The NRC staff reviewed the history of operations, including the liquid waste disposal, and the NRC staff has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. Therefore, except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

The aspects of the liquid waste that are changed from the approved license application, as amended, consist of the following:

- Potentially three additional Class I deep disposal wells;
- Wastewater mass balance; and
- Mudpits associated with drilling through an ore aquifer that had been subjected to operations.

4.2.3.1.1 Potentially Three Additional Class I Deep Disposal Wells

In Table ADJ-1 of the LCE Amendment (LCI, 2017a), the applicant states that a permit for three additional Class I deep disposal wells will be submitted to WDEQ depending on the need for additional wells. The need will be based on the effectiveness of the water disposal capacity at Lost Creek. In response to RAI-16 (LCI, 2017c), the applicant reiterated its commitment to permit the three additional Class I wells should the wastewater capacity necessitates.

The NRC staff finds that the applicant's commitments are acceptable because the liquid waste, and the design, construction and monitoring of any new deep disposal wells will be consistent with those details for the approved disposal wells. Specifically, in Section 4.2.3.1.1 of the SER for the initial license, the NRC staff evaluated requirements of 10 CFR 20.2002 for deep wells and found that the licensee would be in compliance with the NRC regulations for the alternate disposal of byproduct material in 10 CFR 20.2002, as well as the dose limits in 10 CFR 20.1301.

4.2.3.1.2 Wastewater Mass Balance

The applicant provides water mass balance diagrams for various phases of operational conditions within the wellfields on Figures OP-5a-f (LCI, 2017c). The phases include: (a) production only; (b) production with ground water sweep (GWS); (c) production with GWS and reverse osmosis (RO); (d) production with RO; and (e) GWS and RO only. The estimated waste water flow rate to the Class I deep disposal wells was 151, 265, 231, 231, 265 lpm [40, 70, 61, 61, 70 gpm] for the five respective phases. The estimated waste water flow rate to the Class V shallow disposal wells was 68, 712, 757, 204, 757 lpm [18, 188, 200, 54, 200 gpm] for the five respective phases.

The wastewater mass balances differs from that in the approved license application, as amended, in two regards. First, the wastewater mass balances in the Amendment depict five phases of operations whereas that in the original license application depicted one overall mass balance. Second, the wastewater mass balances in the Amendment depict a component to the

Class V facilities which were not approved in the initial license. The Class V facilities were approved by Amendment 5.

The NRC staff finds that estimated wastewater flow rates are consistent with the existing permitted levels for the Class I and Class V wells.

Several phases of the operations included consumptive use (i.e., net natural influx of groundwater to a wellfield undergoing restoration of 984 lpm [260 gpm] (or 0.33 bleed). This consumptive use exceeds that used in the applicant's model on consumptive use (generally a maximum of 438 lpm [116 gpm]) (LCI, 2018a). However, the applicant confirmed that the consumptive use depicted on the wastewater mass balance figures represent a "maximum" consumptive use (LCI, 2018d). The NRC staff agrees that the overall consumptive use can be controlled by reducing the component to the Class V wells and thus the consumptive use values used in the applicant's model is the best representation for long term.

Therefore, staff finds the applicant's wastewater mass balances meets acceptance criteria in SRP Section 4.2.3.

4.2.3.1.3 Mudpits Associated with Drilling Through an Ore Aquifer That Had Been Subjected to Operations

The NRC staff's review of the mudpits associated with the drilling through an ore aquifer in the HJ Horizon that had been subjected is found in SER sections 3.1.3 and 5.7.7.3.3.

4.2.3.2 Solid Waste

The discussions on solid wastes generated under the proposed activities are presented in the Operations Plan Section OP 5.3. The applicant states that amendment includes no changes to the currently approved effluent control methods and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2017).

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	4.3
SER	4.3
KM and LCE Application	OP 5.2

For those sections that incorporate by reference the approved application, as amended, the NRC staff verified that the prior descriptions on the solid wastes are applicable to the proposed activities. The NRC staff reviewed the history of operations, including the control and disposal of solid wastes and the continued agreement for off-site 11e.(2) disposal, and the NRC staff has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. Therefore, except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

No aspect of the management and control of solids waste are changed from the approved license application, as amended.

4.2.4 Evaluation Findings

The NRC staff has completed its review of the liquid and solid waste management and control in the Amendment application. Many aspects of those controls remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

For that aspect that is changed, i.e., three additional Class I deep disposal wells and liquid wastewater mass balance, the NRC staff finds that the proposed changes are consistent with the applicable acceptance criteria in Section 4.2.3 of the SRP (NRC, 2003a) because the applicant commits to installing the three additional should the wastewater capacity warrants it, and the wastewater balance documents that liquid wastewater disposal system is sufficient for the proposed activities to perform in a manner that is protective of human health and safety and the environment.

Therefore, the NRC staff concludes that the management and controls of liquid and solid wastes are acceptable and in compliance with requirements and specifications in 10 CFR 20.1301, which defines dose limits allowable for individual members of the public; 10 CFR 20.2002, which requires approval of proposed disposal procedures; and, 10 CFR 20.2007, which requires compliance with environmental and health protection regulations, for liquid waste; and 10 CFR Part 40, Appendix A, Criterion 2, which requires non-proliferation of small waste disposal sites.

5.0 OPERATIONS

5.1 Corporate Organization and Administrative Procedures

This section describes the NRC staff's evaluation of the applicant's description of the corporate organization and administrative procedures for the proposed Amendment. The applicant stated that information on the corporate organization and administrative procedures was provided in the operation plans of the LCE Amendment and clarified in a response to staff's clarification comments that the corporate organization and administrative procedures are unchanged from those for the current license (LCI, 2017a; 2018d).

5.1.1 Regulatory Requirements

The NRC staff determines if the applicant demonstrated that the corporate organization and administrative procedures carried out as part of the proposed activities for the Amendment meet requirements of 10 CFR 20.1101, which defines the radiation protection program elements, 10 CFR 40.32(b), 10 CFR 40.32(c).

5.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria outlined in SRP Section 5.1.3, "Acceptance Criteria" (NRC, 2003a).

5.1.3 Staff Review and Analysis

The applicant states in the amendment and, in response to staff's clarifying comments, confirmed that the proposed corporate organization and administrative procedures in the Amendment include no changes to the currently approved corporate organization and administrative procedures and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2018d). The confirmation clarified that the proposed activities will incorporate unchanged the existing corporate organization and administrative procedures, specifically the management structure including the role and independence of the Radiation Safety Officer (RSO), and the Safety and Environmental Review Panel (SERP), in the approved license application, as amended.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.1
SER	5.1
KM and LCE Application	Operations Plan Attachment to NRC Form 313 Preamble to KM Amendment
License SUA-1598	License Conditions 9.4, 9.7, 10.17 & 12.14

The NRC staff verified that the prior descriptions on the corporate organization and administrative procedures in the approved license application, as amended, are applicable to the proposed activities. Furthermore, the NRC staff verified that license conditions 9.4, 9.7,

10.17 and 12.14 impose requirements on the licensee for the roles of the RSO (LC 9.7) and SERP (LC 9.4), and commitments to follow Regulatory Guide 8.31 (LC 9.7 and 10.17). The commitment to conform responsibilities of the corporate management in the Quality Assurance Project Plan (QAPP) to the Regulatory Guide 4.15 was completed in fulfillment of pre-operational License Condition 12.14, which is document in the NRC staff's verification letter and the 2013 pre-operation inspection report (NRC, 2013b; 2014c)

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issues and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff acknowledges that the evaluation findings in Section 5.1.4 of the prior SER for the approved license application, as amended, states that information was consistent with the acceptance criteria in SRP Section 5.1.3, "Acceptance Criteria" (NRC, 2003a) and met the requirements of 10 CFR 40.32(b). The prior evaluation findings did not specifically state that the information met the requirements of 10 CFR 20.1101 or 10 CFR 40.32(c).¹⁴ However, though not specifically stated in the evaluation findings of the prior SER, the NRC staff finds for this SER that the prior findings and review met the requirements of 10 CFR 20.1101 and 10 CFR 40.32(c) because staff concluded the descriptions for the corporate organization and administrative procedures met the acceptance criteria in SRP Section 5.1.3, "Acceptance Criteria" (NRC, 2003a) and staff documented in its detailed review of the descriptions for the corporate organization and administrative procedures conformed to guidance recommended in Regulatory Guide 8.31 to meet 10 CFR Part 20 Subparts B, C, D and F. Section 10 CFR 20.1101 is 10 CFR Part 20 Subpart B. Furthermore, SRP Section 5.1.4 states "[i]n addition, the requirements of 10 CFR 40.32(b), (c), and (d) are met as they relate to the proposed corporate organization and Safety and Environmental Review Panel functions" which, due to the passive voice, indicates conforming to Regulatory Guide 8.31 and requirements of 10 CFR 20.1101 that the finding for compliance with 10 CFR 40.32 are met with respect to the review areas for this section.

The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.1.4 Evaluation Findings

The NRC staff has completed its review of the corporate organization and administrative procedures included in this Amendment application. Staff finds that the proposed corporate organization and administrative procedures remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Based upon the above, the NRC staff concludes that the proposed corporate organization and administrative procedures are acceptable and in compliance with requirements 10 CFR 20.1101, 10 CFR 40.32(b), and 10 CFR 40.32(c), requiring that an adequate radiation protection

¹⁴ For 10 CFR 40.32(d), see Footnote 2.

program is established, that the applicant is qualified to use source material, and that the applicant's proposed equipment, facilities and procedures are adequate to protect the health and safety and the environment, and to minimize danger to life or property.

5.2 Management Control Program

This section describes the NRC staff's evaluation of the applicant's management control program for the proposed Amendment. The applicant stated that information on the management control program was provided in the operation plans of the LCE Amendment and clarified in a response to staff's clarification comments that the management control program is unchanged from that for the current license (LCI, 2017a; 2018d).

5.2.1 Regulatory Requirements

The NRC staff determines if the applicant demonstrated that the management control program carried out as part of the proposed activities for the Amendment application meet requirements of subparts L "Records" and M "Reports" of 10 CFR Part 20, 10 CFR 40.61, and Criteria 8 and 8a of Appendix A to 10 CFR Part 40.

5.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria outlined in SRP Section 5.2.3, "Acceptance Criteria" (NRC, 2003a).

5.2.3 Staff Review and Analysis

In response to staff's clarifying comments, the applicant confirmed that the proposed management control program in the Amendment include no changes to the currently approved management control program and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2018d). The confirmation clarified that the proposed activities associated with the Amendment application will incorporate unchanged the existing management control program, specifically the creation and updating of procedures for routing and non-routine work or maintenance and record keeping important for decommissioning and dose assessment.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.2
SER	5.2
Dryer Amendment Application	all
SER Amendment 1	all
KM and LCE Application	Operations Plan Preamble to KM Amendment
License SUA-1598	License Conditions 9.4, 9.8, 9.10, 11.1 & 11.6

The NRC staff verified that the prior descriptions on the management control program in the approved license application, as amended, are applicable to the proposed activities. Furthermore, the NRC staff verified that license conditions 9.4, 9.8, 9.10, 11.1 and 11.6, which impose or reiterated requirements on the licensee for the SERP (LC 9.4), records on cultural resources inventory (9.8), record maintenance (9.10), reporting requirements (11.1) and records important to decommissioning (11.6), and upon which the NRC staff's prior review and findings were based, in part, remain in effect.

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.2.4 Evaluation Findings

The NRC staff has completed its review of the management control process included in this Amendment application. Staff finds that the proposed management control process remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Therefore, the NRC staff concludes that the proposed in situ recovery process and equipment are acceptable and in compliance with requirements and specifications in subparts L "Records" and M "Reports" of 10 CFR Part 20, 10 CFR 40.61, and Criteria 8 and 8a of Appendix A to 10 CFR Part 40.

5.3 Management Audit and Inspection Program

This section describes the NRC staff's evaluation of the applicant's management audit and inspection program for the proposed Amendment. The applicant stated that information on the management audit and inspection program was provided in the operation plans of the LCE Amendment and clarified in a response to staff's clarification comments that the management audit and inspection program are unchanged from those for the current license (LCI, 2017a; 2018d).

5.3.1 Regulatory Requirements

The NRC staff determines if the applicant demonstrated that the management audit and inspection program carried out as part of the proposed activities for the Amendment meet requirements of 10 CFR 20.1101, 10 CFR 20.1702, 10 CFR 40.32(b) and (c), and Criteria 8 and 8a of Appendix A to 10 CFR Part 40.

5.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment was reviewed for compliance with the applicable requirements of 10 CFR parts 20 and 40 using the acceptance criteria outlined in SRP Section 5.3.3, "Acceptance Criteria" (NRC, 2003a).

5.3.3 Staff Review and Analysis

In response to staff's clarifying comments, the applicant confirmed that the proposed management audit and inspection programs in the Amendment include no changes to the currently approved management audit and inspection programs and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2018d). The confirmation clarified that the proposed activities associated with the Amendment will incorporate unchanged the existing management audit and inspection programs that are emplaced to maintain worker exposures and effluent releases are as low as reasonably achievable.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.3
SER	5.3
Dryer Amendment Application	all
SER Amendment 1	all
KM and LCE Application	Operations Plan Preamble to KM Amendment
License SUA-1598	License Conditions 9.7, 10.8, 10.18 & 11.1

The NRC staff verified that the prior descriptions on the management control program in the approved license application, as amended, are applicable to the proposed activities. Furthermore, the NRC staff verified that license conditions 9.7, 10.8 and 11.1, which impose or reiterated requirements on the licensee for conforming to Regulatory Guides 8.22, 8.30 and 8.31 (LC 9.7), impoundment inspections (10.8) and reporting requirements (11.1), and upon which the NRC staff's prior review and findings were based, in part, remain in effect. License condition 10.18 was added to License SUA-1598 with Amendment 1 with the approval of the dryer. This license condition requires the licensee to maintain effluent control systems and remains in effect.

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described.

The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.3.4 Evaluation Findings

The NRC staff has completed its review of the management audit and inspection programs included in the proposed Amendment application. Staff finds that the proposed management audit and inspection programs remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the programs to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

The NRC Staff concludes that the proposed management audit and inspection programs are acceptable and in compliance with requirements and specifications in 10 CFR 20.1101, which contain requirements for maintaining radiation exposure limits as low as is reasonably achievable, 10 CFR 20.1702, which requires use of process or other engineering controls to control the concentrations of radioactive material in the air, 10 CFR 4032(b) and (c) as they relate to the acceptability of audit and inspection programs to ensure protection of health and minimize danger to life and property, and Criteria 8 and 8a of Appendix A to 10 CFR Part 40, as they relate to the control of airborne effluent releases related to the yellowcake production and inspections of surface impoundments.

5.4 Qualifications for Personnel Conducting the Radiation Safety Program

This section describes the NRC staff's evaluation of the applicant's established qualifications for personnel conducting the radiation safety program for the proposed Amendment. The applicant stated that information on the qualifications for personnel conducting the radiation safety program was provided in the operation plans of the LCE Amendment and clarified in a response to staff's clarification comments that the qualifications for personnel conducting the radiation safety program are unchanged from those for the current license (LCI, 2017a; 2018d).

5.4.1 Regulatory Requirements

The staff determines if the applicant demonstrated that the qualifications for personnel conducting the radiation safety program carried out as part of the proposed activities for the Amendment application meet requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

5.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria outlined in SRP Section 5.4.3, "Acceptance Criteria" (NRC, 2003a).

5.4.3 Staff Review and Analysis

In response to staff's clarifying comments, the applicant confirmed that the proposed qualifications for personnel conducting the radiation safety program in the Amendment include no changes to the currently approved qualifications for personnel conducting the radiation safety program and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2018d). The confirmation clarified that the proposed activities

associated with the Amendment application will incorporate unchanged the existing qualifications for personnel conducting the radiation safety program that are emplaced to maintain qualified personnel conducting the radiation safety program.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.4
SER	5.4
Dryer Amendment Application	all
SER Amendment 1	all
KM and LCE Application	Operations Plan Preamble to KM Amendment
License SUA-1598	License Conditions 9.7, 12.3 & 12.5

The NRC staff verified that the prior descriptions on the qualifications for personnel conducting the radiation safety program in the approved license application, as amended, are applicable to the proposed activities. Furthermore, the NRC staff verified that license conditions 9.7, 12.3 and 12.5, which impose or reiterated requirements on the licensee for conforming to Regulatory Guide 8.31 (LC 9.7), for completing operating procedures for the radiation safety program (12.3) and for submitting qualifications of the radiation safety staff members (12.5), and upon which the NRC staff's prior review and findings were based, in part, remain in effect or were verified as completed during the preoperational inspection.

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.4.4 Evaluation Findings

The NRC staff has completed its review of the qualifications for personnel conducting the radiation safety program included in the Amendment application. The NRC staff finds that the qualifications for personnel conducting the radiation safety program remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Therefore, the NRC staff concludes that the proposed qualifications for personnel conducting the radiation safety program are acceptable conforming to recommendations in Regulatory Guide 8.31 and thus in compliance with requirements 10 CFR 20.1101, which defines the

radiation protection program and 10 CFR 40.32(b), which requires an applicant to be qualify use source and byproduct material to protect health and minimize danger to life or property.

5.5 Radiation Safety Training

This section describes the NRC staff's evaluation of the applicant's radiation safety training for the proposed Amendment. The applicant stated that information on the radiation safety training was provided in the operation plans of the LCE Amendment and clarified in a response to staff's clarification comments that the qualifications for personnel conducting the radiation safety program are unchanged from those for the current license (LCI, 2017a; 2018d).

5.5.1 Regulatory Requirements

The NRC staff determines if the applicant has demonstrated that the proposed radiation safety training program for the Amendment complies with 10 CFR 19.12, which provides requirements for instructions to workers, 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), as it relates to applicant qualifications through training.

5.5.2 Regulatory Acceptance Criteria

The NRC staff reviews the application for compliance with the applicable requirements of 10 CFR Parts 19, 20, and 40 using the acceptance criteria outlined in SRP Section 5.5.3 (NRC, 2003aa). Regulatory Guides 8.13 (NRC, 1999a), 8.29 (NRC, 1996a), and 8.31 (NRC, 2002b) provide guidance on (1) protecting the fetus, (2) a basis for training employees on the risks from radiation exposure in the work place, and (3) the fundamentals of protection against exposure to uranium and its progeny, respectively.

5.5.3 Staff Review and Analysis

In the LCE Amendment, the applicant provides no specific discussion of its radiation safety training program. In the KM Amendment, the Preamble incorporates by reference the version provided during the initial licensing of the Lost Creek licensed area (LCI, 2017a). The radiation safety training program for the Lost Creek licensed area was verified by staff as compliant with the acceptance criteria in Section 5.5.3 of the SRP and guidance in Regulatory Guides 8.13 (NRC, 1999a), 8.29 (NRC, 1996a), and 8.31 (NRC, 2002b).

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.5
SER	5.5
KM and LCE Application	Preamble (KM Amendment)
RAI Responses	none
License SUA-1598	License Condition 10.17

In the initial license application for the Lost Creek licensed area (LCI, 2008), as amended, the applicant described its radiation safety training program, including the content of the initial

training or indoctrination, testing, on-the-job training, and the extent and frequency of retraining. The NRC staff also reviewed the radiation safety training for visitors and contractors who handle contaminated equipment, and radiological and non-radiological hazard prevention specific to the areas of visitation.

The NRC staff found that the radiation safety training program proposed by the applicant for the Lost Creek licensed area was primarily complete except for the following items: (1) how the applicant's policy on declared pregnant women may affect a woman's work situation after she has filed a written declaration of pregnancy consistent with 10 CFR 20.1208 as recommended in Regulatory Guide 8.13 (NRC, 1999a); (2) acknowledgement in writing by each trainee that the instruction has been received and understood as recommended in Regulatory Guides 8.29 (NRC, 1996a) and 8.31 (NRC, 2002b); and (3) risk of biological effects resulting from exposure to radiation commensurate with the radiological risks present in the workplace as recommended in Regulatory Guide 8.29. The NRC staff's reasonable assurance determination was contingent upon the fulfillment of License Condition 10.17, which requires the applicant to ensure that radiation safety training is consistent with Regulatory Guides 8.13, "Instruction Concerning Prenatal Radiation Exposure" (as revised); Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure" (as revised); and Section 2.5 of Regulatory Guide 8.31 (as revised), or NRC approved equivalent.

During the pre-operational inspections, the NRC inspectors verified that the licensee was in compliance with elements of License Condition 10.17 (NRC, 2014c). There have been no changes to LC 10.17 since issuance of the initial license.

As noted in other sections of this SER, wellfield operations in the Lost Creek licensed area and LCE area will be similar during routine and non-routine operations. The NRC staff finds that the radiation safety training program that has been approved for the Lost Creek licensed area is acceptable for the LCE area during routine and non-routine operations, maintenance and cleanup activities. The NRC staff finds that aspects of the radiation safety training program are unchanged from the approved license application, as amended. Therefore, the radiation safety training program for the LCE area is acceptable because the same approved radiation safety program will be used and is compliance with SRP Section 5.5.3 and meets the requirements of 10 CFR 19.12, 10 CFR Part 20, Subpart C, and 10 CFR 40.40.32(b).

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.5.4 Evaluation Findings

The NRC staff has completed its review of the radiation safety training program at the LCE area *in situ* leach facility. This review included an evaluation using the review procedures in SRP Section 5.5.2 and the acceptance criteria outlined in SRP Section 5.5.3.

The radiation safety training program at the *in situ* leach site is consistent with the guidance contained in NRC Regulatory Guides 8.31 (NRC, 2002b), 8.13 (NRC, 1999), and 8.29 (NRC, 1996). The content of the training material, testing, on-the-job training, and the extent and

frequency of retraining are acceptable. Radiation safety instructions for employees are acceptable.

Based on the information provided in the application and the detailed review conducted of the radiation safety training program for the LCE area *in situ* leach facility, the staff concludes that the radiation safety training program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), as it relates to applicant qualifications through training.

5.6 Security

This section describes the NRC staff's evaluation of the applicant's security for the proposed Amendment. The applicant stated that information on the security was provided in the operation plans of the LCE Amendment and clarified in a response to staff's clarification comments that the security are unchanged from those for the current license (LCI, 2017a; 2018d).

5.6.1 Regulatory Requirements

The staff determines if the applicant demonstrated that the security carried out as part of the proposed activities for the Amendment meet requirements of 10 CFR Part 20, Subpart I.

5.6.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria outlined in SRP Section 5.6.3, "Acceptance Criteria" (NRC, 2003a).

5.6.3 Staff Review and Analysis

In response to staff's clarifying comments, the applicant confirmed that the proposed security in the Amendment include no changes to the currently approved security and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2018d). The confirmation clarified that the proposed activities associated with the Amendment will incorporate unchanged the existing security requirements that are emplaced to maintain security of stored material and control of material not in storage.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.6
SER	5.6
Dryer Amendment Application	all
SER Amendment 1	all
KM and LCE Application	Operations Plan Preamble to KM Amendment

The NRC staff verified that the prior descriptions on the security in the approved license application, as amended, are applicable to the proposed activities. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner

that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described.

The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.6.4 Evaluation Findings

The NRC staff has completed its review of the security included in this Amendment. The NRC staff finds that the proposed security remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Therefore, the NRC Staff concludes that the proposed security is acceptable and in compliance with requirements and specifications in Part 20, requiring the applicant maintain security of stored material and control of material not in storage.

5.7 Radiation Safety Controls and Monitoring

This section describes the NRC staff's evaluation of the applicant's radiation safety controls and monitoring programs used to ensure the applicant maintains radiation exposures and releases of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable (ALARA).

5.7.1 Effluent Control Techniques

5.7.1.1 Regulatory Requirements

The NRC staff determines if the applicant demonstrated that the proposed process instrumentation and controls used during operations carried out as part of the proposed activities for the Amendment meet requirements of 10 CFR 40.32(c), 10 CFR 40.32(d) and 10 CFR 40.41(c).

5.7.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 5.7.1.3, "Acceptance Criteria" (NRC, 2003a).

5.7.1.3 Staff Review and Analysis

During the course of the review, the NRC staff determined that areas of review and acceptance criteria in SRP Section 5.7.1 (NRC, 2003aa), which addresses effluent control techniques, are addressed in other sections of this SER. Specifically, the NRC staff's review of the applicant's effluent control techniques and monitoring are in SER Sections 4.1 and 5.7.7, respectively.

5.7.1.4 Evaluation Findings

The NRC staff has completed its review of the effluent control techniques at the LCE area *in situ* leach facility. This review included an evaluation using the review procedures in SRP Section 5.7.1.2 and the acceptance criteria outlined in SRP Section 5.7.1.3. The applicant has proposed an acceptable effluent control techniques at the LCE area *in situ* leach site. The applicant has demonstrated that important effluent streams are controlled and monitored. The applicant has used an acceptable pressurized processing tank system or appropriate ventilation systems in buildings where radon gas is vented. Acceptable control of the yellowcake dryer system is evidenced by a vacuum dryer or other appropriate particulate scrubber equipment on the dryer stack. The applicant has shown that the discharge of process water is within the dose limits of 10 CFR 20.1301. The applicant has demonstrated acceptable effluent control techniques and associated test and inspection frequencies to ensure specified performance. Record keeping and monitoring procedures are acceptable. Acceptable emergency procedures for managing equipment failures or spills are described by the applicant.

Based on the information provided in the application and the detailed review conducted of the effluent control techniques at the *in situ* leach facility, the NRC staff concludes that this program is acceptable and is in compliance with 10 CFR 20.1301, which provides dose limits for members of the public; 10 CFR 20.1101, which defines radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1201(a), which provides occupational dose limits; and 10 CFR Part 20, Subpart M, which defines requirements for reports. In addition, the staff concludes that the effluent control techniques meet the requirements of 10 CFR 40.32(b) to protect health and minimize danger to life and property, and 10 CFR Part 40, Appendix A, Criterion 8, which specifies standards for yellowcake dryer operations.

5.7.2 External Radiation Exposure Monitoring Program

5.7.2.1 Regulatory Requirements

The NRC staff determines if the applicant has demonstrated that its external radiation exposure monitoring program meets the requirements of 10 CFR 20.1101, 10 CFR Part 20, Subpart C, 10 CFR 20.1501(c), 10 CFR 20.1502, 10 CFR Part 20, Subpart L, 10 CFR Part 20, Subpart M, and 10 CFR 40.61.

5.7.2.2 Regulatory Acceptance Criteria

The NRC staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria in SRP Section 5.7.2.3, "Acceptance Criteria," (NRC; 2003). Regulatory Guides 8.30 (NRC, 2002a) and 8.31 (NRC, 2002b) provide guidance on demonstrating compliance with the regulations.

5.7.2.3 Staff Review and Analysis

In the LCE Amendment, the applicant provides no specific discussion of its external radiation exposure monitoring program. In the KM Amendment, the Preamble incorporates by reference the application provided during the initial licensing of the Lost Creek licensed area (LCI, 2017a). Subsequently (see discussion below), that external radiation exposure monitoring program for the Lost Creek licensed area was verified by staff as compliant with the acceptance criteria in

Section 5.7.2.3 of the SRP and guidance in Regulatory Guides 8.30 (NRC, 2002a) and 8.31 (NRC, 2002b)

The applicable sections reviewed by the NRC staff in the Amendment, referenced documents and associated SER's are as follows:

Approved License Application	5.7.2
SER	5.7.3
SER Amendment 1	all
SER Amendment 4	all
KM and LCE Application	Preamble (KM Amendment)
RAI Responses	none
License SUA-1598	License Conditions 10.14, 10.16

In the SER for the initial license application (NRC, 2011a), the NRC staff's review and analysis of the external radiation exposure monitoring program for the Lost Creek licensed area addressed radiation surveys, personnel monitoring, records, and reporting. The NRC staff found reasonable assurance that the applicant will comply with radiation exposure limits in 10 CFR Part 20 by ensuring that unrestricted areas do not exceed 2 mrem/hr and that surveys will be conducted with the appropriate survey instruments. The NRC staff included two license conditions to ensure that these requirements are met, as discussed below.

The first license condition, LC 10.16, addressed the treatment of controlled areas or restricted areas, which stated "Any area with exposure rates that exceed 2 millirem in any 1 hour must be immediately treated as either a controlled area or restricted area in accordance with 10 CFR 20.1301(a)(2)" (NRC, 2011a). Subsequently, the NRC staff found that the wording of LC 10.16 is not consistent with 10 CFR 20.1301(a)(2), which states that dose limits for individual members of the public are limited such that the dose in any unrestricted area from external sources does not exceed 2 millirem (0.02 millisievert) in any one hour. In Amendment 1 to the license (NRC 2013a), the wording of license condition 10.16 was changed to state, "Any area with exposure rates that exceed 2 millirem in any 1 hour must be immediately treated as a restricted area in accordance with 10 CFR 20.1301(a)(2)." There have been no changes to LC 10.16 since issuance of Amendment 1.

The second license condition, LC 10.14 was included in the initial license to address the requirement in 10 CFR 20.1501(a)(2)(i) to conduct surveys evaluating the magnitude and extent of radiation levels. The license condition states, "The licensee will use calibrated radiation instrumentation that can measure the full range of radiation exposure rates, or dose rates, that can be reasonably expected at an ISR facility to ensure the magnitude and extent of radiation levels are measured in accordance with 10 CFR 20.1501(a)(2)(i). The instrumentation used to measure airborne concentrations of radioactive materials will allow for a lower limit of detection (LLD), as described in Regulatory Guide 8.30 (as revised), to provide a 95% confidence that measurements are in conformance with 10 CFR 20.1201, 20.1204, 20.1301, 20.1501, and 20.1502." There are no changes to LC 10.14 since issuance of the initial license.

For monitoring external radiation in the LCE area, the NRC staff finds that aspects of the

external radiation monitoring program are unchanged from the approved license application, as amended, and that proposed activities in the LCE area are similar to licensed activities in the Lost Creek licensed area. Therefore, the approved external radiation monitoring program for the Lost Creek licensed area is acceptable for the scope of operations in the LCE area because the same survey methods, instrumentation, and equipment will be used for determining exposures of employees to external radiation during routine and non-routine operations, maintenance and clean-up activities.

The NRC staff reviewed the history of operations and has determined that the applicant has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.7.2.4 Evaluation Findings

The NRC staff has completed its review of the external radiation exposure monitoring program at the LCE area *in situ* leach facility. This review included an evaluation using the review procedures in SRP Section 5.7.2.2 and the acceptance criteria outlined in SRP Section 5.7.2.3. The applicant has proposed an acceptable external radiation exposure monitoring program at the LCE area *in situ* leach site. The applicant has provided an acceptable drawing(s) that depicts the facility layout and the location of external radiation monitors. The external radiation monitors are acceptably placed. The applicant has established appropriate criteria to determine which employees should receive external radiation monitoring. The applicant has demonstrated that the range, sensitivity, and calibration of external radiation monitors will protect health and safety of employees during the full scope of facility operations. Planned radiation surveys are adequate. Planned documentation of radiation exposures is acceptable.

The applicant's monitoring program is acceptable to protect workers from beta and gamma radiation. Based on the information provided in the application and the detailed review conducted of the external radiation exposure monitoring program at the LCE area *in situ* leach facility, the staff concludes that the external radiation exposure monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines a radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1201(a), which defines occupational dose limits; 10 CFR 20.1501, which provides requirements of surveying and radiation monitoring; 10 CFR 20.1502, which defines conditions requiring individual monitoring of external dose; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and 10 CFR Part 20, Subpart M, which defines reporting requirements.

5.7.3 Airborne Radiation Monitoring Program

5.7.3.1 Regulatory Requirements

The NRC staff determines if the applicant demonstrated that its airborne radiation monitoring program for the Amendment application meets the requirements of 10 CFR Part 20, Subparts B and C, 10 CFR 20.1501, and 10 CFR 20.1702.

5.7.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.3.3 of the SRP (NRC, 2003a). Regulatory Guide 8.30 (NRC 2002a) provides guidance on demonstrating compliance with the regulations.

5.7.3.3 Staff Review and Analysis

In the LCE Amendment, the applicant provides no specific discussion of its occupational airborne radiation monitoring program. In the KM Amendment, the Preamble incorporates by reference the application provided during the initial licensing of the Lost Creek licensed area (LCI, 2017a). The airborne radiation monitoring program for the Lost Creek licensed area was verified by staff as compliant with the acceptance criteria in Section 5.7.3.3 of the SRP and guidance in Regulatory Guides 8.30 (NRC, 2002a) and 8.31 (NRC, 2002b)

The applicable sections reviewed by the NRC staff in the Amendment application, referenced documents and associated SER's are as follows:

Approved License Application	5.7.3
SER	5.7.4
Amendment 1	all
Amendment 4	all
KM and LCE Application	Preamble (KM Amendment)
RAI Responses	none
License SUA-1598	License Conditions 10.15, 12.10(D)

In the SER for the initial license application (NRC, 2011a), the NRC staff's review and analysis of the airborne radiation monitoring program for the Lost Creek licensed area addressed airborne uranium particulate monitoring, radon progeny concentration monitoring, and respiratory protection program. Airborne radiation monitoring measures airborne concentrations at various locations in the processing plant and wellfields to determine necessary posting requirements, respiratory protection needs, and dose assessments. The airborne radiation monitoring program includes monitoring for the two primary contaminants, airborne particulates and radon progeny, and the instruments used for collecting and analyzing the results of air samples.

In the initial license application for the Lost Creek licensed area (LCI, 2008), as amended, the applicant identified methods that will meet the occupational dose limit requirements of Subpart C of 10 CFR Part 20 and will control the concentration of radioactive material in air as required in 10 CFR 20.1701. The applicant committed to using the sum of fractions method to determine the appropriate DAC if a radionuclide mixture is identified that does not meet the exclusion rule of 10 CFR 20.1204(g). In the SER for the initial license (NRC, 2011a), the NRC staff concluded that the information provided in the application, as supplemented by information to be submitted in accordance with a license condition, met the applicable acceptance criteria of SRP Section 5.7.3.3 and the requirements of 10 CFR Part 20, Subparts B, C, and H, 10 CFR 20.1501, and 10 CFR 20.1502(b). License condition (LC) 10.15 was included in the initial license to ensure

the applicant meets this commitment and complies with the exposure limits in 10 CFR 20.1201, 10 CFR 20.1204, and Table 1 of Appendix B to 10 CFR Part 20. This license condition states, “the licensee shall conduct radiological characterization of airborne samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 for each restricted area air particulate sampling location at a frequency of once every 6 months for the first 2 years following issuance of the license, and annually thereafter to ensure compliance with 10 CFR 20.1204(g). The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required for compliance with 10 CFR 20.1204(g).” There are no changes to LC 10.15 since issuance of the initial license (NRC, 2011a).

In April 2013, the applicant received NRC approval to operate two yellowcake rotary vacuum dryers within the central processing plant at the Lost Creek licensed area (NRC, 2013a). As part of its review, the NRC staff found acceptable the applicant’s airborne radiation monitoring program in the location of the vacuum dryers (NRC, 2013a). See Appendix A of this SER for information on Amendment 1 of the license.

For the Lost Creek licensed area, in Amendment 4 (NRC, 2016d), the NRC staff found that the applicant discussed how, in accordance with 10 CFR 20.1501, occupational doses from gaseous and particulates received throughout the entire licensed area from operations will be accounted for, and verified by surveys and/or monitoring. For information on Amendment 4, see SER section 5.7.7 and Appendix A.

Wellfield operations in the Lost Creek licensed area and LCE area will be similar, and during routine and non-routine operations, airborne radioactivity could result during routine and non-routine operations that include maintenance, spills, leaks, and clean-up activities. For monitoring airborne radioactivity in the LCE area, the NRC staff finds that aspects of the airborne radiation monitoring program are unchanged from the approved license application, as amended, and that the proposed activities in the LCE area are similar to licensed activities in the Lost Creek licensed area. Therefore, the approved airborne radiation monitoring program for the Lost Creek licensed area is acceptable for the scope of operations in the LCE area because the same instruments, survey methods, and criteria for determining airborne radiation monitoring locations and sampling frequencies will be used for determining exposures of employees to airborne radioactive materials.

The NRC staff reviewed the history of operations and has determined that the applicant has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.7.3.4 Evaluation Findings

The NRC staff has completed its review of the airborne radiation monitoring program at the LCE area *in situ* leach facility. This review included an evaluation using the review procedures in SRP Section 5.7.3.2 and the acceptance criteria outlined in SRP Section 5.7.3.3. The applicant has an acceptable airborne radiation monitoring program at the existing *in situ* leach site. The applicant has provided an acceptable drawing(s) that depicts the facility layout and the locations of airborne radiation monitors. The airborne radiation monitors are acceptably placed. The applicant demonstrated that the range, sensitivity, and calibration of monitors of airborne

radiation will enable accurate determinations of the concentrations of airborne radioactive species so as to protect the health and safety of employees during facility operations. The workers are acceptably protected from radon gas releases from venting of processing tanks and from yellowcake dust from drying operations, spills, and maintenance activities. Planned radiation surveys are acceptable. Planned documentation of radiation exposures is consistent with the requirements. The applicant's respiratory protection program is acceptable. The applicant program for monitoring uranium and sampling of radon or its daughters is acceptable. Employee internal exposure calculations will be performed in accordance with 10 CFR 20.1204(a).

Based on the information provided in the application and the detailed review conducted of the airborne radiation monitoring program at the LCE area *in situ* leach facility, the staff has concluded that the airborne radiation monitoring program is acceptable for extension to the LCE expansion and is in compliance with 10 CFR 20.1101, which defines radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1201(a), which provides individual occupational dose limits; 10 CFR 20.1201(e), which specifies allowed intake of soluble uranium; 10 CFR 20.1202, which describes the means of compliance when summing internal and external doses; 10 CFR 20.1203, for determination of dose from airborne external radiation; 10 CFR 20.1208, which specifies the exposure limits to a fetus during pregnancy; 10 CFR 20.1301 which identifies public dose limits; 10 CFR 20.1702, which allows employees to limit dose to individuals by controlling access, limiting exposure times, prescribing use of respiratory equipment, or use of other controls; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; 10 CFR Part 20, Subpart M, which provides requirements for reports and notification; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluents.

5.7.4 Exposure Calculations

5.7.4.1 Regulatory Requirements

The NRC staff determines if the applicant has demonstrated that the proposed exposure calculation for the Amendment application meets requirements of Subparts C, F, L, and M of 10 CFR Part 20. Specific regulations that must be followed include 10 CFR 20.1101, 10 CFR 20.1201(e), 10 CFR 20.1202, 10 CFR 20.1203, 10 CFR 20.1204(f), 10 CFR 20.1204(g), 10 CFR 20.1502, and 10 CFR 20.1208.

5.7.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.4.3 of the SRP (NRC, 2003a). Regulatory Guides 8.13, 8.30, 8.34 and 8.36 (NRC, 1999; 2002b; 1992a;b) provide guidance on demonstrating compliance with the regulations.

5.7.4.3 Staff Review and Analysis

In the LCE Amendment, the applicant provides no specific discussion of its exposure calculations. In the KM Amendment, the Preamble incorporates by reference the version provided during the initial licensing of the Lost Creek licensed area (LCI, 2017a). Exposure calculations for the Lost Creek licensed area were verified by staff as compliant with the

acceptance criteria in Section 5.7.4.3 of the SRP and guidance in Regulatory Guides 8.13 (NRC, 1992a) and 8.36 (NRC, 1992b)

The applicable sections reviewed by the NRC staff in the Amendment application, referenced documents and associated SER's are as follows:

Approved License Application	5.7.4
SER	5.7.5
SER Amendment 4	all
KM and LCE Application	Preamble (KM Amendment)
RAI Responses	none
License SUA-1598	License Conditions 12.12, 10.15

In the initial license application for the Lost Creek licensed area (LCI, 2008), as amended, the applicant described exposure calculations for workers and members of the public, and reporting and record keeping procedures. The NRC staff reviewed the applicant's exposure calculations in the SER for the initial license application (NRC, 2011a), in accordance with SRP Section 5.7.4.3 (NRC, 2003a). The NRC staff review included the applicant's reporting and recordkeeping procedures, exposure calculations for determining intake of radioactive materials by personnel in work areas (including natural uranium and airborne radon progeny), external and internal dose, and prenatal and fetal radiation exposures during routine operations, non-routine operations, maintenance, and cleanup activities. The NRC staff included License Condition 10.15 to ensure the applicant will identify each radionuclide in a mixture when the concentration of one or more is not known, so that the DAC for the mixture is the most restrictive DAC of any radionuclide in the mixture, as required by 10 CFR 20.1204 and 20.1502(b). See SER Section 5.7.4 for information on LC 10.15. There have been no changes to LC 10.15 since issuance of the initial license.

The NRC staff found the applicant's program for calculating internal and external exposures to workers acceptable, except that the applicant did not completely describe methods to ensure unmonitored employees who do not have dosimetry have not exceeded 10 percent of the dose limit. The initial license for the Lost Creek licensed area included a license condition (LC 12.12) to ensure compliance with 10 CFR 20.1502(a)(1), which required the applicant to submit to the NRC for review and approval the procedures by which it will ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C.

In letter dated June 13, 2013 (LCI, 2013c), the applicant provided a response to LC 12.12 and requested a license amendment to remove LC 12.12. The NRC staff found the applicant has established appropriate criteria to ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C, and the requirement of LC 12.12 was satisfied (NRC, 2016d). See Appendix A for additional information on Amendment 4 to the license.

As noted in other sections of this SER, wellfield operations in the Lost Creek licensed area and LCE area will be similar during routine and non-routine operations. The NRC staff finds that the parameters used in exposure calculations for the Lost Creek licensed area are representative of

conditions at the LCE area, and that the 10 percent increase in uranium production will not increase airborne uranium concentrations because there is no associated change in the maximum approved flow rate of lixiviant in the central processing plant. Therefore, the NRC staff finds the approved exposure calculation methodologies for the Lost Creek licensed area is acceptable for the scope of operations in the LCE area to calculate exposures to radioactive materials by personnel in work areas and during routine and non-routine operations, maintenance and cleanup activities.

For those sections that incorporate by reference the approved application, as amended, the NRC staff verified that the prior descriptions on the equipment used and materials processed in the processing cycle are applicable to the proposed activities. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.7.4.4 Evaluation Findings

The NRC staff has completed its review of the exposure calculations at the LCE area *in situ* leach facility. This review included an evaluation using the review procedures in SRP Section 5.7.4.2 and the acceptance criteria outlined in SRP Section 5.7.4.3.

The applicant has provided acceptable techniques for exposure calculations at the LCE area *in situ* leach site. The applicant has techniques to determine intake of radioactive materials by personnel in work areas. The applicant exposure calculations for natural uranium and airborne radon daughter exposure are acceptable and are in conformance with the guidance in Regulatory Guide 8.30 (NRC, 2002a) and Regulatory Guide 8.34 (NRC, 1992a). The applicant has acceptable methods to calculate prenatal and fetal radiation exposures consistent with Regulatory Guides 8.13 (NRC, 1999) and 8.36 (NRC, 1992b). All exposure calculation methods for routine operations, non-routine operations, maintenance, and cleanup activities are acceptable and are consistent with Regulatory Guide 8.30 (NRC, 2002a) and Regulatory Guide 8.34 (NRC, 1992a). The applicant has used parameters that are representative of the site, such as using both full- and part-time workers in exposure calculations. The applicant has considered maximum production capacity and anticipated efficiencies of airborne particulate control systems in exposure calculations. All reporting and record keeping is in conformance with Regulatory Guide 8.7 (NRC, 2005).

Based on the information provided in the application and the detailed review conducted of the exposure calculations at the *in situ* leach facility, the staff has concluded that the exposure calculations are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR 20.1201(a), which specifies individual occupational dose limits; 10 CFR 20.1201(e), which defines allowed intake of soluble uranium; 10 CFR 20.1202, which describes the means of compliance when summing internal and external doses; 10 CFR 20.1203, for determination of dose from airborne external radiation; 10 CFR 20.1204, which provides requirements for determination of internal exposure; and 10 CFR 20.1208, which specifies the exposure limits for a fetus.

5.7.5 Bioassay Program

5.7.5.1 Regulatory Requirements

The NRC staff determines if the applicant has demonstrated that the bioassay program for the Amendment application meets the requirements of Subparts C, L and M of 10 CFR Part 20.

5.7.5.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria in SPR Section 5.7.5.3 (NRC, 2003aa). Regulatory Guides 8.9 (NRC, 1993b), 8.22 (NRC, 1988), 8.30 (NRC, 2002a), and 8.34 (NRC, 1992a) provide guidance on demonstrating compliance the applicable regulations.

5.7.5.3 Staff Review and Analysis

In the LCE Amendment, the applicant provides no specific discussion of its bioassay program. In the KM Amendment, the Preamble incorporates by reference the version provided during the initial licensing of the Lost Creek licensed area (LCI, 2017a). The bioassay program for the Lost Creek licensed area was verified by staff as compliant with the acceptance criteria in Section 5.7.5.3 of the SRP.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.7.5
SER	5.7.6
KM and LCE Application	Preamble (KM Amendment)
RAI Responses	none
License SUA-1598	License Conditions None

In the initial license application for the Lost Creek licensed area (LCI, 2008), as amended, the applicant described its bioassay program, which is designed to monitor and document potential internal uptakes and radiation exposures and to confirm the results of the airborne uranium particulate monitoring program. The NRC staff found that the proposed collection frequency and analysis of urine samples are consistent with recommendations in Regulatory Guide 8.22 to ensure occupational exposures are monitored and comply with the limits in 10 CFR Part 20, Subparts C and F. In the approved License application, as amended (LCI, 2008c, 2010a), the applicant stated that it would perform in vivo analyses as follow up to confirmed urinalysis results in excess of action levels, as specified in Table 1 of Regulatory Guide 8.22. The NRC staff found that this procedure is acceptable, as it is consistent with the recommendations in Regulatory Guide 8.22 and complies with occupational exposure requirements in 10 CFR Part 20, Subparts C and F. The applicant defined an acceptable method for evaluating events when the applicant confirms positive bioassay urinalysis results and makes a decision to convert the confirmed results to a dose. The NRC staff found that the applicant's methodology for evaluating events complies with the requirements in 10 CFR Part 20, Subparts C and F.

The NRC staff found that the applicant's recordkeeping and reporting activities are consistent with recommendations in Regulatory Guide 8.30, and meet acceptance criterion (5) of SRP Section 5.7.5.3, and the regulatory requirements in 10 CFR Part 20, Subparts L and M. The applicant's plan to provide copies of exposure records to employees complies with 10 CFR 19.13.

Regarding the QA/QC for bioassay program, the NRC staff found that the applicant provided sufficient details to determine the QA/QC program is consistent with recommendations contained in Regulatory Guide 8.7 regarding blind samples, duplicates, sample turn-around time, and analytical LLD. The NRC staff found acceptable the applicant's QA/QC procedures for the bioassay program because the bioassay data will meet the (a) monitoring requirements in 10 CFR 20.1502; (b) exposure limits in 10 CFR 20.1201, 20.1207, or 20.1208; and (c) recording requirements in 10 CFR 20.2106.

For the purpose of establishing a DAC during operations, the applicant assumed U-238 inhalation Class W in accordance with Table 1 of Appendix B to 10 CFR Part 20 (LCI, 2008c; LCI, 2010a). The NRC staff found that the initial DAC of Class W is appropriate for determining compliance with Subpart C of 10 CFR Part 20. The chemical form of uranium mined from the Lost Creek licensed area and LCE area will be similar because of the proximity of their respective ore bodies and the use of the same lixiviant, processing equipment and techniques for the uranium mined in those areas. Therefore, the NRC staff finds that the continued use of U-238 inhalation Class W is acceptable for the LCE area.

Worker exposure to yellowcake dust occurs primarily from activities in the central processing plant, such as the yellowcake drying area and when regular maintenance is performed on drying and ventilation/filtration equipment. The Amendment application is for the expansion of wellfields in the LCE area, and does not include new sources of yellowcake dust because the uranium mined from the LCE area will be processed at the central processing plant in the Lost Creek licensed area. Therefore, the NRC staff finds that worker exposures to yellowcake dust will not change due to activities in the LCE area.

The NRC staff finds that aspects of the bioassay program are unchanged from the approved license application, as amended. Therefore, the bioassay program for the LCE area is acceptable because the same approved bioassay program will be used and is compliance with SRP Section 5.7.5 and meets the requirements of 10 CFR Part 20, Subparts C, L, and M.

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.7.5.4 Evaluation Findings

The NRC staff has completed its review of the bioassay program at the LCE area *in situ* leach facility. This review included an evaluation using the review procedures in SRP Section 5.7.5.2 and the acceptance criteria outlined in SRP Section 5.7.5.3.

The applicant has established an acceptable bioassay program at the LCE area *in situ* leach site that is consistent with Regulatory Guide 8.22 (NRC, 1988). An acceptable program for baseline urinalysis and exit bioassay is in place. Individuals routinely exposed to yellowcake dust are a part of the bioassay program. An acceptable action program to curtail uranium intake is established, and appropriate actions levels are set. The applicant has established reporting and record keeping protocols in conformance with the requirements of 10 CFR Part 20, Subpart L.

Based on the information provided in the application and the detailed review conducted of the bioassay program at the *in situ* leach facility, the staff concludes that the bioassay program is acceptable and is in compliance with 10 CFR 20.1204, which provides requirements for the determination of internal exposure; and 10 CFR Part 20, Subpart L, which establishes record keeping requirements.

5.7.6 Contamination Control Program

5.7.6.1 Regulatory Requirements

The NRC staff determines if the applicant has demonstrated that the proposed contamination control program for the Amendment application meets requirements of Subparts B, C, and F of 10 CFR Part 20.

5.7.6.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria in SRP Section 5.7.6.3 (NRC, 2003aa). Regulatory Guide 8.30 provides guidance on demonstrating compliance with the applicable regulations.

5.7.6.3 Staff Review and Analysis

In the LCE Amendment, the applicant provides no specific discussion of its radiation safety training program. In the KM Amendment, the Preamble incorporates by reference the version provided during the initial licensing of the Lost Creek licensed area (LCI, 2017a). The contamination control program for the Lost Creek licensed area was verified by staff as compliant with the acceptance criteria in Section 5.7.6.3 of the SRP and guidance in Regulatory Guides Regulatory Guides 8.30.

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.7.6
SER	5.7.7
KM and LCE Application	Preamble (KM Amendment)
RAI Responses	none
License SUA-1598	License Condition 12.11

In the initial license application for the Lost Creek licensed area (LCI, 2008), as amended, the

applicant described its contamination control program. The NRC staff's review of the contamination control program for the Lost Creek licensed area included contamination surveys for personnel, plant area, and material and equipment release; survey equipment; inspections; spill prevention methods; and records keeping and reporting activities of the applicant.

The NRC staff found that the applicant identified controls for preventing contamination from leaving a restricted area using appropriate survey equipment and instrumentation for natural uranium. The NRC staff found that the applicant described its radiation protection program in sufficient detail, followed survey guidance in Regulatory Guide 8.30, and committed to evaluating the isotopic composition of airborne radioactive material and the need for site specific beta-gamma surveys. The NRC staff also found that the applicant has provided a description of contamination survey instruments capability in dpm per 100 cm² that demonstrates that the range and calibration of the monitoring equipment will protect the health and safety of employees during the full scope of facility operations.

In the SER for the initial license (NRC, 2011a), the NRC staff concluded that the information provided in the application, as supplemented by information submitted in accordance with License Condition 12.11, meets the applicable acceptance criteria of SRP Section 5.7.5.3. This license condition required the applicant, prior to the preoperational inspection, to develop a survey program for beta-gamma contamination for personnel contamination from restricted areas, and beta-gamma contamination in unrestricted and restricted areas, that will meet the requirements of 10 CFR Part 20, Subpart F. License Condition 12.11 also required the applicant to provide, for NRC review and written verification, the surface contamination detection capability (scan MDC) for radiation survey meters used for contamination surveys to release equipment and materials for unrestricted use and for personnel contamination surveys. The detection capability in the scanning mode for the alpha and beta-gamma radiation expected shall be provided in terms of dpm per 100 cm².

In letter dated June 13, 2013 (LCI, 2013c), the applicant provided a response to LC 12.11 and requested a license amendment to remove LC 12.11. The NRC staff found the applicant has adequately described its monitoring equipment sensitivity, calibration methods and frequency, and planned use. The NRC staff found that the requirement of LC 12.11 was satisfied (NRC, 2016d). See Appendix A for additional information on Amendment 4 to the license.

Contamination within the LCE area can take the form of loose surface contamination and reside on structures, equipment, materials, personnel or land areas. Contamination control programs are designed to detect radiological contaminants that have escaped the boundary of the uranium recovery process equipment, and ensure that contamination will be confined and monitored in known areas and not spread to other areas. Potential contaminants in the Lost Creek licensed area and LCE area will be similar because of the proximity of their respective ore bodies, the lixiviant from the LCE area will be chemically similar to the lixiviant approved for use at the Lost Creek licensed area, and similar equipment, processing techniques and procedures will be used in both locations. Therefore, the NRC staff finds that the contamination control program that has been approved for the Lost Creek licensed area is acceptable for the LCE area.

The NRC staff finds that aspects of the contamination control program are unchanged from the approved license application, as amended. Therefore, the contamination control program for the LCE area is acceptable because the same approved contamination control program will be used and is compliance with SRP Section 5.7.6 and meets the requirements of 10 CFR Part 20, Subpart B, C, and f 10 CFR 40.32(b).

The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

5.7.6.4 Evaluation Findings

The NRC staff has completed its review of the contamination control program at the LCE area *in situ* leach facility. This review included an evaluation using the review procedures in SRP Section 5.7.6.2 and the acceptance criteria outlined in SRP Section 5.7.6.3.

The applicant has established an acceptable contamination control program at the LCE area *in situ* leach site. Acceptable controls are in place to prevent contaminated employees from entering clean areas or from leaving the site. The standard operating procedures will include provisions for contamination control, such as maintaining changing areas and personal alpha radiation monitoring before leaving radiation areas. Acceptable action levels have been set in accordance with Regulatory Guide 8.30 (NRC, 2002), and plans for surveys are in place for skin and personal clothing contamination. The applicant has established that all items removed from the restricted area are surveyed by the radiation safety staff and meet release limits. All reporting and record keeping is done in conformance with protocols established in Regulatory Guide 8.7 (NRC, 2005). The applicant has demonstrated that the range, sensitivity, and calibration of monitoring equipment will protect the health and safety of employees during the full scope of facility operations. The licensee has demonstrated that contaminated surfaces will not be covered unless, before covering, a survey documents that the contamination level is below the limits specified in Table 5.7.6.3-1. The applicant will determine the radioactivity on the interior surfaces of pipes, drain lines, or duct work by making measurements at appropriate access points that will have been shown to be representative of the interior contamination. The applicant has committed to establishing that contamination on equipment, or scrap will be within the limits in Table 5.7.6.3-1 before unrestricted release. To relinquish possession or control of equipment, or scrap with material in excess of the limits specified in Table 5.7.6.3-1, the applicant will provide detailed information on the contaminated material, provide a detailed health and safety analysis that shows that the release of the contaminated material will not result in an unreasonable risk to the health and safety of the public, and obtain NRC staff approval.

Based on the information provided in the application and the detailed review conducted of the contamination control program at the LCE area *in situ* leach facility, the staff concludes that the contamination control program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1501, which provides survey and monitoring requirements; and 10 CFR 20.1702, which allows employees to limit dose to individuals by controlling access, limiting exposure times, prescribing use of respiratory equipment, or other controls.

5.7.7 Airborne Effluent and Environmental Monitoring

This section discusses the applicant's proposed changes to its airborne effluent and environmental monitoring program to include operations in the LCE area, which focuses on radiation monitoring outside of the Lost Creek central processing plant area during operations and environmental monitoring around the facility.

5.7.7.1 Regulatory Requirements

The NRC staff determines if the applicant has demonstrated that proposed revisions to its airborne effluent and environmental monitoring program for the LCE Amendment meet the requirements of 10 CFR 20.1301, 10 CFR 20.1302, 10 CFR 20.1101(d), 10 CFR 20.1501, 10 CFR Part 20, Subpart L, 10 CFR 40.65, and Criterion 7 and 8 of Appendix A to 10 CFR Part 40.

5.7.7.2 Regulatory Acceptance Criteria

The LCE Amendment was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria presented in SRP Sections 5.7.1.3, 5.7.7.3, and 7.3.1 (NRC, 2003a), except that the NRC staff determined that SRP Section 7.3.1.1.3 is not applicable because there are no public exposures from water pathways at the LCE area. Regulatory Guide 4.14 "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980), and Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities" (NRC, 1993a) provide guidance on how to demonstrate compliance with the applicable regulations.

5.7.7.3 Staff Review and Analysis

The applicant's discussions on the airborne effluent and monitoring program are presented in Section OP-5.0, "Effluent Control Systems" and Section OP-6.0, "Airborne Effluent and Environmental Monitoring Program" (LCI, 2017a). The applicant states that the LCE Amendment includes no changes to the currently-approved equipment used, materials processed in effluent control systems, and incorporates by reference the applicable sections in the approved license application, as amended (LCI, 2017a). The applicant states in Section OP-5.1.2, "Radioactive Emissions," that the Amendment proposes to increase the total number of wellfields and, therefore, effluent quantities will change. The applicant states in Section OP-6.0 that the airborne effluent and environmental monitoring program will be conducted as described in Sections 5.7.7 and 5.7.8 of the approved license application, as amended, and SERP-approved changes to this program (LCI, 2017c; 2018a)

The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SERs are as follows:

Approved License Application	5.7.1, 5.7.7
SER	5.7.2, 5.7.8
Dryer Amendment Application	all
SER Amendment 1	all
SER Amendment 4	all
SER Amendment 5	Section 5.1.1
SER Amendment 6	all

For those application sections that incorporate by reference the approved license application, as amended, the NRC staff verified that the prior descriptions of the equipment used and materials processed are applicable to the proposed activities. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. Therefore, the NRC staff's prior determination on these systems remains current. The NRC staff determined that no changes in effluent controls are required for the LCE area because the proposed expansion is for new wellfields using previously approved procedures and equipment. In the following subsections, the NRC staff focused its evaluation on those changes proposed by the applicant required to support the expansion in the LCE area.

Unless otherwise stated, the information reviewed in this section is from information contained in the LCE Amendment (LCI, 2017a) and other sources, as described below. The following sections discuss the applicant's proposed revisions to its airborne effluent and environmental monitoring program. This includes radiation monitoring outside of the plant area during operations and environmental monitoring around the facility.

5.7.7.3.1 Airborne Effluent and Monitoring

For the airborne effluent monitoring program, the NRC staff's evaluation is provided in the SER for the initial license (NRC, 2011a) and, as described below, in the subsequent SER in support of removing preoperational license conditions (NRC, 2016d). In the 2011 evaluation, the NRC staff stated that it found the applicant's proposed airborne effluent monitoring program acceptable aside from two slight deficiencies: assessing doses in unrestricted areas and the lack of stack sampling. The NRC staff noted that the proposed sampling program could be part of the applicant's compliance strategy, but required the applicant to inform the NRC of the precise manner in which effluents will be quantified. The NRC staff had reasonable assurance that the applicant would monitor airborne effluents and control doses to the public in accordance with 10 CFR 20.1301. The reasonable assurance determination was contingent upon the applicant's fulfillment of a license condition in SER Section 5.7.8.4 (NRC 2011a). The text of the license condition (number 12.10) in the initial license was:

"Prior to the preoperational inspection, the licensee shall provide for the following information for the airborne effluent and environmental monitoring program in which it shall develop written procedures to:

- (a) Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring.
- (b) Evaluate the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302.
- (c) Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with

10 CFR Part 20, Appendix B, Table 2.

- (d) Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire license area from licensed operations will be accounted-for in, and verified by, surveys and/or monitoring.

In response to the License Condition 12.10 described above, the applicant submitted to the NRC letters dated January 16, 2015, July 28, 2015, and January 26, 2016 (LCI, 2015f, 2015g, 2016h). These letters provide information about the monitoring program for air effluent releases, and how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire license area from licensed operations will be accounted-for in, and verified by, surveys and/or monitoring. The NRC staff evaluated the program descriptions contained in these letters and, in March 2016, approved Amendment 4 to remove License Condition 12.10 (NRC, 2016d). At that time, the NRC staff also revised License Condition 9.2 to state that the licensee shall conduct operations in accordance with the licensee's commitments, representations, and statements contained in these three letters. See Appendix A of this SER for additional information on Amendment 4.

In accordance with specific commitments regarding effluent monitoring (LCI, 2015f, 2015g, 2016h) for the Lost Creek licensed area, airborne concentrations of radon progeny and radionuclide particulate matter emissions will be measured in wellfields and header houses in the LCE area (LCI, 2017). For the wellfields, measurements of radon daughter concentrations at representative injection and production wells are used to estimate quantities of radon released to the atmosphere. For the header houses, radon, radon daughter, and uranium concentration measurements are made in 20% of the header houses, and direct measurements of header house ventilation fan flow rates are taken, or design flow rates if measurements cannot be made, to estimate quantities of radionuclides released.

The NRC staff has reviewed the commitments in these letters, and finds that the applicant's commitments, statements, and representations, are sufficiently broad to encompass operations for the LCE area, as described further below.

5.7.7.3.2 Environmental Monitoring

The applicant states in Section 5.1.2, "Radioactive Emissions," that the total number of wellfields and, therefore, the source of radon will change due to operations in the LCE area (LCI, 2017). Wellfields are a source of diffuse emissions of gaseous radon, radon progeny, and radioactive particulate matter. Therefore, in this SER section, the NRC staff focused its review on the applicant's proposed revisions to its airborne monitoring program to include diffuse emissions of gaseous radon and radon progeny, and radioactive particulate matter, from wellfield activities in the LCE area.

The licensee's operational environmental monitoring program for the Lost Creek licensed area is described in Section 5.7.7 of the approved license application, as amended (LCI 2008a, 2010a). The NRC staff's evaluation of environmental monitoring station locations for the LCE area is described in Section 2.9 of this SER. In response to RAI-18, the applicant provided an updated description of its environmental monitoring program (LCI, 2017c, 2018a). Air particulate, radon, radon progeny and direct radiation area collected from monitoring stations located throughout the Lost Creek licensed area. Also, samples of airborne effluents are collected from vents that exhaust process tanks to the environment. For the LCE area, Section

D.4.2, "Air Quality," of the LCE Amendment (LCI, 2017a), states that an additional environmental monitoring station (number HV-6/PR-13) was installed at the eastern boundary of the LC East area in 2012. The results of measurements taken for six quarters from this station are presented in Section D10, "Background Radiological Characteristics" of the Lost Creek Amendment (LCI, 2017a), and include natural gamma readings collected from OSLs, airborne radionuclides sampled by a high volume air station and radon-222 readings from track etch cups. In response to RAI-18 (LCI, 2018a), the applicant committed to resume operation of monitoring station HV-6/PR-13 upon start of operations in the LCE area.

For the Lost Creek licensed area, environmental and effluent monitoring has been conducted on a quarterly basis since 2013. The applicant is required by License Condition 11.1(D) to submit to the NRC a semi-annual report that documents the results of its environmental and effluent monitoring program. See Table 6 of Appendix A to this SER for information on these reports. The applicant has not proposed revisions to its effluent and environmental monitoring program, except for the addition of data acquired from monitoring station HV-6/PR-13 upon start of operations in the LCE area.

The NRC staff finds that the environmental monitoring program for the Amendment is acceptable. Furthermore, the NRC staff agrees that monitoring station HV-6/PR-13 should be included in the applicant's environmental monitoring program upon commencement of wellfield operations in the LCE area.

5.7.7.3.3 Public Dose Assessment

The Lost Creek Amendment includes a request to increase the total annual production from 2.0 million pounds [0.91 million kg] to 2.2 million pounds [1.0 million kg] equivalent of dried yellowcake product (10% increase). The total annual production of 2.2 million pounds [1.0 million kg] equivalent of dried yellowcake product is taken into account in the public dose assessment described below. For the Lost Creek licensed area, the NRC staff previously found that the applicant discussed how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources would be accounted-for and verified by surveys and/or monitoring. For the LCE Amendment, the applicant will account for the quantity of principal radionuclides from all point and diffuse sources using the same procedures and equipment previously approved by the NRC staff for the Lost Creek licensed area. As discussed below, the NRC staff finds nothing to invalidate its previous findings. The LCE area and the activities proposed for it are substantially similar to the areas previously reviewed and hereby extends the previous findings for those effluent control techniques to the proposed expansion. Therefore, the NRC staff finds the applicant's effluent control techniques consistent with acceptance criteria (2) of SRP Section 4.1.3 and (4) of SRP Section 5.7.1.3 by describing (a) the airborne effluent control systems that are appropriate for the types of effluents generated and (b) performance specifications for the operation of the effluent controls that are consistent with those in Regulatory Guide 3.56, Section 1 (NRC, 1986a).

The applicant demonstrates compliance with public dose limits using the method in 10 CFR 20.1302(b)(1), in which it must show, by measurement or calculation, that the total effective dose equivalent (TEDE) to the individual likely to receive the highest dose from licensed operation does not exceed the annual dose limit (NRC, 2016d). By letter dated January 26, 2015 (LCI 2015f), the applicant stated that either a package delivery driver or on-site contractor are the individuals likely to receive the highest public dose. In letter dated July 28, 2015 (LCI, 2015g), the applicant's estimate of the annual TEDE to the package delivery driver was about 0.2 mrem per year. For the onsite contractor, the dose was estimated by assuming that

contractors visit the plant for 24 hours per year, and received a dose rate equivalent to that of the highest occupational dose received at the plant, exclusive of the dryer operator. The applicant stated that this approach is very conservative because contractors at the plant would normally be considered to receive an occupational dose and would receive radiation worker training. The NRC staff notes that, in the letter dated July 28, 2015 letter (LCI, 2015g), the applicant estimated the public dose to a contract worker was about 50 mrem per year. The applicant updates public dose estimates in the semi-annual effluent and environmental monitoring reports submitted to the NRC. The estimated public dose to a contract worker was about 3 mrem per year, according to information contained in the semi-annual report for the second half of year 2017. See Table 6 of Appendix A to this SER for information on the semi-annual reports.

The applicant also evaluated doses to other members of the public outside a controlled or restricted area, including the controlled area immediately to the east of the central processing plant, in the prevailing downwind direction, near the holding ponds. Based on low occupancy times of less than one day per year, the applicant concluded that the potential TEDE at this location is very low and would not be the location of the maximally exposed member of the public. Also, the applicant performed downwind air sampling at nine locations to confirm that individuals near the facility are not receiving the highest dose from licensed operations. Measurements at these locations include quarterly radon by track-etch device, quarterly radon progeny by modified Kusnetz, quarterly gamma exposure rate measurements, and quarterly air particulate samples for uranium. The NRC staff found that the requirement in License Condition 12.10(b) was met (NRC, 2016d).

In LCE Amendment Attachment D10-2, "Revised Estimated Radiation Doses to Members of the Public from the Lost Creek Project Including the Eastern Expansion, Sweetwater County, WY," the applicant updated its evaluation of the maximally exposed member of the public to include licensed activities in the LCE area (LCI, 2018a). The applicant provided in Attachment D10-2 the results of an analysis using the MILDOS-AREA code version 3.10. The applicant stated that the facility has a vacuum dryer with no particulate matter releases, so only radon-222 releases were considered in its evaluation. The MILDOS-AREA output in Attachment D10-2 shows that the applicant modeled doses to 21 off-site receptors within 24 km (15 mi) over 14 years of operations in the Lost Creek licensed area and the LCE area. The applicant also modeled collective doses for the offsite population within 80 km (50 mi). The applicant estimated the maximum annual total effective dose equivalent, at any individual receptor location, to be 8.6 mrem per year in the sixth year of operation in the LCE area. The applicant stated all doses were below the 100 mrem per year dose limit in 10 CFR 20.1301 for individual members of the public.

To evaluate the applicant's calculation, the NRC staff independently verified the applicants estimated dose to the member of the public likely to receive the highest dose using the applicant's detailed production schedule in Lost Creek Technical Report, Figure RP-3, "Proposed Bond Schedule," the applicant's descriptions of individual emission sources, and the MILDOS-AREA computer code version 4.02 to (for model input and output, see NRC, 2018c). Figure RP-3 indicates that expected operations for 14 years include simultaneous operation and restoration of wellfields in the Lost Creek and Lost Creek East areas. The NRC staff modeled the wellfield bleed from the Lost Creek and Lost Creek East sites as area sources located at the Lost Creek central processing plant ponds. The NRC staff also modeled wellfield leaks in each production area as separate area sources. The release of radon during ion exchange resin transfers was modeled as a point source at the central processing plant, and the releases of radon from mud pits during initial well construction was modeled as an area source. The NRC

used the on-site meteorological data set that was used by the applicant in its calculation; the data are discussed in SER Section 2.3.3.4.

The NRC staff's verification model estimated the highest annual individual total effective dose equivalent to be 5.9 mrem per year during the fifth year of operations in the Lost Creek licensed area and LCE area. The results are at the same location of the highest estimated annual individual dose estimated by the applicant, which is downwind of the central processing plant. The NRC staff attributes the slight differences in modeling results (i.e., 5.9 mrem per year in the fifth year of operation versus 8.6 mrem per year in the sixth year of operation) from the applicant's estimates to differences in modeling assumptions and versions of the MILDOS-AREA code used by the NRC staff and applicant.

In addition, the NRC staff evaluated nearby individuals likely to receive the highest dose, including residents at the Sweetwater Uranium Mill, the town of Baroil, Wyoming, an onsite contractor located near the central processing plant, and six additional locations expected to receive the highest dose. The NRC staff's estimate of the highest dose to a resident at the Sweetwater Uranium Mill guard trailer was 0.3 mrem per year during the fifth year of operations in the LCE area, and 0.1 mrem per year in Bairoil, WY during the eleventh year of operations in the LCE area. These annual dose estimates compare favorably with the applicant's estimates of annual dose at these locations. These doses are below the 100 mrem per year dose standard in 10 CFR 20.1301 for individual members of the public and are, therefore, acceptable and consistent with the applicant's conclusion (LCI, 2018a)

5.7.7.3.4 Consideration of Radon-222 Progeny

In accordance with commitments by the licensee made in the three letters described above, the applicant is required to measure radon at the boundaries of the unrestricted areas. At the Lost Creek licensed area, unrestricted areas are located outside the central processing plant and outside well field production areas. The applicant committed to factor radon progeny into its public dose estimates by using measurements of radon progeny (i.e., working levels) at each location where members of the public are likely to receive the highest exposures in accordance with 10 CFR 20.1302. The NRC staff found that the applicant discussed and identified how radon progeny will be accounted for in analyzing public dose, and met the requirement of license condition 12.10(C). The NRC staff found that the applicant discussed and identified how radon progeny will be accounted for in analyzing public dose, and met the requirement of license condition 12.10(C).

The new wellfields in the LCE area should have similar radon progeny concentrations as the Lost Creek licensed area because of the similarities in aquifer baseline chemistry and lixiviant makeup. Therefore, the NRC staff finds that this method is acceptable for the measurement of radon progeny in the LCE area.

5.7.7.4 Evaluation Findings

The NRC staff previously reviewed and found acceptable the applicant's airborne effluent and environmental monitoring program for the Lost Creek licensed area (NRC 2016d). The NRC staff has completed its review of changes to the airborne effluent and environmental monitoring program at the LCE area, which included an evaluation using the review procedures in SRP Section 5.7.7.2, "Review Procedures," and the acceptance criteria outlined in SRP Section 5.7.7.3, "Acceptance Criteria." The applicant has established acceptable airborne effluent and environmental monitoring programs at the LCE area. The programs are consistent with

guidance in Regulatory Guide 4.14 (NRC 1980). The applicant will continue to sample effluent and environmental media in accordance with its approved effluent and environmental program for the licensed Lost Creek area, and supplement this program with an additional monitoring station for the LCE area. Locations of monitoring stations are consistent with Regulatory Guide 4.14 (NRC 1980). Instrumentation is appropriate.

Based on the information provided in the Lost Creek East Amendment (LCI, 2017a) and applicant's commitment to include an additional environmental monitoring station for the LCE area, the NRC staff concludes that the airborne effluent and environmental monitoring programs are acceptable and are in compliance with 10 CFR 20.1302, which requires effluent monitoring to determine dose to individual members of the public; 10 CFR 20.1501, which specifies survey and monitoring requirements; 10 CFR Part 20, Subpart L, which establishes record keeping requirements; and 10 CFR 40.65, which specifies effluent and environmental monitoring requirements.

5.7.8 Groundwater and Surface Water Monitoring Programs

5.7.8.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed operational groundwater and surface water monitoring programs meet the requirements of 10 CFR 40.32(c); 10 CFR 40.41(c); and 10 CFR Part 40, Appendix A, Criterion 5B, 5D and 7.

5.7.8.2 Regulatory Acceptance Criteria

The Amendment was reviewed for compliance with applicable requirements of 10 CFR Part 40 using acceptance criteria outlined in SRP Section 5.7.8.3 (NRC, 2003a).

5.7.8.3 Staff Review and Analysis

The applicant's operational groundwater and surface water monitoring programs are presented in the Operations Plan sections 3.2 and 3.6.4. The applicant states that Amendment includes no changes to the programs and incorporates by reference the applicable sections (Section 5.7.8) in the approved license application, as amended (LCI, 2017). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	5.7.8, 3.2
SER	5.7.9, 3.2, 4.2.3.1, 2.4.4
Class V Amendment Application	All
SER	All
KM and LCE Application	Operational Plan Section 3.2, 3.6.4 (LCE Amendment)
RAI Responses	RAI-4
License SUA-1598	License Conditions 10.9, 10.11, 10.12, 10.20, 11.3, 11.4, 11.5, 12.3, 12.4, 12.7, 12.15

The applicant incorporates, by reference, Section 5.7.8 of the approved license application, as amended. In Section 5.7.9 of the SER for the license application (NRC, 2011a), the NRC staff reviewed the operational monitoring programs including the baseline monitoring, excursion monitoring, wellfield pumping tests, life-of-mine wells, nearby private wells, storage impoundment wells, surface water and corrective actions. The Amendment incorporates by reference the amendment that includes a monitoring program for the Class V shallow disposal well (see Amendment 5). For those sections that incorporate by reference the approved application, as amended, the NRC staff verified that the groundwater and surface water monitoring programs are applicable to the proposed activities. The NRC staff reviewed the history of operations and has determined that the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the procedures and equipment will be carried out in the future as described. Except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends them to the LCE expansion.

The NRC staff finds the following aspect is a change from the programs evaluated for the approved license application, as amended:

- Excursion Monitoring Program where mine units in the KM and HJ horizons overlap.

The NRC staff evaluated the above change in SER Section 3.1.3. The NRC staff's finding that the change is acceptable based on a revision to License Condition 11.5 (see Section 3.1.4). Furthermore, NRC staff's evaluation in SER Section 3.1.4 is the basis for a finding that the changes meets Acceptance Criterion 5.7.8.3(3) of the SRP.

Based on the above, the NRC staff finds the applicant's operational groundwater and surface water monitoring programs meets the acceptance criteria in SRP Section 5.7.8.3.

5.7.8.4 Evaluation Findings

The NRC staff has completed its review of the operational groundwater and surface water monitoring programs included in this Amendment. Staff finds that the operational groundwater and surface water monitoring programs remain unchanged from those previously reviewed in the approved license application, as amended, except as noted below. The NRC staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends them to the LCE expansion.

The change in the groundwater and surface water monitoring programs is the excursion monitoring program where mine units in the HJ and KM horizons overlap. Staff found that the change is acceptable with the modifications to License Condition 11.5 as described in SER Section 3.1.4.

Therefore, the NRC staff concludes that the operational groundwater and surface water monitoring programs are acceptable and in compliance of 10 CFR 40.32(c), which requires the applicant's proposed equipment, facilities and procedures to provide adequate protection of health and minimize danger to life and property; 10 CFR 40.41(c), which requires the applicant

to confine source and byproduct material to the locations and purposes authorized in the license; and 10 CFR Part 40, Appendix A, Criteria 5B and 5C, which provide concentration limits for contaminants, Criterion 5D, which requires a groundwater corrective action program, and Criterion 7, which requires operational groundwater and surface water monitoring programs.

5.7.9 Quality Assurance

5.7.9.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed quality assurance program for the LCE area meets requirements of 10 CFR 20.1101, 10 CFR Part 20 Subpart L, and Subpart M.

5.7.9.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 5.7.9.3 (NRC, 2003a). Regulatory Guide 4.15 (NRC, 1979, as revised) provides guidance on demonstrating compliance with the applicable regulations.

5.7.9.3 Staff Review and Analysis

In the LCE Amendment, the applicant provides no specific discussion of its Quality Assurance Project Program (QAPP). In the KM Amendment (LCI, 2017a), the Preamble incorporates by reference the version provided during the initial licensing of the Lost Creek licensed area (LCI, 2008). Subsequently (see discussion below), the QAPP version for the Lost Creek licensed area was verified by staff as compliant with the acceptance criteria in Section 5.7.9.3 of the SRP and guidance in Regulatory Guide 4.15 (NRC, 1979, as revised).

The applicable sections reviewed by the NRC staff in the LCE Amendment, other referenced documents and associated SERs are as follows:

Approved License Application	5.7.9
SER	5.7.10
Amendment 7	all
KM and LCE Application	Preamble (KM Amendment)
RAI Responses	RAI-19
License SUA-1598	License Condition 12.14

In the SER for the original license application, the NRC staff found that the applicant provided only sufficient information for an outline of its QAPP, and required the applicant to submit a completed QAPP to the NRC to verify that it was consistent with acceptance criteria in SRP Section 5.7.9.3 and Regulatory Guide 4.15 (NRC, 1979, as revised). Consequently, the NRC staff imposed license condition (LC) 12.14 for the applicant to submit the completed QAPP at least 60 days prior to the preoperational inspection. The applicant submitted a completed QAPP in April 2013 for NRC staff review prior to the preoperational inspection, along with a request to remove LC 12.14 (LCI, 2013a). In response to NRC staff comments on the QAPP

elements (NRC, 2013b), the applicant submitted a revised QAPP in July 2013 (LCI, 2013b), which the NRC staff verified was consistent with the acceptance criteria in SRP Section 5.7.9 and guidance in Regulatory Guide 4.15 (NRC, 1979, as revised). The NRC staff's evaluation of the approved QAPP for the Lost Creek licensed area is provided in Amendment 7 (NRC, 2018d).

The NRC staff requested, in RAI-19, the applicant to submit an updated version of the QAPP to verify its applicability for the LCE Amendment (NRC, 2017e). In response to RAI-19, the applicant stated that the QAPP for the Lost Creek licensed area is applicable to the LCE Amendment (LCI, 2017c) and submitted a version of the QAPP from May 2016 (LCI, 2018a). The NRC staff found that May 2016 version of the QAPP did not fully incorporate the quality assurance elements contained in approved version of the QAPP (NRC, 2018d). In response, the applicant submitted an updated version of the QAPP in June 2018 (LCI, 2018f). The NRC staff reviewed the July 2018 version and finds that it is consistent with the approved version of the QAPP (NRC 2018d), with only minor updates reflecting changes in the applicant's organization and operations.

The NRC staff finds that aspects of the applicant's quality assurance program (LCI, 2018f) are unchanged from the approved license application, as amended, (NRC, 2018d) and that the programs proposed in the LCE Amendment do not require additional quality assurance elements. Therefore, the NRC staff finds that the applicant has demonstrated a quality assurance program that meets the acceptance criteria in the SRP and guidance in Regulatory Guide 4.15 (NRC, 1979, as revised).

5.7.9.4 Evaluation Findings

The NRC staff has completed its review of the quality assurance program for the LCE area. This review included an evaluation using the review procedures in SRP Section 5.7.9.2 and the acceptance criteria outlined in SRP Section 5.7.9.3.

The applicant has established an acceptable quality assurance program for the LCE area. The quality assurance program has been applied to all radiological, effluent, and environmental programs consistent with Regulatory Guides 4.14 (NRC, 1980) and 4.15 (NRC, 1979, as revised) and acceptance criteria in Section 5.7.9 of the SRP. The applicant has agreed to retain survey and instrument calibration records for 3 years and to retain records to demonstrate compliance and evaluate dose, intake, and releases to the environment until NRC terminates the license.

Based on the information provided in the application and the detailed review conducted of the quality assurance program at the *in situ* leach facility, NRC staff concludes that the quality assurance program is acceptable and is in compliance with 10 CFR 20.1101, which provides requirements for radiation protection programs; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and 10 CFR Part 20, Subpart M, which defines reporting and notification requirements.

6.0 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

In this SER Section, the NRC staff's evaluation is focused on the applicant's description of its groundwater quality restoration program, surface reclamation, and facility decommissioning for the Lost Creek facility with the addition of the proposed activities associated with the current Amendment application. The NRC staff's prior review of the existing plans for groundwater quality restoration, surface reclamation, and facility decommissioning in the approved license application, as amendment, are documented in the NRC staff's SER's for the Lost Creek ISR Project and the Class V Amendment (NRC, 2011a; 2016c).

The descriptions of the program within current Amendment application are found in the included LCE Reclamation Plan and a revised schedule for the operations, restorations and facility decommissioning. The applicant states that the LCE Reclamation Plan includes only minor changes from the previously approved plan with most sections of the LCE Restoration Plan incorporating by reference wholesale sections of the previously approved plan. The minor changes are identified by the applicant as the addition of the Class V wells, a revised schedule and collection of baseline data for the LCE area (LCI, 2017b).

For those aspects that reportedly remain unchanged, the NRC staff's evaluation consists of verifying that the proposed activities are consistent with the previously approved plans, evaluating the historic site operations to determine that the facility has operated in a safe manner, identifying any un-reviewed safety-related issues, and ensuring the plans will be followed in the future in accordance with Appendix A of the SRP (NRC, 2003a). For those changes identified by the applicant as well as other changes identified by the NRC Staff, the NRC staff's evaluation was performed in accordance with guidance found in Section 6 of the SRP (NRC, 2003a).

6.1 Plans and Schedules for Groundwater Quality Restoration

6.1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed plans and schedules for groundwater quality restoration meet the requirements of 10 CFR 40.32(c), 10 CFR 40.32(d), 10 CFR Part 40.42, and Criteria 5B(5) and 6(7) of Appendix A to 10 CFR Part 40.

6.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 6.1.3 or Appendix A of the SRP (NRC, 2003a).

6.1.3 Staff Review and Analysis

The applicant states that all sections in the LCE Restoration Plan, including the plans and schedules for groundwater quality restoration, incorporate by reference unchanged sections of the approved License Application (LCI, 2017). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application 6.1, 6.2 & 6.3

SER	6.1
Class V Amendment Application SER Amendment 5	all all
KM and LCE Application	RP 1.0 –RP 3.0 Figure RP-3 OP 2.1 Table OP-3 Figure OP-4a Figure OP-5a-f Plates OP-2a&b
RAI Responses	RAI-4, RAI-8, RAI-16

For those sections that incorporate the approved license application, as amended, by reference, the NRC staff verified that the prior descriptions, plans and schedules for groundwater quality restoration are applicable to the plans and schedules for groundwater quality restoration for the proposed activities except those aspects noted below. The NRC staff reviewed the history of operations and, though no restoration has been performed as yet, the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A), including the generation of appropriate standard operating procedures for determining baseline conditions and other restoration activities. The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. Except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends them to the LCE expansion.

The aspects of the plans and schedules for groundwater quality restoration that are changed from the approved license application, as amended, consist of the following:

- Restoration schedule;
- Details on a life of a mine unit;
- Groundwater transfer; and
- Restoration of overlapping mine units.

Restoration Schedule

The applicant included a revised schedule of operations, including restoration, which are graphically shown on figures OP-4a and RP-3. The change to the schedule from that in the approved license application, as amended, is the increase in number of additional wellfields reflected in the Amendment application. As discussed in SER Section 3.X, the proposed plans is to not increase the rates upon which restoration is achieved but extends the life of operations at the project for another 6 to 8 years beyond that included in the approved license application, as amended.

In the revised schedule, groundwater restoration for each individual mine unit remains under 24 months as was proposed in the approved license application, as amended. As the restoration becomes more imminent and the schedule is further revised, the licensee will be required to

submit a revised schedule especially if the restoration will take longer than 24 months. In the Amendment application, the application acknowledges its commitment to this requirement in the approved license application, as amended, and that the requirement remains valid for this application.

The NRC staff finds the revised restoration acceptable because it reflects the proposed activities of the Amendment application, includes the same previously approved processes, and acknowledges commitments, in the approved license application, as amended.

Details on a Life of a Mine Unit

In Section OP 2.1 of the Amendment application, the applicant provides details on its calculations of the expected development and production phases of a mine unit. The details include the number and timing for the monitoring well installations, pumping tests, application preparation, production well installations, construction, estimated production rates, pore volumes during production, recovery percentage and minimum production grade. Based on those estimates, the applicant states that the development of an individual mine unit is on the order of two years and production between one and two years.

The approved license application, as amended, included similar timeframes for development and production but provided minimal backup data.

The NRC staff finds the details on the life of a mine unit acceptable because it provides justification for the estimated life of a mine unit based on the licensee's operational experience at the Lost Creek project as witnessed by the NRC staff during routine inspections.

Groundwater Transfer

The title for Section RP 2.3.1 of the Amendment application is "Groundwater Transfer". That section incorporates by reference Section 6.2.3 of the approved license application, as amended; however, groundwater transfer is not discussed in Section 6.2.3 or any section of the approved license application, as amended.

Groundwater transfer is a restoration phase in which fluids from a wellfield at the end of its production phase is transferred directly into another wellfield that is at its initial production startup, and vice versa. The purpose of groundwater transfer is to inject mature lixiviant fluids into a new wellfield and replacing fluids at the end of production with natural groundwater. Groundwater transfer has a mutualistic benefit for both wellfields in that the new wellfield is condition with the reuse of chemicals from the older wellfield, and the older wellfield will begin its restoration process using natural groundwater rather than lixiviant with treatment. The limitation for this restoration method is timing, i.e., one wellfield must be at the end of its production life at the same time a new wellfield is beginning its production. Similar restoration techniques have been proposed and approved for other NRC license uranium recovery facilities.

In response to NRC Staff's clarifying comments, Lost Creek provided its meaning for groundwater transfer (LCI, 2018d). The response is consistent with the NRC staff's description above. Therefore, the NRC staff finds that groundwater transfer is acceptable as an approved method for restoration.

Restoration of overlapping mine units

For the proposed activities, the applicant states that the production area of several mine units in the HJ Horizon will overlap a production area of a mine unit in the KM Horizon. The applicant further states that, in general, the KM Horizon mine unit will be subject to production prior to the overlying HJ Horizon mine unit primarily because it would limit having to drill wells through the HJ Horizon that was subject to ISR operations. The applicant proposes flexibility in the restoration of the first mine unit undergoing production, regardless of it being the KM or HJ horizon, by having restoration completed prior to, simultaneously or post restoration of the second mine unit restoration. This aspect to restoration differs from that in the approved license application, as amended. In the approved license application, as amended, the HJ Horizon may have contained multiple stacked ore fronts; however, all operations in the HJ Horizon, including restoration, are to be conducted simultaneously at all stacked roll fronts within the HJ Horizon mine unit.

Using the conceptual model of an interim confining unit between the HJ and KM horizons, the staff finds that the flexibility to the restoration timing to the two horizons would not substantially affect the restoration of either horizon because horizons are effectively hydraulically isolate. However, the restoration timing will have an impact on the monitoring scheme which is addressed in SER Section 5.7.8.

6.1.4 Evaluation Findings

The NRC staff has completed its review of the plans and schedules for groundwater quality restoration included in this Amendment application. Many aspects of those plans remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

For those aspects that are changed, the NRC staff finds that the proposed changes are consistent with the applicable acceptance criteria in Section 6.1.3 of the SRP (NRC, 2003a).

Therefore, the NRC Staff concludes that the proposed plans and schedules for groundwater quality restoration are acceptable and in compliance with requirements and specifications in Part 40 Appendix A (specifically Criterion 5(B)5 and 6(7)), 10 CFR 40.32(c), requiring the applicant's proposed equipment, facilities and procedures to be adequate to protect health and minimize danger to life or property, 10 CFR 40.32(d), requiring an issuance of a license that will not be adverse to the common defense and security or to the health and safety of the public, and 10 CFR 40.42(h) requiring the decommissioning of a site or separate building or outdoor area as soon as practicable.

6.2 Plans for Reclaiming Disturbed Lands

6.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed plans for reclaiming disturbed lands meet the requirements of 10 CFR 40.42, and Criteria 2, 6(6) and 9(f)(4) of Appendix A to 10 CFR Part 40.

6.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the Amendment was reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 6.2.3 of the SRP (NRC, 2003a).

6.2.3 Staff Review and Analysis

The applicant states that all sections in the LCE Restoration Plan, including plans for reclaiming disturbed lands, incorporate by reference unchanged sections of the approved License Application (LCI, 2017). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	6.4
SER	6.2
KM and LCE Application	RP 4.0 –RP 4.4

The NRC staff verified that the prior approved plans for reclaiming disturbed lands are applicable to the plans for reclaiming disturbed lands for the proposed activities. The NRC staff reviewed the history of operations and, though no restoration has been performed as yet, the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. Except for those aspects noted below, the NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

The staff also reviewed the recent financial surety calculations for the 2018 annual update. In the calculations, Lost Creek included costs for remediation of soils impacted by the unplanned releases of source or byproduct material. The NRC staff has found that the costs satisfy requirements of Criterion 9(f)(4) of 10 CFR Part 40. Appendix A.

6.2.4 Evaluation

The NRC staff has completed its review of the plans for reclaiming disturbed lands included in this Amendment application. The staff finds that plans remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Therefore, the NRC Staff concludes that the proposed plans for reclaiming disturbed lands are acceptable and in compliance with requirements and specifications in Part 40 Appendix A (specifically Criteria 2, 6(6) and 9(f)(4)) and 10 CFR 40.42, requiring the applicant's proposed

plans for reclaiming disturbed lands include those to properly dispose of and reasonable effort be made to eliminate residual radioactive contamination and be in compliance with the applicable standards to prevent threats to human health and the environment.

6.3 Removal and Disposal of Structures, Waste Material, and Equipment

6.3.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the proposed plans for removal and disposal of structures, waste material and equipment, meet the requirements of 10 CFR 40.42 and Criterion 2 of 10 CFR Part 40, Appendix A.

6.3.2 Regulatory Acceptance Criteria

The Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.3.3 (NRC, 2003a).

6.3.3 Staff Review and Analysis

The applicant states that all sections in the LCE Restoration Plan, including plans for removal and disposal of structures, waste material and equipment, incorporate by reference unchanged sections of the approved License Application (LCI, 2017). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	6.4.2
SER	6.3
KM and LCE Application	RP 4.1

The NRC staff verified that the prior approved plans for removal and disposal of structures, waste material and equipment, are applicable to the plans for removal and disposal of structures, waste material and equipment for the proposed activities. The NRC staff reviewed the history of operations and, though no restoration has been performed as yet, the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

6.3.4 Evaluation Findings

The NRC staff has completed its review of the plans for reclaiming disturbed lands included in this Amendment application. The staff finds that plans remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the plans and schedules to be carried out in the future.

Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Therefore, the NRC Staff concludes that the proposed plans for removal and disposal of structures, waste material and equipment are acceptable and in compliance with requirements and specifications in Part 40 Appendix A (specifically Criterion 2) and 10 CFR 40.42, requiring the applicant's proposed plans for removal and disposal of structures, waste material and equipment include those to properly dispose of and reasonable effort be made to eliminate residual radioactive contamination and be in compliance with the applicable standards to prevent threats to human health and the environment.

6.4 Methodologies for Conducting Post-Reclamation and Decommissioning Surveys

6.4.1 Regulatory Requirements

The purpose of this section is to determine whether the licensee has demonstrated that the proposed methodologies for conducting post-reclamation and decommissioning radiological surveys meet the requirements of Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.4.2 Regulatory Acceptance Criteria

The Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.4.3, "Acceptance Criteria" (NRC, 2003a).

6.4.3 Staff Review and Analysis

The applicant states that all sections in the LCE Restoration Plan, including methodologies for conducting post-reclamation and decommissioning surveys, incorporate by reference unchanged sections of the approved License Application (LCI, 2017). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	6.5, 6.6 and 6.7
SER	6.4

KM and LCE Application	RP 4.5
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The NRC staff verified that the prior approved methodologies for conducting post-reclamation and decommissioning surveys, are applicable to the methodologies for conducting post-reclamation and decommissioning surveys for the proposed activities. The NRC staff reviewed the history of operations and, though no restoration has been performed as yet, the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

6.4.4 Evaluation Findings

The NRC staff has completed its review of the methodologies for conducting post-reclamation and decommissioning surveys included in this Amendment application. The staff finds that methodologies remain unchanged from those previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the methodologies to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

Therefore, the NRC Staff concludes that the proposed methodologies for conducting post-reclamation and decommissioning surveys are acceptable and in compliance with requirements and specifications in Part 40 Appendix A (specifically Criterion 6(6)) requiring the applicant's proposed methodologies adequately measure residual radioactive contamination to ensure compliance with the applicable standards to prevent threats to human health and the environment.

6.5 Financial Assurance

6.5.1 Regulatory Requirements

The purpose of this section is to determine whether the licensee has demonstrated that the proposed financial assurance assessments meet the requirements of Criterion 9 of Appendix A to 10 CFR Part 40.

6.5.2 Regulatory Acceptance Criteria

The Amendment application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.5.3, "Acceptance Criteria" (NRC, 2003a).

6.5.3 Staff Review and Analysis

The applicant states that all sections in the LCE Restoration Plan, including financial assurance assessments incorporate by reference unchanged sections of the approved license application (LCI, 2017). The applicable sections reviewed by the NRC staff in the application, referenced documents and associated SER's are as follows:

Approved License Application	6.8
SER	6.5
KM and LCE Application	RP 5.0

The NRC staff verified that the prior approved financial assurance assessments, are applicable to the financial assurance assessments for the proposed activities. The NRC staff reviewed the history of operations and, though no restoration has been performed as yet, the licensee has operated the facility in a manner that is protective of human health and safety and the environment (see Appendix A). The NRC staff has not identified any un-reviewed safety issue and has reasonable assurance that the plans will be carried out in the future as described. The NRC staff finds nothing to invalidate its previous findings and the prior conclusions remain valid.

Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion.

The financial surety calculations have been updated annually since issuance of the Byproduct and Source Materials License SUA-1598 (see Appendix A). Each annual update has been approved by the NRC staff concluding that the update demonstrated that the licensee has maintained sufficient funds in the surety for completion of the above-referenced activities by an independent contractor.

6.5.4 Evaluation Findings

The NRC staff has completed its review of the financial assurance assessment included in this Amendment application. The staff finds that financial assurance assessment remains unchanged from that previously reviewed in the approved license application, as amended, and staff concludes that the prior conclusions remain valid because the licensee has operated the facility in a manner that is protective of human health and safety and the environment, has not identified any un-reviewed safety-related issue and expects the methodologies to be carried out in the future. Therefore, the NRC staff hereby incorporates those prior conclusions into this SER and extends those conclusions to the LCE expansion. Furthermore, the NRC staff has acknowledge that the licensee has provided timely and appropriate updates to the financial assurance calculations.

Therefore, the NRC Staff concludes that the proposed financial assurance assessment is acceptable and in compliance with requirements and specifications in Part 40 Appendix A (specifically Criterion 9) requiring that sufficient funds are available for decontamination, reclamation and decommissioning of the Lost Creek site by an independent contractor.

7.0 ACCIDENTS

In this SER Section, the NRC staff's evaluation is focused on the applicant's description of its procedures for on-site accident prevention, mitigation and cleanup programs. The SRP states that specific areas where consequences could be significant are: (1) radon releases from the process streams; (2) yellowcake dryer explosions; (3) lixiviant leaks in buried piping between the wellfields and processing plant; and (4) chemical accidents. In the preamble for the KM Amendment, the applicant states that the environmental effects described in the approved license application, as amended, is updated in the Lost Creek East Environmental Report.

7.1 Regulatory Requirements

The staff determines if the applicant has addressed potential accidents and demonstrated that the facility will meet 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect public health and minimize danger to life or property should an accident occur.

7.2 Regulatory Acceptance Criteria

The staff reviewed the Amendment for consistency with applicable regulations of 10 CFR Part 40 using review procedures in Section 7.5.2 and acceptance criteria in Section 7.5.3 of the SRP (NRC, 2003a).

7.3 Staff Review and Analysis

The applicable sections reviewed by the NRC staff in the application, other referenced documents and associated SER's are as follows:

Approved License Application	7.4
SER	7.1
Dryer Amendment Application	all
SER Amendment 1	all
KM and LCE Application	Environmental Report (LCE Amendment) Preamble (KM Amendment)

In the LCE Environmental Report, the applicant provided limited analyses on the environmental effects from non-routine activities such as accidents or unplanned events. Section 7.5.1 of the SRP states that the NRC has evaluated the effects of accidents at ISR facilities and determined that the consequences are minor for most credible potential accidents, provided that effective emergency procedures and properly trained personnel are used. Nevertheless, consequences that could be significant are:

- radon releases from process streams;
- yellowcake dryer explosions;
- lixiviant leaks in buried piping between the wellfields and the processing facility; and
- chemical accidents.

In the SER for the approved license application, as amended, the NRC staff evaluated the licensee's evaluation of accidents from chemical storage and use, radiological releases,

groundwater contamination, wellfield spills, transportation, fire and explosions for the existing facility (NRC, 2011a). The staff concluded that the information met the acceptance criteria in SRP Section 7.3 because the bases for the analyses were based on established guidance (i.e., NUREG-0706 and NUREG/CR-6733).

The changes to the facility since include the installation of yellowcake dryers and increasing the total annual production of yellowcake from 1.0 to 2.0 million pounds [0.91 to 1.0 million kg] due to toll milling. The licensee provided an analysis of potential accidents attributed to the increase in transportation due to the toll milling and yellowcake dryer explosion in the Amendment 1 application (LCI, 2012a;b;c;d;e). The NRC staff evaluated that information and found it acceptable (NRC, 2013a).

For those aspects that reportedly remain unchanged, the NRC staff's evaluation consists of verifying that the proposed activities are consistent with the previously approved plans, evaluating the historic site operations to determine that the facility has operated in a safe manner, identifying any un-reviewed safety-related issues, and ensuring the plans will be followed in the future in accordance with Appendix A of the SRP (NRC, 2003a). For those changes identified by the applicant as well as other changes identified by the NRC staff, the NRC staff's evaluation was performed in accordance with guidance found in Section 4 of the SRP (NRC, 2003a).

The changes associated with the Amendment include: (1) increases the transportation accidents related the 0.2-million pound [0.09 million kg] increase in annual yellowcake production and potentially 100 percent increase in toll milling; and (2) increases in the potential for leaks from the additional piping to the LCE area. In Section 4.2.1 of the LCE Environmental report, the applicant reports that the expected number of tractor trailers round trips under the traveling to and provides an estimate of truck traffic of 1.15 truck trips per day (for the increase in yellowcake annual production to 2.2 million pounds [1.0 million kg] to approximately 2.0 truck trips per day for 100 percent toll milling. This estimate compares to the approximate 0.75 truck trips evaluated in staff's EA for Amendment 1 (NRC, 2013a). These estimates are consistent with those used to estimate the risks in NUREG-0706 and NUREG/CR-6733.

The increase in underground piping is discussed in SER Section 2.1.3. The increase is estimated by staff to be from 5.6 km [3.5 mi] under the existing license to approximately 8 km [5 mi] under the LCE Amendment. The applicant reports that the currently used construction techniques, as-built testing and monitoring will be applied to the new underground piping. The NRC staff reviewed the increased length of piping and determined that it is consistent with the length of piping at other licensed facilities. Furthermore, the applicant plans to continue with the current monitoring program and has developed appropriate operating procedures to monitor and respond to a leak or spill from an underground pipe consistent with the guidance in NUREG-0706 and NUREG/CR-6733.

Therefore, the NRC staff finds that the applicant's analyses of the risks of accidents meet the acceptance criteria in Section 7.5.3 of the SRP (NRC, 2003a).

7.4 Evaluation Findings

The NRC staff reviewed potential accidents that could occur in accordance with acceptance criteria in SRP Section 7.5.3. The applicant cites information in NUREG-0706 and NUREG/CR-6733 as bases for the accident consequences analyses. The staff concludes that these accident consequences analyses are appropriate and applicable to the Amendment thus

meet 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect public health and minimize danger to life or property should an accident occur.

8.0 REFERENCES

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NRC, 2018c. MILDOS-AREA Calculation Lost Creek SER. May 15, 2018. ADAMS Accession No. ML18136A883.

NRC, 2018d. Letter from B. Von Till, NRC, to S. Hatten, Lost Creek, dated August 5, 2018, RE: Amendment 7, Source and Byproduct Materials License SUA-1598, Lost Creek ISR Project, Sweetwater County, WY, Administrative Removal of Preoperational License Conditions. ADAMS Accession No ML18143B715.

Wyoming Department of Environmental Quality (WDEQ). 2000. Guideline No. 4, "In Situ Mining" (revised).

Wyoming Department of Environmental Quality (WDEQ). 2013c. Revised Guideline No. 4, " In Situ Mining Noncoal." Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Land Quality Division.

Wyoming Department of Environmental Quality (WDEQ). 2014. Wyoming Department of Environmental Quality Comments and Determination of Incomplete for the KM Mine Plan Revision and Lost Creek East Amendment. November 12, 2014. ADAMS Accession No. ML14328A143.

Wyoming Department of Environmental Quality (WDEQ). 2018. Wyoming Department of Environmental Quality Comments and Determination of Incomplete for the Lost Creek East and KM Zone Amendment. May 29, 2018. ADAMS Accession No. ML18192B556.

Historical Aspects of Site Performance: Lost Creek Project

For reviewing new license applications, amendments to an existing license or renewals of existing licenses the NRC staff follows guidance in NUREG-1569 “Standard Review Plan for In Situ Leach Uranium Extraction License Applications” (NRC, 2003a). Guidance in Appendix A “Guidance for Reviewing Historical Aspects of Site Performance for License Renewals and Amendments” of NUREG-1569 describes specific areas that the NRC staff should review as part of an amendment application or license renewal. The specific areas include the licensee’s compliance history, record of site operations and changes proposed by the amendment or renewal. Specifically, Appendix A states:

If, after a review of these historical aspects of site operations, the staff concludes that the site has been operated so as to protect health and safety and the environment and that no unreviewed safety-related concerns have been identified, then only those changes proposed by the license renewal or amendment application should be reviewed using the appropriate sections of this standard review plan. Aspects of the facility and its operations that have not changed since the last license renewal or amendment should not be reexamined.

Following this guidance, the NRC staff has not reexamined those aspects of the Lost Creek ISR Project that remain unchanged from those described in the approved license application, as amended, provided that:

- the unchanged aspects remain applicable and appropriate for the proposed amendment activities;
- the licensee has operated in a safe manner since the license was issued; and
- no unreviewed safety issue is identified.

As documented below, the NRC staff reviewed historical aspects of site operations since License SUA-1598 was issued to Lost Creek ISR, LLC, in August 2011. On the basis of this review, the NRC staff concludes that the Lost Creek ISR Project has operated so as to protect human health and safety and the environment. In addition, the NRC staff has not identified any unreviewed safety-related concerns.

A.1 Amendments

As of December 31, 2017, the NRC has approved and issued five amendments to the Source and Byproduct Materials License SUA-1598 since its issuance to Lost Creek ISR, LLC, in August 2011 (ML111940057). The license amendments are as follows:

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SUA-1598 Amendment No.	Date	Purpose of Amendment	Reference
Initial	08/17/2011	Initial License	ML111940057
1	04/22/2013	Technical Report Page Changes, 2011-12 Financial Surety update, Addition of Two Dryers and Increase in Annual Production	ML13016A071
2	12/16/2013	2012-13 Financial Surety Update	ML13276A567
3	07/15/2015	Surety Update and Removal of Preoperational License Conditions	ML14162A031
4	03/18/2016	License Condition 12.10, 12.11 & 12.12	ML15279A572
5	09/06/2016	Surety Update and Class V Disposal Well	ML16123A332
6	02/14/2018	Discontinue Collecting Meteorological Data	ML16335A315

Amendment No. 1 modified several operational practices and procedures. First and foremost, Amendment No. 1 authorized the final product for the facility from a “slurry”, as was prior approved, to a “slurry or dried yellowcake”. This change required new on-site equipment (dryers), additional procedures for use of the new equipment, and modifications to the radiation protection programs, effluent monitoring program and transportation. Amendment No. 1 also increased the maximum annual production of yellowcake from 1.0 million pounds [0.46 million kg] per year to 2.0 million pounds [0.91 million kg] per year. This change is based on an increased toll milling of resins equivalent to 1.0 million pounds [0.46 million kg] per year and is not based on increased on-site production of uranium by ISR operations. As documented in the prior-approved application, the plant was designed to accommodate the elution and precipitation processing of 2.0 million pounds [0.91 million kg] per year and thus Amendment No. 1 did not require any modifications to the plant equipment other than the addition of a new dry and ancillary equipment. The change resulted in increased traffic to the facility associated with the toll milling. Finally, Amendment No. 1 modified minor language changes to several license conditions, clarified commitments in the approved license application with minor language changes, and permitted use of a designee for daily inspections under the radiation protection program.

The license conditions affected by Amendment No.1 were License Condition 9.2, 9.4, 9.5, 9.7, 10.2, 10.7, 10.16, 10.18, 10.19, 11.3, 12.6, and 12.13. The license application was modified by Amendment 1 by incorporation of page changes to the approved application or commitments submitted by the licensee to the NRC on the following dates: November 11, 2010 (ML103210590), November 16, 2010 (ML103280186), December 3, 2010 (ML103490862), September 13, 2011 (ML112580267), November 8, 2011 (ML11319A196), January 6, 2012 (ML120470353), February 10, 2012 (No. ML12048A678), February 17, 2012 (ML12053A326), March 5, 2012 (120670278), July 27, 2012 (ML12219A076), July 31, 2012 (ML12244A404), November 8, 2012(ML13029A734), November 29, 2012 (ML12335A016), and March 27, 2013 (ML13100A138). The submittals are tie-down to the approved license application through License Condition 9.2.

The environmental review of the Amendment No. 1 actions determined that the impacts met the criteria for preparation of an Environmental Assessment in accordance with 10 CFR 51.21. The impacts were documented in an Environmental Assessment dated April 22, 2013 (ML13081A129).

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Amendment No. 2 and No.3 consisted of revising the license to reflect changes in the amounts for an annual surety update or minor administrative changes but did not change any operating practices or procedures. The environmental review of the Amendment Nos. 2 and 3 actions determined that the impacts of those actions met the criterion for a categorical exclusion in accordance with 10 CFR 51.22.

Amendment No. 4 consisted of removing three preoperational license conditions (LC 12.10, 12.11 and 12.13). The license conditions were removed following approval of procedures for the effluent monitoring program, the beta-gamma survey program, and the licensee's procedures for demonstrating that unmonitored employees would not exceed 10 percent of the established dose limits. The license conditions affected by Amendment No.4 consisted of deleting License Condition 12.10, 12.11 and 12.12 and modifying LC 9.2. The license application was modified by incorporating page changes or commitments submitted by the licensee to the NRC on the following dates: January 16, 2015 (ML15029A423), July 28, 2015 (ML15218A055), and January 26, 2016 (ML16043A365). The submittals are tie-down to the approved license application through License Condition 9.2.

The environmental review of the Amendment No. 4 actions determined that the impacts of those actions met the criterion for a categorical exclusion in accordance with 10 CFR 51.22.

Amendment No.5 authorized modification to the on-site wastewater disposal system. The modifications included adding an ion exchange vessel in the plant and associated piping, and the disposal of treated permeate on-site to the shallow aquifer through an on-site Class V disposal well(s). The ion exchange vessel contains specialized resins to capture radium from the permeate as a final step in the treatment process to meet the permitted limits for the on-site disposal of treated permeate. The license conditions affected by Amendment No.4 consisted of modifying LC 9.2, 9.5 10.9 and adding LC 10.20. The license application was modified by page changes or commitments submitted by the licensee to the NRC on the following dates: January 16, 2015 (ML15029A423), March 3, 2015 (ML15076A380), July 28, 2015 (ML15218A055), August 17, 2015 (ML15239A726), January 26, 2016 (ML16043A365) and February 8, 2016 (ML16042A069). The submittals are tie-down to the approved license application through License Condition 9.2.

The environmental review of the Amendment No. 5 actions determined that the impacts met the criteria for preparation of an Environmental Assessment in accordance with 10 CFR 51.21. The impacts were documented in an Environmental Assessment dated August 31, 2016 (ML16216A273).

Amendment No.6 removed License Condition (LC) 10.19, which required the licensee to collect data from its onsite meteorological station on a continuous basis until the NRC staff determined that the data are representative of long-term conditions. The Lost Creek meteorological monitoring program was approved for monitoring meteorological conditions at the Lost Creek Project area for the initial licensing. The location of the Lost Creek meteorological monitoring tower, instrumentation, and data quality were addressed in Section 2.2, "Meteorology," of the August 2011 Safety Evaluation Report (SER) for the license application (NRC 2011). Although the NRC staff found that the licensee provided meteorological data to represent conditions at the site, the NRC staff found that the licensee had not satisfactorily analyzed the data to demonstrate that the data provided were representative of long-term meteorological conditions. The NRC staff required a license condition for the licensee to continue collecting meteorological data at the Lost Creek facility until it was determined that the collected data were representative of long-term conditions as a pre-operational license condition. The preoperational license

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condition was numbered as LC 12.8, which was subsequently renumbered as LC 10.19 (operational) with issuance of Amendment No. 1 to the license (NRC, 2013).

Following an additional meteorological monitoring period of four years, the licensee submitted a request to remove license condition 10.19 with meteorological data collected for the period from June 2007 through July 2015, along with a revised data set that met established quality criterion of at least a 90 percent recovery rate and an analysis of the data (Lost Creek 2017, 2018). The NRC staff's review of regional and site meteorology is documented in the SER for the removal of License Condition 10.19 for the Lost Creek ISR Project (ML16335A315). The purpose of that SER was to determine for the approved license application, as amended, whether meteorological data used for assessing impacts are representative of expected long-term conditions at and near the site, consistent with NRC review guidance (NRC, 2003a). The NRC staff analyzed the revised data and analyses submitted by the licensee (Lost Creek 2018) for its independent analysis. Based on its review of the revised dataset and analyses submitted by the licensee, the NRC staff concluded that the data collected for the years 2009 to 2010 and 2012 to 2014 were of sufficient duration and quality, and representative of long-term meteorological conditions in the site vicinity. Therefore, the NRC staff found it appropriate to remove LC 10.19 from Materials License SUA-1598.

A.2 Changes to Operating Practices or Procedures

As of December 31, 2016, Lost Creek's Safety & Environmental Review Panels (SERPs) approved 29 changes to the licensing basis for the operating practices or procedures at the facility without requiring NRC prior approval (i.e., license amendment). The approved changes are as follows:

Table 1. Summary of SERP performed by Lost Creek ISR, LLC

ID	Date	Title	Description	Comments
2013				
LC130108-01	1/8/13	Pond Liner Specification Changes	Review change to pond liner thickness	Approved
LC130123-01	1/23/13	MU1 Monitoring Ring Well Changes	Review replacement of Wells M-114, M-115, and M-116	Approved
LC130529-01	5/29/13	Restricted Area (RA) Boundary Review and Change	RA boundary change to exclude lab	Approved
LC130529-02	5/29/13	Technical Report (TR) Edits - Org Chart Change	Changes in org chart	Approved
LC130718-01	N/A	TR Edit - Soil Cleanup Criteria fix	Fix consistency error in TR for soil Ra & U criteria	N/A
LC130730-01	7/30/13	TR Edit - Sump Vent	Change TR language to exclude sump vents	Approved
LC130730-02	7/30/13	TR Edit - DW Pipeline Inspection	Change TR language for DW pipeline inspection	Approved
LC130805-01	N/A	Temporary Revised RA Boundary	Temporary exclusion of Shop and Precipitation Area from the Restricted Area	N/A
LC130805-02	8/5/13	MU1 Acceptance Review and UCL Recalculation	UCL recalculation for MU1 and MU1 acceptance	Approved
LC130918-01	9/18/13	IX Venting	Removal of vent lines on IX vessels	Approved
LC131107-01	11/7/13	Permeate Wellfield Injection	Temp disposal of RO perm by injection to HH1-4	Approved
LC131120-01	N/A	Ponds as Restricted Area	Review storage of 11e2 bin in pond area	N/A

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2014				
LC14-01	3/30/14	Recirculation of wellfield production water	Need recirc to prevent freezing in wellfield while prod is stopped	Approved
LC14-02	4/10/14	Pond leak detection	Describe leak detection system for Ponds	Approved
LC14-03	4/14/14	Disposal Well filter installation	Installation of a filter pod at each disposal well	Approved
LC14-04	4/18/14	Dryer loading volume	Discuss how to quantify yellowcake loads to dryer	N/A
LC14-05	5/1/14	Dryer room air "scrubber"	Discussed adding air scrubber to vac exhaust in dryer room	N/A
LC14-06	5/1/14	Filter Press recirculation to precipitation tank	Discussed adding a flow line to connect filter press with precip tanks to recirculate rinsewater	N/A
LC14-07	5/12/14	Dryer venting to outside of Plant	Add flow option to send exhaust to outside of Plant	Approved
LC14-08	5/13/14	HH1-7 Linde O2 system installation	Install Linde O2 injection manifold at HH1-7 and remainder of MU1 HHs (<i>Project was cancelled</i>)	Cancelled
LC14-09	11/11/14	Alternate RSO	Allow an Alternate RSO to be designated	Approved
2015				
LC15-01	1/22/15	Plant Ventilation	Reconfigure Plant ventilation to improve air flow	Approved
LC15-02	2/19/15	11e2 Bin Reloc	Move bin from Pond area to corral next to Plant	Approved
LC15-03	5/1/15	HPT Installment	Approve new HPT	Approved
LC15-04	5/8/15	Clay Dispersant	Review and approve use of clay dispersant within wells	Approved
LC15-05	6/29/15	Injection Well Perforation	Test effectiveness of Class III injection well stimulation	Approved
LC15-06	12/17/15	Pond Netting Installation	Review of bird netting installation ORC	Approved
2016				
LC16-01	1/11/16	Alt. Discharge line to Pond	Discuss the alternate use of a hose from the Plant to the Pond	Approved
LC16-02	1/15/16	MU1 Baseline Data	Review and approve the recalculated MU1 baseline data	Approved
LC16-03	1/26/16	Mini Filter Press	Approve use of a small filter press in Plant for waste water filtration	Approved
LC16-04	2/2/16	IP Well Patterns	Review/approve alternate geometry of IP patterns in the wellfields	Cancelled
LC16-05	4/28/16	Header House filter banks	Review test for adding filter banks to header houses	Approved
LC16-06	4/15/16	Permeate tank vent	Remove perm tank vent from manifold. Pipe direct to roof.	Approved
LC16-07	9/30/16	TR Org Chart change	Change the TR Org Chart and descriptions re: RSO	Approved
LC16-08	10/17/16	Add Reverse Osmosis (RO) Tank vent	Add vent line and connect from RO tank to restoration IX vent line	Approved
LC16-09	11/16/16	Class V system Radon purge	Test to purge Rn from permeate using air injection	Approved
LC16-10	12/2/16	Restricted Area (RA) Boundary change	Add area SW corner of Plant in RA boundary	Suspended
LC16-11	12/7/16	RE2 IE2 vent line	Isolate the RE2 IE2 vent line from Elution Circuit manifold	Approved

Source: Annual Reports: 2013 (ML14065A111); 2014 (ML15050A042); 2015 (ML16057A188); 2016 (ML17083A258)

The SERP approvals are reviewed by staff on two occasions during operations. The first occasion is during onsite inspections in which those SERP's that occurred since the preceding inspection are reviewed by the NRC inspectors (for history of the inspections, see Section A3). The second occasion is a review by staff of the annual report on the SERP activities during the

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calendar year as submitted by the licensee in accordance with License Condition 9.4. The annual reports include page changes to the approved license application affected by the SERP approval.

Based on reviews conducted by the NRC inspectors and the NRC staff review of the annual reports, the licensee had implemented the SERP process in accordance with license condition 9.4 of the Source and Byproduct Materials License SUA-1598.

A.3 Inspections and License violations

As of December 31, 2017, the licensee has been subject to eight (8) inspections by the NRC (Table 2).

Table 2. Summary of NRC Inspections

Inspection	Dates On-site	Type	Report Date	Reference
13-001	June, 24-27, 2013; July 29-30, 2013; 8/27/2013	Announced	5/13/14	ML14134A150
13-002	December 3-5, 2013; February 27, 2014	Unannounced	11/14/14	ML14318A974
14-001	June 25-26, 2014	Announced	11/14/14	ML14318A974
15-001	January 27-29, 2015	Unannounced	9/11/15	ML15254A403
15-002	December 1-3, 2015	Unannounced	1/7/16	ML16007A102
16-001	September 27-29, 2016	Announced	12/21/16	ML16356A671
17-001	May 23-25, 2017	Announced	8/4/17	ML17215A944
17-002	October 17-19, 2017	Announced	11/30/17	ML17331B446

The initial inspection, generally referred to as the pre-operational inspection, determines whether the Licensee's equipment, personnel, practices and procedures are consistent with NRC regulations, the licensee's license conditions and commitments in the approved license application. Should the pre-operational inspection determine that the licensee is in compliance, then the NRC will issue an authorization to conduct operations. In the case of Lost Creek, two inspections were conducted, the first inspection for approval of operations up to the dryer and the second inspection for approval of the dryer operations. The NRC granted authorizations to operate to Lost Creek on August 2, 2013 and October 3, 2013, respectively.

All licensed facilities are subject to routine NRC inspections during operations. For uranium recovery facilities, the frequency of inspections typically varies between once every six months to once every two years. The frequency is dependent upon various factors including status of operations, operational history, etc. In addition, the inspections may be announced (i.e., the licensee is notified of the planned inspection prior to the inspection generally to ensure

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appropriate personnel will be available) or unannounced. For the period since the authorizations to operate were issued in 2013 to the end of 2017, the Lost Creek facility has been subject to seven NRC inspections, generally on a frequency between once every 6-months to once every 1-year, and including both announced and unannounced inspections.

The purpose of the inspections is to ensure a licensee is operating safely, with respect to occupational and public health and safety and the environment, in compliance with the applicable rules and regulations. Should the inspectors identify a potential noncompliant activity, then the process for determining whether the activity warrants a violation is initiated. If warranted, then generally a Notice of Violation (NOV) or a Non-cited Violation (NCV) is documented with the inspection report. For the inspections that were conducted, Lost Creek was issued a total of 16 NOV's and one NCV (Table 3).

Table 3. Summary of Violations

Inspection	Inspection Issued	Violation	Inspection Closed-Out
13-002	13-002	Failure to evaluate the use of storage tanks	15-001
13-002	13-002	Failure to perform work under a Radiation Work Permit (RWP)	15-001
1402-01	14-001	Failure to complete the RSO monthly reports	15-001
1501-01	15-001	Failure to perform work under a RWP	15-002
1501-02	15-001	Non-cited violation - Failure to follow procedures resulting in pressurized drums	15-001
1501-03	15-001	Potential storage pond leakage	15-002
2015002-01	15-002	Failure to maintain inward hydraulic gradient	17-001
2015002-02	15-002	Failure to store 11.e(2) waste per license	16-001
2015002-03	15-002	Failure to perform daily storage pond inspections	16-001
2015002-04	15-002	Failure to maintain 3 feet freeboard in storage ponds	16-001
2016001-01	16-001	Failure to SERP Organizational & RSO duties changes	17-001
2016001-02	16-001	Failure to secure 11.e(2) waste in storage	17-001
2016001-03	16-001	Failure to obtain a RWP	17-001
2016001-04	16-001	Inadequate surveys for free release	17-002
2017001-01	17-001	Failure to name radionuclides on shipping papers	17-002
2017001-02	17-001	Failure to ensure radioactive waste containers were covered	
2017002-01	17-002	Failure to ensure radioactive waste containers were covered	

The severity level for the NOV's was Level IV, the lowest severity level. For a severity level IV NOV, a licensee is required to submit a report detailing the root cause for the violation and corrective actions to be undertaken or have been undertaken. The NRC inspectors review the submittals and, during a subsequent inspection, if the corrective actions are properly

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implemented, close out the NOV. All but two of the NOV's have been closed out. The two NOV's have not been closed out were those issued during the most recent inspection. It is expected that Lost Creek will provide adequate corrective actions such that the recently issued NOV's will be closed out during a future inspection.

A.4 Excursions, incident investigations, and root cause analyses

A.4.1 Excursions and Pond Leakages

As of December 31, 2017, Lost Creek ISR project has reported four wells on excursion status during five separate events since operations began in 2013 (Table 4).

Table 4. Summary of Excursions and Pond Leakages

Excursions			
Well	Date Excursion Status Started	Date Excursion Status Terminated	References
MU-109	27-May-15	22-Sep-15	ML15173A077; ML15314A066
MU-104	15-Jul-15	04-Aug-15	ML15197A292; ML15198A342; ML15314A067
MU-104	26-Aug-15	14-Sep-15	ML15314A067
MO-108	29-Sep-16	04-Jan-17	ML16278A607; ML17193A230
KPW-2	09-Oct-17		ML17283A216; ML17296A163
Pond Leakage			
Pond	Date Pond Leakage Identified	Date Pond Leakage Corrected	References
South Pond	22-Dec-14	24-Apr-15	ML15023A415; ML15218A014
North Pond		24-Apr-15	ML15218A014
North and South Pond	02-Feb-16	04-Mar-16	ML16071A052; ML16126A201
North Pond	20-Mar-16	22-Mar-16	ML16126A201
North Pond	22-Jan-18		ML18029A311

The excursion status were for wells screened in either the overlying or underlying aquifers. In accordance with License Conditions 10.10, the production in the area was curtailed until the excursion had been corrected. Because an excursion status is based on conservative parameters (i.e., non-hazardous constituents that migrate fastest in a plume) and that the corrective actions were implemented within a short timeframe, the impacts to the adjacent aquifer(s) would be minimal. The excursion status has been terminated for all five events. The

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effectiveness of the corrective actions will be verified during routine monitoring after the excursion status is corrected (terminated).

Lost Creek has notified NRC of pond leakage in both ponds on two occasions. For the first occasion, the cause was determined to loss of integrity of the boots connecting the piping to the ponds (see ML15218A014). After the corrective action, residual material continued to be detected in the leak detection system for a period of time after the boots were repaired; however, that material is considered to be residual of the leakage because the volume of material greatly diminished over time. The second occasion was determined not to be a new leakage but a pulse of residual material related to thawing conditions.

The purpose of the pond leak detection system is to identify and correct leaks in the primary liner. The design of the liner system includes a secondary liner under the primary liner. Because the leakage was only in the primary liner, no constituents entered the environment. In addition, the impact to the environment is monitored at wells installed in the first underlying aquifer surrounding the ponds. No impacts have been identified at those wells.

A.4.2 Incidents – Reportable Unplanned Releases

As of December 31, 2017, the Lost Creek ISR Project has had 30 unplanned releases reported to the State of Wyoming (Table 5).

Table 5. Summary of Unplanned Releases

Spill Number	Date	Volume (Gal)	Cause
1	8/3/2013	2197	Pipeline to injector well
2	8/4/2013	59538	Pipe failure from unburied pipe
3	11/12/2013	3360	Human error
4	11/23/2013	840	Cracked air vent
5	1/18/2014	736 & 680	Freezing of vents
	2/18/2014		Hole LC254
6	2/25/2014	1400	Equip failure at DDW-4
7	3/20/2014	1900	Pipe moved out of pond
8	3/25/2014	600	Inject wellhead 11182
9	3/25/2014	6000	Lateral pipe to 1P026
10	3/29/2014	11300	HH 1-5 gasket on main pipe
11	5/30/2014	900	Leaking lateral pipeline (at same location as Spill #9)
12	6/3/2014	41000	Pipeline rupture
13	7/13/2014	1260	Human Error - after cleanout at 11306
14	9/14/2014	370	11166 & 11167 leak from casing
15	11/20/2014	700	11172
16	12/12/2014	5520	HH1-7
17	12/12/2014	2935	11304
18	12/16/2014	480	11256P
19	1/13/2015	6128	11402
20	3/5/2015		DDW Pipeline
21	3/11/2015	813	HH1-8 Trunk Line

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22	4/8/2015	960	faulty vent
23	7/20/2016	11000	Pipeline Break
24	12/23/2016	582	HH1-5
25	1/9/2017	3654	well 11365
26	2/6/2017	3200	HH1-8 Valve Station Pipe
27	5/22/2017	707	HH1-10
A	6/20/2017	0.5 pounds	Yellowcake spill in Truck
28	8/18/2017	188000	HH1-6 Pipe
29	9/5/2017	10000	HH1-10 Basement
30	10/3/2017	11760	Valve Station by HH2-2

A - Not reported to WDEQ but to the DOT because of its location/activity

In accordance with License Condition 11.6, Lost Creek has provided notification to the NRC because the unplanned release met the notification to the State of Wyoming. None of the unplanned releases met NRC reporting criteria in either 10 CFR 20, Subpart M or 10 CFR 40.60.

If the impact of an unplanned release results in an exceedence of established radiological cleanup criteria, then the subsurface soils need to be remediated. For spills of a liquid source or byproduct material, slurry, or yellowcake at an ISR facility, the primary radionuclides of concern are radium-226 and natural uranium. The licensee may elect to remediate the subsurface soils at the time of release or defer the cleanup to the final decontamination and decommissioning of the facility. If the cleanup is deferred, then the licensee must provide an estimate of the amount of onsite contamination and costs for cleanup in its financial assurance in accordance with Criteria 9(b)(2) and 9(f)(4) in Appendix A of 10 CFR Part 40. Lost Creek is in compliance with the applicable criteria.

A.4.3 Incidents –other

Lost Creek has had two noteworthy incidents beyond the typical unplanned release, excursion or pond leakage. The first is production fluid migration through the abandoned drill hole LC254. The incident was identified when the migration was observed at ground surface. Lost Creek did not consider this incident as a reportable unplanned release as the volume released to the surface was below the reporting threshold for the State of Wyoming (ML14091A461). The second noteworthy incident was the spill of yellowcake from the dryer (ML14318A974). The spill was limited to the interior of the processing plant.

A.4.4 Root Cause Analyses

Lost Creek performed root cause analyses for all NOV, NCV, excursions, unplanned releases and other incidents listed above. Based on the root cause analysis, Lost Creek initiated a corrective action to mitigate the incident (i.e., vacuum excess liquid) or minimize the potential incident from re-occurring. The NRC staff has reviewed the corrective actions and found they were appropriate for the noted incidents.

A.5 Radiation-related regulatory exceedences

There have been no occupational or public radiation-related regulatory exceedences reported in either semi-annual effluent reports submitted in accordance with 10 CFR 40.65 or the annual

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LARA audits. The reports provided since Lost Creek ISR Project began operations are listed in Table 6.

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Table 6. Summary of Reports Submitted by Lost Creek to NRC Required by License

Reporting Period (Annual, Semi-Annual, Quarter)	Quarterly Report on Pond Inspection, Wells on Excursion Status	Semi-Annual Report on Operational Parameters	Semi-Annual Report on Effluent Monitoring	Annual ALARA Audit	Annual Pond Inspection
	License Conditions 11.1(A) and 10.8(C)	License Condition 11.1(B)	License Condition 11.1(D)	License Condition 11.2	License Condition 11.1(E)
2017 (Annual)					ML17313A787
4th Qtr /2nd Semi-annual					
3rd Qtr	ML17313A787				
2nd Qtr /1st Semi-annual	ML17216A036	ML17216A037	ML17268A151		
1st Qtr	ML17139D388				
2016 (Annual)				ML17102B076	ML17362A164
4th Qtr /2nd Semi-annual	ML17040A411	ML17040A412	ML17102B084		
3rd Qtr	ML16315A387				
2nd Qtr /1st Semi-annual	ML16230A015	ML16230A016	ML16258A013		
1st Qtr	ML16126A201				
2015 (Annual)				ML16126A202	ML16022A144
4th Qtr /2nd Semi-annual	ML16041A269	ML16041A270	ML16088A024		
3rd Qtr	ML15331A015				
2nd Qtr /1st Semi-annual	ML15218A014	ML15218A015	ML15253A502		
1st Qtr	ML15139A044				
2014 (Annual)				ML15218A013	ML15139A044
4th Qtr /2nd Semi-annual	ML15036A051	ML15041A551	ML15069A256		
3rd Qtr	ML14310A185				
2nd Qtr /1st Semi-annual	ML14219A322	ML14219A323	ML14253A214		
1st Qtr	ML14121A115				
2013 (Annual)					ML14219A322
4th Qtr /2nd Semi-annual	ML14036A124	ML14036A123	ML14070A448		
3rd Qtr	ML13310A312				
2nd Qtr /1st Semi-annual	ML13219B125	ML13219B125	ML15057A067		
1st Qtr	ML13142A224				
2012 (Annual)					
4th Qtr /2nd Semi-annual			ML15057A067		
3rd Qtr					
2nd Qtr /1st Semi-annual					
1st Qtr					

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A.6 Changes or updates important to exposure pathways and doses

As documented above, several changes or updates to operations have occurred at the Lost Creek ISR Project since operations began in 2013 and not documented in the routine documents. The primary changes are as follows:

Lower than Expected Wastewater Disposal Capacity

For a short period of time following the initial startup of operations, the capacity for disposal of wastewater was hampered primarily because of (1) a significant loss of injectivity for the first Class I deep disposal well; (2) problems in regulatory approval of the second Class I deep disposal well, (3) problems with the treatment equipment, (4) severe cold during winter freezing the underground piping to the ponds, and (5) limited need for permeate as no wellfields were in restoration during the this period. The difficulties resulted in the licensee developing several creative solutions, some of which resulted in violations and/or environmental impacts, but others proved to be beneficial from a safety perspective. The creative solutions include (1) a lack of a production bleed to maintain an inward gradient at the wellfield as a first line of defense for an excursion (this action resulted in NRC issuing a violation), (2) installation of overland piping to the ponds when the underground pipes froze (this action resulted in a spill), (3) overfilling of fluids in the ponds (this action resulted in NRC issuing a violation), (4) improperly evaluating the use of temporary storage tanks on the pond embankment (this action resulted in NRC issuing a violation) and (5) injecting treated permeate into a permitted Class V well (this was a design change requiring NRC approval (amendment to the license)). The disposal limitations were alleviated when the second Class I well was approved and put into operation, the reverse osmosis treatment system became fully functional, and, eventually, the use of the Class V well for the disposal of treated permeate. The violations have been addressed and the facility is currently being operated with sufficient wastewater disposal capacity.

Sediment Load in Lixiviant

The licensee had experienced problems with sediment load in the production and wastewater fluids (see SERP's LC14-03, LC16-03 and LC16-05). The licensee evaluated the effectiveness of adding filters to the header houses and has installed banks of four filter canisters in all the header houses. The filter contains "socks" to collect the sediment and the socks need to be routinely replaced after collecting sufficient sediment (which impedes the flow/increases the back pressure). The socks may become sources of radiation to the workers due to the buildup of radionuclides in the accumulated sediment. The licensee was given a violation for improperly storing in the open used filter socks at four header houses (2017001-02). The violation is currently open since it was only recently issued.

Extreme Winter Weather

In the approved license application, Lost Creek reports the monthly average high and low temperatures for the Lost Creek site as well as nearby cities/towns. The monthly average low temperatures for the winter months (i.e., December through March) were generally in the single digits. During one inspection, the NRC inspectors noted temperatures of -20 degrees Fahrenheit during the early morning.

The low winter temperatures have had an impact on operations, in particular the surface impoundments, during the second winter season. First, in December 2014, the leak detection

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monitoring identified loss of integrity of the primary liners in both impoundments. The cause was not directly attributed to the winter weather but ascribed to failure of boots connecting the piping to the impoundments. As noted above, the purpose of the pond leak detection program is to identify and correct leaks in the primary liner before any fluid from the pond enters the environment. In addition, any impact to the environment is monitored at wells installed in the first underlying aquifer surrounding the ponds. No impacts have been identified at those wells.

During the end of that winter season, because the piping had frozen, the licensee had placed an above ground temporary piping to one impoundment. Because the piping was not “tied-down”, the pressure result in the piping rising out of the impoundment creating an unplanned release to the ground surface and vault housing the piping to the impoundments (see ML14203A116). The spill was limited to the berm between the ponds and its volume was estimated to be approximately 1900 gallons. The licensee’s procedures for cleanup of spills include collecting any residual fluids at the surface, mapping of the spill location, and collection of subsurface samples. If the levels in the soil exceed the cleanup criteria, Lost Creek has to either cleanup the soils at the time of the release or increase the surety to cleanup the soils during decommissioning. It is anticipated that the constituents in the spilled fluid would absorb onto the soil during the fluid migration through the unsaturated zone. Given the location of the spill (i.e., the berm between the ponds), decommissioning would include cleanup and offsite disposal of any impacted soils even if this spill did not occur. Finally, at this location, monitoring wells have been installed to monitor the impacts from a pond release and would be able to detect impacts from this spill. No impacts have been detected at the monitoring wells.

At the end of winter of 2016, the leak detection systems also indicated a possible loss of integrity for both impoundments. However, the licensee attributed the detections to the spring thaw which permitted residual water between the liners in both impoundments (from the earlier loss of integrity) to flow to the leak detection systems.

In January 2018, the leak detection system in the north impoundment indicated a possible loss of integrity of the liner in that impoundment. Because of the ice, a sample of the fluids in the impoundment could not be obtained to verify the potential. Furthermore, the ice prevented the timely implementation of corrective actions (i.e., lowering of water levels in the affected impoundment) because removing any fluids would remove the support for the ice thus putting unacceptable stresses of the liner where it was in contact with the ice.

The issues with the fluids in the leak detection systems for the surface impoundments places stresses on the secondary liners for the impoundments. The loss of integrity of the secondary liner may lead to a release to the subsurface environment. The procedures are to remove the fluids as quickly as possible to minimize any stresses on the secondary liner. Furthermore, monitoring of fluids at wells installed in the first underlying aquifer surrounding the ponds is a defense in depth strategy should the unlikely failure of the secondary liner occur.

A.7 Conclusions

The NRC staff finds that the facility has operated safely and in accordance with the approved license, as amended by Licensee’s SERP process. The NRC staff has not identified any un-reviewed safety concerns related to the changes by the Licensee’s SERP process. Therefore, the changes implemented by the Licensee’s SEP process are valid and will be incorporated as part of the approved license application.

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Based on the on-site inspections and review of reports submitted by the licensee as documented below, the NRC staff finds that the facility has operated safely and in accordance with the approved license, as amended by the five amendments approved by the NRC staff. The NRC staff has not identified any un-reviewed safety concerns related to the changes by the amendment. Therefore, the prior staff approvals of the amendments are valid.

A.7 References

NRC, 2003a. *Standard Review Plan for In Situ Leach Uranium Extraction License Applications*. NUREG-1569, Washington, D.C. ADAMS Accession No. ML032250177.

Appendix B

New or Revised License Conditions

SER Section	LC	License Condition (LC)
1.4	9.1	<p>The authorized place of use shall be the licensee’s Lost Creek Project and the Lost Creek East Project in Sweetwater County, Wyoming. The licensee shall conduct operations within the license area boundaries shown on Plates OP-2a and OP-2b (ML17275A669) with the exception that operations in the KM Horizon within the licensed area (Mine Unit 3 and Mine Unit 12) are not authorized.</p>
1.4	9.2	<p>The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license application dated March 31, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML081060525), which is supplemented by the submittals dated December 12, 2008 (ML090080451), January 16, 2009 (ML090360163), February 27, 2009 (ML090840399), August 5, 2009 (ML092310728), April 22, 2010 (ML102100263, ML102420249), May 14, 2010 (ML101600528), June 17, 2010 (ML101720161), June 24, 2010 (ML101820155), November 11, 2010 (ML103210590), November 16, 2010 (ML103280186), December 3, 2010 (ML103490862), September 13, 2011 (ML112580267), November 8, 2011 (ML11319A196), January 6, 2012 (ML120470353), February 10, 2012 (No. ML12048A678), February 17, 2012 (ML12053A326), March 5, 2012 (120670278), July 27, 2012 (ML12219A076), July 31, 2012 (ML12244A404), November 8, 2012(ML13029A734), November 29, 2012 (ML12335A016), March 27, 2013 (ML13100A138), January 16, 2015 (ML15029A423), March 3, 2015 (ML15076A380), July 28, 2015 (ML15218A055), August 17, 2015 (ML15239A726), January 26, 2016 (ML16043A365), February 8, 2016 (ML16042A069), February 27, 2018 (ML17069A296), April 18, 2017 (ML17115A215), September 25, 2017 (ML17275A669), December 5, 2017 (ML17353A211), January 5, 2018 (ML18017A809) and April 24, 2018 (ML18115A230). The approved application and supplements are, hereby, incorporated by reference, except where superseded by specific conditions in this license. The licensee must maintain the approved license application on site.</p> <p>Whenever the word “will” or “shall” is used in the above referenced documents, it shall denote a requirement. The use of “verification” in this license with respect to a document submitted for U.S. Nuclear Regulatory Commission (NRC)</p>

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SER Section	LC	License Condition (LC)
		staff review means a written acknowledgement by NRC staff that the specified submitted material is consistent with commitments in the approved license application, or requirements in a license condition or regulation. A verification will not require a license amendment.
2.5.4	10.22	The licensee is restricted from conducting ISR operations in the HJ Horizon in areas in which the HJ Horizon is not fully saturated as depicted on Figure 10 in Attachment OP-2 of the Lost Creek East Amendment Application (ML18017A809).
2.5.4	10.23	The licensee is prohibited from operations in the KM Horizon within the initial licensed area (Mine Unit 3 and Mine Unit 12).
2.6.4	12.16	Prior to major site construction in the Lost Creek East area, the licensee will complete the background characterization of groundwater at wells M-N3, M-FG2, MHJ1, M-L7, M-L9 and M-L11A. The background characterization for the L Horizon wells includes potentiometric head data to establish the seasonal variability.
2.7.4	12.17	<p>Prior to major site construction in the LCE area, the licensee will submit to the NRC one or more radiological environmental monitoring program reports that address the following:</p> <ul style="list-style-type: none"> (1) Results of additional preoperational surface and subsurface soil sampling, and a comparison of the surface and subsurface soil sampling results to the OHV scan surveys results conducted in year 2012 at the LCE area (2) A comparison of the results of MILDOS-AREA modeling for the Lost Creek licensed area and LCE area. If the comparison shows a change in the location of the highest predicted airborne radionuclide concentration due to milling operations, the licensee shall collect additional vegetation samples consistent with Regulatory Guide 4.14 (3) Results of additional preoperational sediment sampling at a pond located at the northeast-northwest quarter of Section 21, T25N R92W. The

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SER Section	LC	License Condition (LC)
		<p>sediment samples shall be collected and analyzed for radionuclide concentrations of uranium, lead-210, radium-226, and thorium-230 consistent with Regulatory Guide 4.14.</p>
3.1.4	10.24	<p>For drillholes through the HJ Horizon mine unit pattern area for which restoration has not been approved, the licensee will dispose of waste drilling fluids to the existing waste water system (i.e, surface impoundments).</p>
3.1.4	11.5	<p><u>Excursion Monitoring.</u> Monitoring for excursions shall occur twice monthly (semi-monthly) and at least 10 days apart for all wells installed under LC 11.3 (B) and (C) at all wellfields. If, for any well during a semi-monthly sampling event, the concentrations of any two excursion indicator parameters exceed their respective UCL or any one excursion indicator parameter exceeds its UCL by 20 percent, then the excursion criterion is exceeded and a verification sample shall be taken from that well within 48 hours after results of the first analyses are received. If the verification sample confirms that the excursion criterion is exceeded, then the well is placed on excursion status. If the verification sample does not confirm that the excursion criterion is exceeded, a third sample shall be taken within 48 hours after the verification sampling. If the third sample shows that the excursion criterion is exceeded, the well is placed on excursion status. If the third sample does not show that the excursion criterion is exceeded, the first sample shall be considered to be an error and routine excursion monitoring is resumed (the well is not placed on excursion status).</p> <p>Upon confirmation of an excursion, the licensee shall notify NRC, as discussed below, implement corrective action, and increase the sampling frequency for the excursion indicator parameters at the well on excursion status to at least once every 7 days. Corrective actions for confirmed excursions may be, but are not limited to, those described in Section 5.7.8.2 of the approved license application. An excursion is considered corrected when concentrations of all indicator parameters are below the concentration levels defining the excursion for three consecutive weekly samples.</p> <p>If an excursion is not corrected within 60 days of confirmation, the licensee shall either (a) terminate injection of lixiviant within the wellfield until an excursion is corrected; or (b) increase the surety in an amount to cover the full third-party cost of correcting and cleaning up the excursion. The</p>

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SER Section	LC	License Condition (LC)
		<p>surety increase shall remain in force until the NRC has verified that the excursion has been corrected and cleaned up. The written 60-day excursion report shall identify which course of action the licensee is taking. Under no circumstances does this condition eliminate the requirement that the licensee must remediate the excursion to meet ground-water protection standards as required by LC 10.7 for all constituents established per LC 11.3.</p> <p>The licensee shall notify the NRC Project Manager (PM) by telephone or email within 24 hours of confirming a lixiviant excursion, and by letter within 7 days from the time the excursion is confirmed, pursuant to LC 11.6 and 9.3. A written report describing the excursion event, corrective actions taken, and the corrective action results shall be submitted to the NRC within 60 days of the excursion confirmation. For all wells that remain on excursion after 60 days, the licensee shall submit a report as discussed in LC 11.1(A).</p> <p>In areas where mine units in the HJ and KM horizons overlap, the licensee will modify the excursion monitoring program in the overlying and underlying aquifers beyond the standard requirements as follows:</p> <ul style="list-style-type: none"> (1) For areas in which the pattern areas in the two mine units directly overlie each other, the licensee will: <ul style="list-style-type: none"> (a) install at least one baseline well in each mine unit prior to the injection of lixiviant in either mine unit that will serve to establish the Commission-approved background for each respective mine unit or as an overlying/underlying unit trend well for the excursion monitoring program (b) if operations of the KM Horizon are conducted prior to the HJ Horizon, for the HJ Horizon mine unit, the excursion monitoring program will include overlying monitoring wells in the Lower FG Horizon at a minimum density of one well per two acres and underlying monitoring wells in the upper L Horizon at a minimum density of one well per four acres (c) if operations in the HJ Horizon are conducted prior to the KM Horizon, for the KM Horizon mine unit, the monitoring program will include overlying monitoring wells in the Lower FG Horizon at a minimum density of one well per four acres and underlying monitoring wells the

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SER Section	LC	License Condition (LC)
		<p>upper L Horizon at a minimum density of one well per four acres.</p> <p>(d) depending upon the state of operations (active restoration, stability monitoring or approved restoration), monitor the trend wells installed in (a) to establish impacts to the exempted aquifer as follows:</p> <ol style="list-style-type: none"> 1. if the non-operational horizon is undergoing active restoration, monitor the fluids in a trend well for restoration success using the parameters TDS (or SC), uranium and alkalinity at a minimum frequency of one sample per 60 days 2. if the non-operational horizon is undergoing stability monitoring or the restoration has been approved, monitor the fluids as an excursion monitoring well for the excursion monitoring parameters based on the trend well background concentrations at the normal monitoring frequency (i.e., a sample semi-monthly or 60 days). <p>(2) For areas within the perimeter well ring in which the pattern areas in the two mine units do not directly overlie each other, the licensee will install a baseline well in the mine unit with the pattern area and a well in the other horizon (lower HJ or upper KM horizon) that will be used as an overlying (or underlying) excursion monitoring well at a minimum density of one well per four acres</p>
3.2.4	10.2	<p><u>Facility Throughput.</u> The Lost Creek processing facility throughput shall not exceed an average daily flow rate equivalent to 6,000 gallons per minute or a maximum instantaneous flow rate of 6,300 gallons per minute, excluding restoration flow. The annual production of yellowcake slurry and/or dried yellowcake shall not exceed 2.2 million pounds equivalent of dried yellowcake product.</p>