U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
DIVISION OF FUEL CYCLE SAFETY, SAFEGUARDS, AND ENVIRONMENTAL REVIEW

FINAL ENVIRONMENTAL ASSESSMENT FOR THE LUDEMAN SATELLITE IN SITU RECOVERY PROJECT, CONVERSE COUNTY, WYOMING

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EXECUTIVE SUMMARY

BACKGROUND

By letter dated December 3, 2011, and as revised on June 28 and August 31, 2017, Uranium One USA Inc. (referred to as Uranium One, or, the licensee) submitted a request to amend its U.S. Nuclear Regulatory Commission (NRC) Source Material License SUA–1341 for the Willow Creek In Situ Recovery (ISR) Project, located in Johnson County, Wyoming (Uranium One, 2011b; Uranium One, 2017a,b). Uranium One requested that the Willow Creek ISR Project be modified to include the Ludeman ISR satellite, which is located in Converse County, Wyoming, and which encompasses approximately 7,633 hectares (ha) [18,861 acres (ac)] of land within the proposed project area.

The Willow Creek Project, formally known as Irigaray and Christensen Ranch, is composed of two distinct project areas. The Irigaray project area contains the Willow Creek central processing plant (CPP) and wellfields and is located in eastern Johnson County, Wyoming. The Christensen Ranch satellite operation contains an ion exchange plant and associated wellfields and is located along the border of Campbell and Johnson Counties [Environmental Assessment (EA) Figure 1-1]. The Christensen Ranch area of the Willow Creek Project contains approximately 5,666 ha [14,000 ac] of land, and the Irigaray area contains approximately 405 ha [1,000 ac] of land. The Irigaray site was licensed for commercial ISR operation in August 1978 under the ownership of Westinghouse Electric Corporation. In 1987, Malapai Resources Company (Malapai) purchased the Irigaray project and incorporated the Christensen Ranch satellite ion exchange plant and associated wellfields in 1988. In 1990, operations at both the Irigaray and Christensen Ranch facilities ceased because of unfavorable market conditions, and in September 1990, Malapai was sold to Electricite de France, a French nuclear utility. In April 1993, COGEMA Mining, Inc. acquired ownership of the Irigaray and Christensen Ranch projects. In January 2010, Uranium One USA, Inc., a daughter company of Uranium One, Inc., completed the purchase of COGEMA, which included the change of control for license SUA–1341 to Uranium One USA, Inc. Active uranium recovery operations restarted at the Willow Creek Project in December 2010, and the license was last renewed in 2013 for a 10-year period (NRC, 2013b).

Under NRC Source Material License SUA–1341, Uranium One is authorized, through its ISR process, to produce up to 1.1 million kilograms (kg) [2.5 million pounds (lb)] per year of tri-uranium octoxide (U_3O_8), also known as “yellowcake” (NRC, 2016a). In 2016, Uranium One produced 27,170 kg [59,900 lb] of yellowcake at the Willow Creek CPP, which is less than 2.5 percent of the license limit (Uranium One, 2017a).

The NRC staff prepared this EA following NRC regulations at Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions” that implement the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. §4321), and the NRC staff guidance in NUREG–1748, “Environmental Review Guidance for Licensing Actions Associated with NMSS Programs” (NRC, 2003b). The purpose of this EA is to assess the potential environmental impacts of granting the proposed license amendment. Based on this EA, the NRC staff has determined that preparation of an Environmental Impact Statement (EIS) is not warranted and will therefore issue a Finding of No Significant Impact (FONSI) to be noticed in the *Federal Register*.

PURPOSE AND NEED FOR THE PROPOSED ACTION

The NRC regulates uranium milling, including the ISR process, under 10 CFR Part 40, "Domestic Licensing of Source Material." Uranium One is seeking an amendment to its Willow Creek ISR Project NRC license for the construction, operations, aquifer restoration, and decommissioning of six additional wellfields within the proposed Ludeman ISR Satellite Project. The proposed federal action is the granting of the requested license amendment. The purpose and need for the proposed federal action is to provide an option that allows Uranium One to recover uranium within the proposed Ludeman ISR Satellite Project. The licensee would process the recovered uranium into yellowcake at the existing CPP currently located on the Willow Creek Irigaray site. Yellowcake is the uranium oxide product of the ISR milling process that is used to produce various products, including fuel for commercially-operated nuclear power reactors.

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954 (AEA), the NRC has no role in a company's business decision to submit a license application to operate an ISR facility at a particular location.

THE PROJECT AREA

The proposed Ludeman ISR Satellite Project and the existing Willow Creek ISR Project are located within the southern portion of the Powder River Basin, a structural and topographic basin in eastern Wyoming and southern Montana. The proposed Ludeman ISR Satellite Project would be located approximately 16 kilometers (km) [10 mile (mi)] northeast of Glenrock, Wyoming, in Converse County, in whole or part, in Township 34N, Range 74W (Sections 12-14 and 22-24); Township 34N, Range 73W (Sections 2-11, 14-28, and 34-36); Township 34N, Range 72W (Sections 19 and 30); and Township 33N, Range 73W (Sections 1-3). The Willow Creek ISR Project is located in Johnson and Campbell Counties, Wyoming, at the base of the Pumpkin Buttes. The Ludeman ISR Satellite Project would consist of wellfields and header houses connected by buried trunklines to an ion-exchange facility and associated liquid waste management facilities. The waste management facilities may include several surface impoundments or Class I deep disposal wells or a combination of both. The licensed Willow Creek CPP is located at the Irigaray site and would be used to process ion exchange resin (shipped by truck) from the Ludeman Project into yellowcake.

SUMMARY OF ENVIRONMENTAL IMPACTS

This EA includes the NRC staff analysis that considers and weighs the environmental impacts from the construction, operations, aquifer restoration, and decommissioning of ISR operations at the proposed Ludeman ISR Satellite Project and for the No-Action Alternative. This EA also describes mitigation measures for the reduction or avoidance of potential adverse impacts that (i) the licensee has committed to in its NRC license amendment request, and (ii) are additional measures the NRC staff identified as having the potential to reduce environmental impacts but that the licensee did not commit to in its application. Where applicable, the EA uses the assessments and conclusions reached in licensing the Willow Creek ISR Project (NRC, 2011c; NRC, 2013a) and in NUREG–1910, "Generic Environmental Impact Statement for In Situ Leach Uranium Milling Facilities," (GEIS) (NRC, 2009) in combination with site-specific information to assess and categorize impacts.

As discussed in the NUREG–1910 (NRC, 2009) and consistent with NUREG–1748 (NRC, 2003b), the significance of potential environmental impacts is categorized as follows:

SMALL: The environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: The environmental effects are sufficient to alter noticeably, but not destabilize, important attributes of the resource.

LARGE: The environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Chapter 4 of this EA provides the NRC evaluation of the potential environmental impacts from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project, summarized as follows.

Land Use

The NRC staff concludes that impacts to land use from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the addition of the Ludeman ISR Satellite Project would disturb as much as 377 ha [932 ac] of land, which is within the 50 to 750 ha [120 to 1,860 ac] range analyzed in the GEIS (NRC, 2009); (ii) the land within the proposed Ludeman ISR Satellite Project is primarily privately owned land with restricted access or state-owned land with similarly limited access, thereby limiting hunting and other recreational activities; (iii) livestock grazing would continue to be restricted around each wellfield during the operations phase, but no additional land disturbance would occur from conducting operational activities; (iv) aquifer restoration activities would use the same infrastructure as during the operations phase; (v) as aquifer restoration proceeds and wellfields are closed, with fewer wells and header houses being used, onsite activities would diminish; and (vi) during the decommissioning phase, the disturbed area would progressively decrease and the land would be reseeded and soil replacement would occur.

Transportation

The NRC staff concludes that impacts to transportation from construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would have a SMALL to MODERATE impact on transportation. This conclusion is based on the following factors: (i) potential impacts would be from vehicles traveling to and from the site carrying workers, equipment, supplies, and materials associated with all phases of the proposed Ludeman ISR Satellite Project; (ii) the NRC staff assumed that commuting workers and commercial deliveries would travel from a variety of locations and would not all commute on the same road; (iii) the proposed transportation activities during operations, aquifer restoration, and decommissioning would not noticeably increase traffic on local and regional roads and would present low hazards and risks under normal and accident conditions.

Geology and Soils

The NRC staff concludes that impacts to geology and soils from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the extent of the disturbed area

is limited; (ii) topsoil stockpiling procedures are proposed for implementation; (iii) Wyoming Department of Environmental Quality (WDEQ)-approved erosion control techniques (e.g., placement, sloping, and seeding of stockpiles) would be implemented, consistent with requirements of a WDEQ Permit to Mine; (iv) the duration of mud pit usage would be short (approximately 30 days following excavation) and subsoil would be redeposited in the mud pit followed by replacement of topsoil; (v) no significant matrix compression or ground subsidence is expected to result in collapse of overlying geologic units due to the uranium mobilization and recovery processes; (vi) damage from seismic activity and reactivation of local faults is extremely unlikely; (vii) the licensee would be required to immediately report spills and establish spill-recovery actions and routine monitoring programs; and (viii) the licensee has stated a goal to decommission and reclaim the site to preproduction conditions.

Water Resources

Surface Water

The NRC staff concludes that impacts to surface water resources from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the limited areal extent of surface disturbance; (ii) the limited extent of surface water and wetlands; (iii) implementation of WDEQ guidelines and conditions associated with a WDEQ Permit to Mine to control erosion, stormwater runoff, and sedimentation; (iv) compliance with the U.S. Army Corps of Engineers permitting requirements for wetlands in Section 404 of the Clean Water Act; (v) a license condition prohibiting construction of any wellfield infrastructure in Wellfield 5 within the surface water impoundment located in Section 28 of T34N R73W, as shown in Figure 2.7A-1 of Addendum 2.7-A of the Revised Technical Report (Uranium One, 2017d); (vi) adherence to NRC and WDEQ design and inspection criteria for ISR facilities and wastewater storage ponds; (vii) compliance with Wyoming Pollutant Discharge Elimination System (WYPDES) permit requirements and NRC effluent limits and disposal standards for any surface discharge of treated aquifer restoration water; (viii) compliance with the terms of the Modified North Platte River Decree; and (ix) ongoing reclamation and decommissioning of the wellfields throughout the project lifecycle that reduces the overall area of disturbance.

Groundwater

The NRC staff concludes that impacts to groundwater resources from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the limited amount of water consumed for routine construction activities; (ii) the use of mud pits to control the spread of drilling fluids to surficial and near-surface aquifers; (iii) the licensee's commitment to follow WDEQ Underground Injection Control (UIC) requirements for Class III well design, construction, and testing; (iv) Uranium One's commitment to implement a mechanical integrity test program to mitigate potential impacts from borehole failures of project wells; (v) the licensee's adherence to WYPDES permit requirements for discharged water; (vi) the licensee's implementation of requirements, guidance, and mitigation measures to protect water quality from potential leaks and spills, including required spill response and cleanup procedures; (vii) adherence to NRC guidelines and WDEQ rules governing design and construction of surface impoundments; (viii) maintenance of inward hydraulic gradients (production and restoration bleeds) to minimize excursions of lixiviant out of the proposed wellfield areas; (ix) analytical modeling results of drawdown during ISR operations that show no impact on groundwater in wells outside the proposed project area; (x) Uranium One's commitment to

construct a monitoring well network around each wellfield to detect potential excursions; (xi) Uranium One's commitment to plug old drill holes near proposed wellfields; (xii) Uranium One's commitment to implement mitigation measures consistent with Uranium One's Storm Water Pollution Prevention Plan that would control erosion and stormwater runoff that could impact surficial and near-surface aquifers; and (xiii) a license condition prohibiting surface water discharge of permeate pond water until the licensee provides for NRC review and approval information to demonstrate that the dose limits for individual members of the public in 10 CFR 20.1301 are met. In addition, Uranium One would submit decommissioning plans, including detailed plans for plugging and abandoning wells, to the NRC and WDEQ for review and approval.

Ecology

The NRC staff concludes that impacts to ecology from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the size of the project area; (ii) the type and amount of vegetation to be disturbed during construction; (iii) proposed revegetation and weed control methods following WDEQ guidelines; (iv) construction of wellfield fences to allow wildlife passage, in accordance with WDEQ guidelines; (v) vehicle speed limits to reduce noise, fugitive dust, and the potential for direct collisions with wildlife; (vi) dust suppression to control fugitive dust emissions from unpaved roads; (vii) limiting stream crossings; (viii) implementing spill response plans; (ix) limiting activities that lead to soil erosion; (x) protecting animal habitat and forage by revegetating disturbed areas, stockpiling soil, and controlling weeds and invasive plant species; (xi) use of existing overhead power lines where possible and implementing practices for new power lines that protect avian wildlife; (xii) conducting annual raptor surveys within and beyond the project area; (xiii) consultation with U.S. Fish and Wildlife Service (FWS) prior to any nest disturbance; (xiv) nest manipulation permitting and legal prohibition against disturbing active migratory bird nests; (xv) protections for avian wildlife in the federal Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act; (xvi) absence of known federally listed species or critical habitats within the Ludeman ISR Satellite Project; (xvii) mandated spill response; (xviii) prompt backfilling of mud pits; (xix) monitoring surface water discharge of treated aquifer restoration water to verify radiological contaminants in treated wastewater are within allowable release limits; (xx) required WDEQ monitoring and action levels for metal concentrations in soils, vegetation, surface water, and groundwater; (xxi) measures to limit wildlife exposures to ISR solutions and a commitment to increase mitigations if mortalities are identified; (xxii) designing surface impoundments to maintain control of ISR solutions; (xxiii) the inclusion of surface water discharge areas in decommissioning surveys; and (xxiv) submittal of an updated reclamation plan for review and approval by NRC and appropriate state agencies.

Air Quality

The NRC staff concludes that impacts to air quality from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) dust suppression to reduce fugitive dust emissions from travel on unpaved roads; (ii) reclaiming disturbed land as soon as practicable to reduce fugitive dust emissions from wind erosion; (iii) using newer drill rigs and construction equipment with engines that meet certain emission standards mandated by the federal government and produces fewer emissions relative to older engines; (iv) bounding particulate matter air concentration estimates below U.S. Environmental Protection Agency's National Ambient Air Quality Standards and Prevention of Significant Deterioration thresholds at

the nearest residence from the proposed Ludeman ISR Satellite Project emission sources; and (v) pollutants other than particulate matter expected to be within the emission levels previously evaluated in the GEIS.

Noise

The NRC staff concludes that impacts to noise from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the rural location of the proposed project; (ii) the low population density of the surrounding area; (iii) proposed mitigation measures (e.g., engineering controls and speed limits); and (iv) noise levels for the operations, aquifer restoration, and decommissioning phases that would be similar to or less than noise levels during the construction phase.

Historical and Cultural Resources

The NRC staff concludes that impacts to historic and cultural resources from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the NRC would require by license condition that Uranium One avoid two sites located within the direct area of potential effect (APE) that are eligible for listing on the National Register of Historic Places, as determined through NRC consultation with Native American Tribes and concurred by the Wyoming State Historic Preservation Office (WY SHPO); (ii) the area of ground disturbance would not change during operations, aquifer restoration, and decommissioning phases; (iii) Uranium One has committed to an inadvertent discovery plan to address the potential identification of previously unrecorded historic and cultural resources during any phase of the project; and (iv) no paleontological resources were identified within the proposed project area; however, if inadvertent paleontological resource discovery occurs, NRC-approved procedures would be followed to address any disturbance in excess of a few feet. Should the licensee determine the need to expand ground-disturbing activities outside the currently defined APE for direct impacts, additional review under Section 106 of the National Historic Preservation Act (NHPA) would be necessary, including consultation with Native American Tribes.

Visual and Scenic

The NRC staff concludes that impacts to visual and scenic resources from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the header houses would be painted to blend in with the natural landscape; (ii) power lines and pipelines would be buried, where appropriate; (iii) dust suppressant would be used to minimize fugitive dust; (iv) the amount of visual disturbances would decrease as wellfields are decommissioned and facilities are removed; and (v) surface disturbances would be recontoured to blend in with the natural terrain and revegetated.

Socioeconomics and Environmental Justice

The NRC staff concludes that impacts to socioeconomics from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) a small number of children would be enrolled in public schools within the area surrounding the proposed project as a result of families relocating to the area; and (ii) workers would command salaries that provide income

levels equal to or higher than the average local and statewide income levels that would not significantly affect regional employment. The NRC staff considered whether the proposed project would impact minority and low-income communities. The NRC staff's evaluation identified no minority and low-income populations within a 6.4-km [4-mi] radius of the Ludeman ISR Satellite Project and concluded that, therefore, there would not be disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Public and Occupational Health

The NRC staff concludes that impacts to public and occupational health from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) annual radiological doses to the population within 80 km [50 mi] of the proposed project would be far below applicable NRC regulations; (ii) relative to a typical ISR facility, the uranium processing (limited to ion exchange) would involve less concentrated uranium solutions and no dried yellowcake; (iii) typical protection measures, such as radiation and occupational monitoring, respiratory protection, standard operating procedures for spill response and cleanup; (iv) worker training in radiological health and emergency response would be required as a part of the licensee's NRC-approved Radiation Protection Program; and (v) a license condition prohibiting surface water discharge of permeate pond water until the licensee provides for NRC review and approval, information to demonstrate that the dose limits for individual members of the public in 10 CFR 20.1301 are met.

Waste Management

The NRC staff concludes that waste management impacts from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project would be SMALL. This conclusion is based on the following factors: (i) the licensee has committed to providing adequate onsite disposal capacity for liquid byproduct material in evaporation ponds and by WDEQ-permitted surface water discharge of treated aquifer restoration water (or deep disposal well capacity, with associated permitting and regulatory controls); (ii) the required preoperational agreement for disposal of solid byproduct material made between the licensee and the licensed disposal facility that would ensure adequate disposal capacity is available for the duration of the project; (iii) the low volume of hazardous waste generated and the proposed disposal of, in accordance with applicable regulations; and (iv) available local municipal solid waste landfill capacity to dispose of the estimated volume of nonhazardous solid waste during the construction, operations, aquifer restoration, and decommissioning phases of the proposed Ludeman ISR Satellite Project.

Table E–1 compares the significant levels of potential environmental impacts of the proposed action and the No-Action Alternative.

Table E–1. Summary of Impacts for the Ludeman ISR Satellite Project		
Resource Area	**Proposed Action**	**No-Action Alternative**
Land Use	SMALL	NONE
Transportation	SMALL to MODERATE*	NONE
Geology and Soils	SMALL	NONE
Surface Water	SMALL	NONE
Groundwater	SMALL	NONE
Ecology	SMALL	NONE
Air Quality	SMALL	NONE
Noise	SMALL	NONE
Historic and Cultural	SMALL	NONE
Visual and Scenic	SMALL	NONE
Socioeconomic and Environmental Justice	SMALL†	NONE
Public and Occupational Health	SMALL	NONE
Waste Management	SMALL	NONE

*The construction phase would have MODERATE impacts on traffic on State Route 93 during the first year of construction and SMALL impacts on transportation on all other traveled roads and on all roads during subsequent years of construction.
†For all phases disproportionately high and adverse impacts are not expected.

CUMULATIVE IMPACTS

Chapter 5 of this EA provides the NRC staff's evaluation of potential cumulative impacts from the construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project license amendment considering other past, present, and reasonably foreseeable future actions. Cumulative impacts from past, present, and reasonably foreseeable future actions were considered and evaluated regardless of what agency (federal or nonfederal) or person undertook the action. The NRC staff determines that the SMALL to MODERATE impacts from the proposed Ludeman ISR Satellite Project license amendment are not expected to significantly increase the existing SMALL to MODERATE cumulative impacts from ongoing uranium and oil and gas exploration activities, existing and potential energy projects, proposed transportation projects, and preconstruction activities at the proposed Ludeman ISR Project area.

COMPARISON OF ALTERNATIVES

For the No-Action Alternative, Uranium One would not construct or operate ISR activities on the proposed Ludeman ISR Satellite Project. As a result, no uranium ore would be recovered from the proposed Ludeman ISR Satellite Project. This alternative would result in neither positive nor negative impacts to any resource area.

FINAL RECOMMENDATION

After weighing the impacts of the proposed license amendment and comparing to the No-Action Alternative, the NRC staff, in accordance with 10 CFR 51.91(d), sets forth its NEPA recommendation regarding the proposed action (granting the request for an NRC license amendment for the proposed Ludeman ISR Satellite Project). Unless safety issues mandate otherwise, the NRC staff recommendation related to the environmental aspects of the proposed

action is that an NRC license amendment be issued. This recommendation is based on (i) the license amendment application, including the revised environmental report and supplemental documents that the licensee submitted and responses to the NRC staff requests for additional information; (ii) consultation with federal, state, Tribal, and local agencies; (iii) the NRC staff independent review; and (iv) the assessments summarized in this EA.

ACRONYMS/ABBREVIATIONS

ac	acre
ACHP	Advisory Council on Historic Preservation
ACL	alternate concentration limit
AEA	Atomic Energy Act
ALARA	as low as is reasonably achievable
ANSS	Advance National Seismic System
APE	area of potential effect
ARMZ	JSC Atomredmetzoloto
BGEPA	Bald and Golden Eagle Protection Act
BKS	BKS Environmental Associates
BLM	Bureau of Land Management
BMP	best management practice
Bq	becquerel
cm	centimeter
CAB	Commission approved background
CBM	coalbed methane
CCSD	Converse County School District
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CPP	central processing plant
dBA	A-weighted decibels
DM&E	Dakota Minnesota and Eastern
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DDW	deep disposal well
EA	environmental assessment
EIA	Energy Information Administration
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ER	environmental report
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FONSI	finding of no significant impact
FR	Federal Register
ft	feet
FHWA	Federal Highway Administration
FWS	U.S. Fish and Wildlife Service
g	gram
gal	gallon
GCRP	U.S. Global Climate Research Program
GEIS	Generic Environmental Impact Statement
gpm	gallons per minute

ha	hectare
HDPE	high density polyethylene
in	inch
IPaC	Information Planning and Conservation
ISR	In Situ Recovery
kg	kilogram
KLJ	KLJ Engineering Planning Services
km	kilometer
L	liter
lb	pound
Lpm	liters per minute
LQD	Land Quality Division
m	meter
m^2	square meter
m^3	cubic meter
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
Mg	milligram
mi	mile
MIT	mechanical integrity test
mrem	milliroentgen equivalent man
mSv	millisievert
MW	megawatt
NAAQS	National Ambient Air Quality Standards
nC	nanocoulomb
NCRP	National Council on Radiation Protection and Measurements
NCSD	Natrona County School District
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NRC	U.S. Nuclear Regulatory Commission
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
O_3	ozone
OSHA	Occupational Safety and Health Administration
Pb	lead
pCi	picocurie
PHMA	Priority Habitat Management Areas
PM_x	particulate matter of size x micrometers in diameter or smaller
ppm	parts per million
PRB	Powder River Basin
PRRIP	Platte River Recovery Implementation Program
PSD	Prevention of Significant Deterioration
PVC	polyvinyl chloride

R	Roentgen
Ra	radium
RAI	request for additional information
RCRA	Resource Conservation and Recovery Act
RFFA	reasonably foreseeable future action
Rn	radon
RO	reverse osmosis
ROI	region of influence
SCS	Soil Conservation Service
SDDENR	South Dakota Department of Environment and Natural Resources
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
STB	Surface Transportation Board
Sv	sievert
SWPPP	Storm Water Pollution Prevention Plan
t	metric ton
T	short ton
TCP	traditional cultural property
TDS	total dissolved solids
TEDE	total effective dose equivalent
TR	technical report
TSS	total suspended solid
UCLs	upper control limits
UIC	Underground Injection Control
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
VRM	Visual Resource Management
WQD	Water Quality Division
WC	Willow Creek
WDAI	Wyoming Department of Administration and Information
WDEQ	Wyoming Department of Environmental Quality
WDOR	Wyoming Department of Revenue
WGFD	Wyoming Game and Fish Department
WMA	Wyoming Mining & Association
WOGCC	Wyoming Oil and Gas Conservation Commission
WYSEO	Wyoming State Engineer's Office
WSGS	Wyoming State Geological Survey
WYDOT	Wyoming Department of Transportation
WY SHPO	Wyoming State Historic Preservation Office

WYPDES	Wyoming Pollutant Discharge Elimination System
yd^3	cubic yard
yr	year

1 INTRODUCTION

By letter dated December 6, 2011 (Uranium One, 2017a,b) and as revised on June 28 and August 31, 2017 (Uranium One, 2017d,e), Uranium One USA Inc. (referred to as Uranium One, or the licensee) submitted a request to amend its U.S. Nuclear Regulatory Commission (NRC) Source Material License SUA–1341 for the Willow Creek (WC) In Situ Recovery (ISR) Project, located in Johnson County, Wyoming (Uranium One, 2011b; Uranium One, 2017d,e). Uranium One requested that the Willow Creek ISR Project permit area be modified to include the Ludeman ISR satellite, which is located in Converse County, Wyoming, and encompasses approximately 7,633 hectares (ha) [18,861 acres (ac)] of land within the proposed permit area.

1.1 Background

The Willow Creek ISR Project is a commercial ISR uranium recovery facility located in the Powder River Basin in Johnson and Campbell Counties, Wyoming. The Willow Creek Project, formally known as Irigaray and Christensen Ranch, is composed of two distinct sites. The Irigaray site contains the Willow Creek central processing plant (CPP) and wellfields and is located in eastern Johnson County, Wyoming. The Christensen Ranch satellite operation contains an ion exchange plant and associated well fields and is located along the border of Campbell and Johnson Counties [Environmental Assessment (EA) Figure 1-1]. The Christensen site of the Willow Creek Project contains approximately 5,666 ha [14,000 ac] of land, and the Irigaray site contains approximately 405 ha [1,000 ac] of land. Approximately half of the land at the Christensen Ranch and Irigaray sites is privately owned and half is owned by the Bureau of Land Management (BLM) and the State of Wyoming (NRC, 1998).

The Irigaray site was licensed for commercial ISR operation in August 1978, under the ownership of Westinghouse Electric Corporation. In 1982, operations ceased at the Irigaray plant and wellfields, and the project was placed on standby status pending improvements in the uranium market. In 1987, Malapai Resources Company (Malapai) purchased the Irigaray project and resumed operations. In 1988, Malapai was granted an amendment to license SUA–1341 to include the Christensen Ranch satellite ion exchange plant and associated wellfields. In February 1990, operations at both the Irigaray and Christensen Ranch facilities ceased because of unfavorable conditions in the uranium market, and in September 1990, Malapai was sold to Electricite de France, a French nuclear utility. In April 1993, COGEMA Mining, Inc. acquired ownership of the Irigaray and Christensen Ranch projects. In January 2010, Uranium One USA, Inc., a daughter company of Uranium One, Inc., completed the purchase of COGEMA, which included the change of control for license SUA–1341 to Uranium One USA, Inc. On June 8, 2010, Uranium One, Inc. entered into a Purchase and Subscription Agreement with JSC Atomredmetzoloto (ARMZ) and its wholly owned subsidiaries, Effective Energy N.V. (Effective Energy), a Dutch limited liability company, and Uranium Mining Company (UMC), a Russian open joint stock company. NRC reviewed and approved an application for change of control and ownership on November 23, 2010 (NRC, 2011b). ARMZ acquired approximately 51 percent stake in Uranium One, Inc. Active uranium recovery operations restarted at the Willow Creek Project in December 2010, and the license was last renewed in 2013 for a 10-year period (NRC, 2013b).

Under NRC Source Material License SUA–1341, Uranium One is authorized, through its ISR process, to produce up to 1.1 million kilograms (kgs) [2.5 million pounds (lbs)] per year of tri-uranium octoxide (U_3O_8), also known as “yellowcake” (NRC, 2016a). In 2016, Uranium One produced 27,170 kgs [59,900 lbs] of yellowcake at the Willow Creek CPP, less than 2.5 percent of the license limit (Uranium One, 2017f).

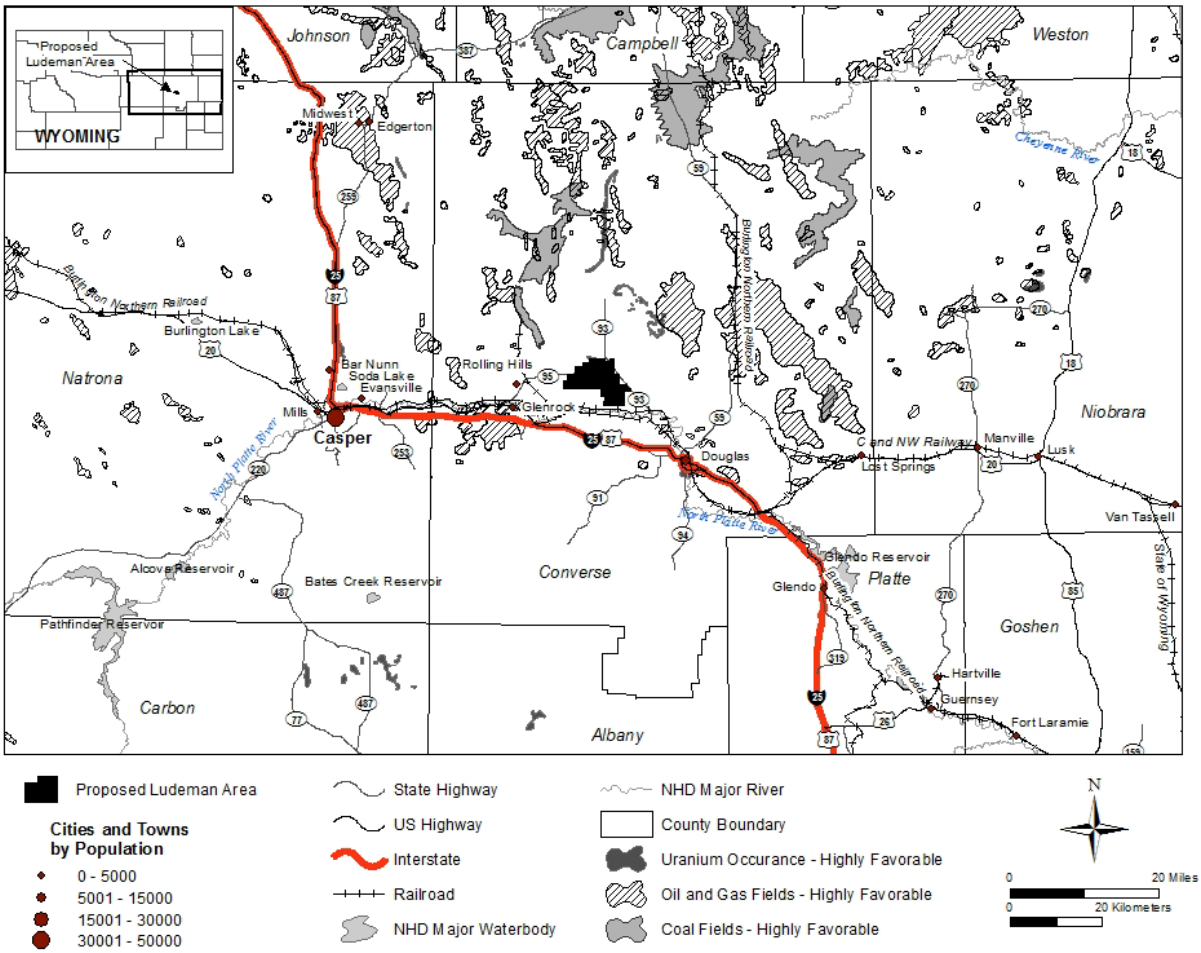


Figure 1-1. Location of the Ludeman ISR Satellite Project

1.2 Proposed Action

On December 3, 2011, Uranium One submitted an application to amend NRC source material license SUA–1341 to construct and operate an ISR satellite facility at the proposed Ludeman ISR Satellite Project. This license amendment application also proposes to conduct aquifer restoration, site decommissioning, and reclamation activities. Based on the application, the NRC's federal action is to either grant or deny amendment of License SUA–1341. The licensee's proposal is described in detail in Chapter 2 of this EA.

1.3 Purpose and Need for the Proposed Action

The NRC regulates uranium milling, including the ISR process, and disposal of the resulting waste byproduct material under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, "Standards for Protection Against Radiation," and Part 40, "Domestic Licensing of Source Material." The licensee is seeking to amend its current NRC source material license to authorize commercial-scale ISR uranium recovery at the proposed Ludeman ISR Satellite Project site. The purpose and need for the proposed federal action is to provide an option that allows the licensee to recover uranium at the proposed Ludeman Project site. Uranium from ion exchange

resins at the proposed Ludeman ISR Satellite Project will be transported and subsequently processed at the Willow Creek CPP, located in Johnson County, Wyoming. Yellowcake, the uranium oxide product of the ISR process, is used in the production of fuel for commercially operated nuclear power reactors.

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954 (AEA), as amended, or findings under the National Environmental Policy Act (NEPA) environmental analysis that would lead NRC to reject a license amendment application, the NRC has no role in a company's business decision to submit a license amendment application for operation of an ISR satellite facility at a particular location.

1.4 Scope of the Environmental Assessment

The NRC staff is reviewing Uranium One's request, in accordance with the NRC's environmental protection regulations in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." Those regulations implement Section 102(2) of NEPA. This document provides the results of the NRC staff's environmental review; the staff's radiation safety review of Uranium One's request will be documented separately in a Safety Evaluation Report (SER).

The NRC staff has prepared this EA in accordance with NRC requirements in 10 CFR 51.21 and 51.30, and with the associated guidance in NUREG–1748, "Environmental Review Guidance for Licensing. Actions Associated with NMSS Programs" (NRC, 2003b). In 40 CFR 1508.9, the Council on Environmental Quality defines an EA as a concise public document that briefly provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact (FONSI).

The NRC staff reviewed and considered the following documents in the development of this EA:

- Uranium One's license amendment application dated December 3, 2011 (Uranium One, 2011b)
- Uranium One's revised license amendment application (Uranium One, 2017d,e)
- Uranium One's responses to NRC requests for additional information (RAIs) and information provided in response to public meetings (Uranium One, 2012; Uranium One, 2013a,b,c; Uranium One, 2014; Uranium One, 2015a,b; Uranium One, 2016a,b,c; Uranium One, 2017a,b,c)
- Previous NRC environmental and safety review documents for the Willow Creek Project (NRC, 2011c; NRC, 2013a,b)
- NRC's Generic Environmental Impact Statement for Uranium Milling Facilities—Final Report (GEIS) (NRC, 2009)

Additional references used for this EA analysis are cited in Section 10.0 of this EA.

In addition, the development of this EA was closely coordinated with the NRC staff's safety analysis development that will be documented in an SER. During the development of the SER,

the NRC staff may identify and include license conditions that apply to the Ludeman site as part of License SUA–1341.

1.5 Structure of the Environmental Assessment

NUREG–1910, "Generic Environmental Impact Statement for Uranium Milling Facilities—Final Report (GEIS)" (NRC, 2009) evaluated broad impacts for ISR projects. In this EA, the NRC staff evaluated the extent to which information and conclusions in the GEIS could be incorporated by reference for evaluation of impacts at the Ludeman project. As practicable, the NRC staff applied these criteria to the site-specific conditions at the Ludeman Project site. The NRC staff also considered, as appropriate, information in the previous environmental reviews that were conducted for the Willow Creek facility (NRC, 2011c; NRC, 2013c). However, except where noted, the NRC staff is not able to reasonably adopt previous conclusions made for the Willow Creek ISR Project for the purpose of the analysis in this EA without further evaluation because the satellite site is not contiguous and may have unique site characteristics. Where possible, the NRC staff has incorporated information from the Willow Creek EA and supplemental EA (NRC, 2011c; NRC, 2013a) or the GEIS (NRC, 2009). Therefore, this EA represents a site-specific analysis of the proposed Ludeman ISR Satellite Project, resulting in a more detailed analysis than what is typically provided in an NRC EA. Chapter 2 of this EA describes the proposed action and No-Action Alternative; Chapter 3 describes the affected environment for the proposed Ludeman Project; and Chapter 4 evaluates the potential environmental impacts from implementing the proposed action. Cumulative impacts are discussed in Chapter 5. Chapter 6 details Uranium One's monitoring and mitigation programs.

2 THE PROPOSED ACTION AND ALTERNATIVE

This chapter describes the Proposed Action (Alternative 1) and the No-Action Alternative (Alternative 2), as required by the National Environmental Policy Act (NEPA) of 1969, as amended. The proposed federal action is to grant a U.S. Nuclear Regulatory Commission (NRC) license amendment requested by Uranium One USA, Inc. (Uranium One or the licensee) to amend the Willow Creek (WC) In Situ Recovery (ISR) Project license No. SUA–1341 to authorize the construction and operation of the Ludeman ISR Satellite Project (e.g., the Ludeman Project, or proposed project) in Converse County, Wyoming. The Willow Creek ISR Project consists of the Irigaray site that contains wellfields and a central processing plant (CPP), as well as the Christensen Ranch Satellite that contains additional wellfields in Johnson and Campbell Counties. If NRC grants the proposed license amendment, the proposed Ludeman ISR Satellite Project would be the second satellite of the Willow Creek ISR Project under license SUA–1341. The source material license SUA–1341 was last renewed by NRC in 2013; licensed uranium recovery operations and related activities have occurred at the Irigaray site since 1974 and at the Christensen Ranch site since 1988. The proposed project and No-Action Alternative are evaluated with regard to the four phases of a uranium recovery operation: (i) construction, (ii) operations, (iii) aquifer restoration, and (iv) decommissioning. The proposed action and alternative have been established based on the purpose and need statement described in Section 1.3 of this environmental assessment (EA).

The NRC staff considered a variety of information sources for the analysis in this EA. These sources include (i) the revised environmental report (ER) (Uranium One, 2017e) and revised technical report (TR) (Uranium One, 2017d); (ii) the licensee's responses to the NRC staff's requests for additional information (RAI) and information provided in response to public meetings (Uranium One, 2012; Uranium One, 2013a,b,c; Uranium One, 2014; Uranium One, 2015a,b; Uranium One, 2016a,b,c; Uranium One, 2017a,b,c); (iii) "Generic Environmental Impact Statement for In Situ Leach Uranium Milling Facilities (GEIS) (NRC, 2009); (iv) the information gathered during the NRC staff site visit in August 2012 (NRC, 2012) and a tribal consultation site visit in November 2017 (EA Section 3.8.2); and (v) multidisciplinary discussions held among the NRC staff and various stakeholders. Uranium One has committed to a number of mitigation measures in its application that will be made binding through a license condition. The NRC's impact conclusions in this EA are based on including in the proposed action only those measures to which Uranium One has committed.

As discussed in EA Section 2.1.1, the proposed Ludeman ISR Satellite Project and the existing Willow Creek ISR Project are both located within the southern portion of the Powder River Basin; however, the Willow Creek CPP and the Ludeman project boundary are approximately 109 kilometers (km) [68 miles (mi)] apart following a straight line and approximately 221 km [137 mi] apart if traveled by road. In cases where a proposed satellite ISR facility is located within the region of influence of a licensed facility, the NRC staff is able to use data obtained from the review of the licensed facility to determine some of the environmental conditions at a proposed satellite project. However, in this case, the proposed project and the existing Willow Creek facility are located farther apart; thus, the NRC staff is not able to reasonably adopt previous conclusions made for the Willow Creek ISR Project for the purpose of the analysis in this EA without further evaluation, except where noted. Where possible, the NRC staff has incorporated information from the Willow Creek EA and supplemental EA (NRC, 2011c; NRC, 2013a) or the GEIS (NRC, 2009). Therefore, this EA represents a site-specific analysis of the proposed Ludeman ISR Satellite Project, resulting in a more detailed analysis than what is typically provided in an NRC EA.

2.1 The Proposed Action

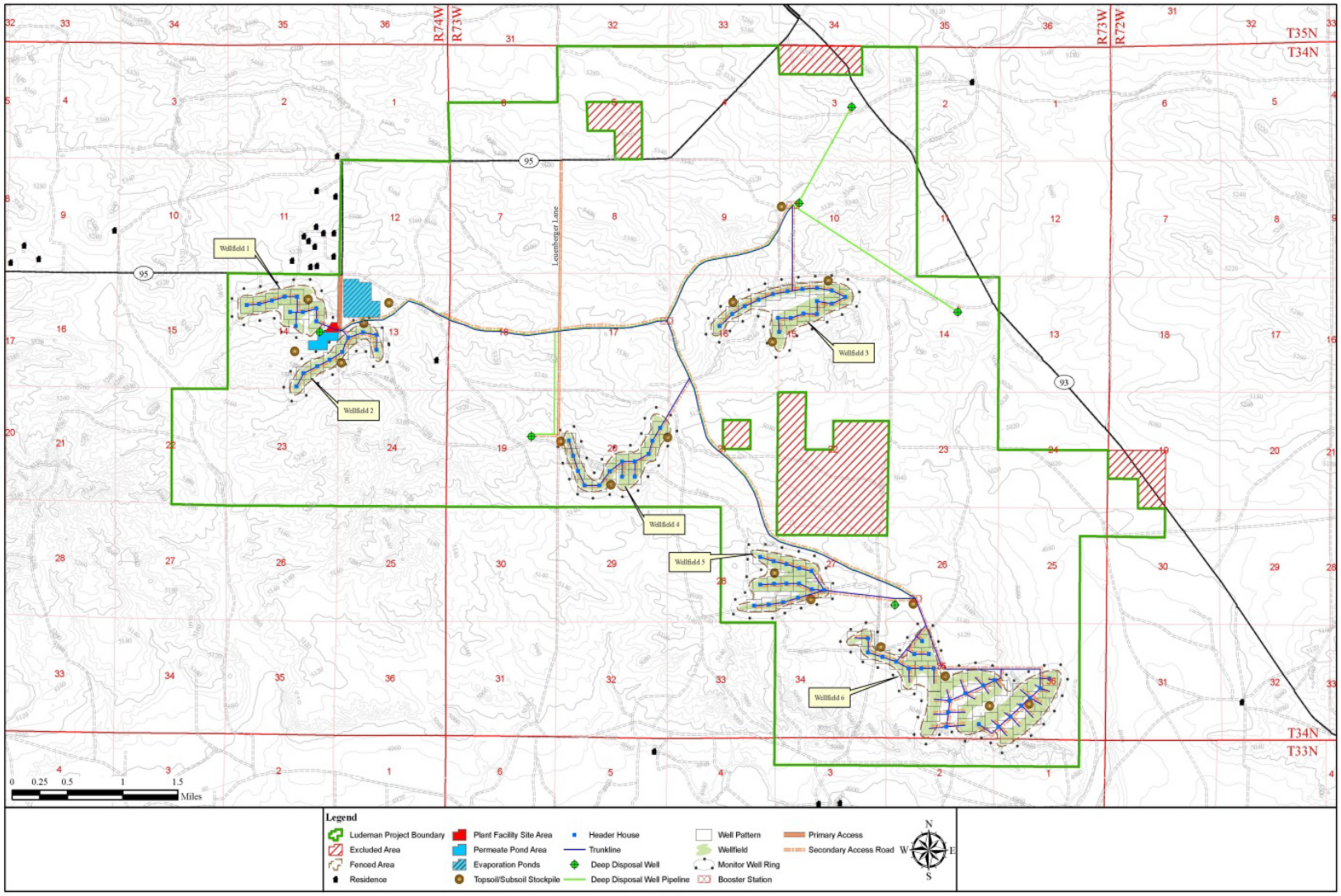
2.1.1 Site Location and Description

The proposed Ludeman ISR Satellite Project and the existing Willow Creek ISR Project are located within the southern portion of the Powder River Basin, a structural and topographic basin in eastern Wyoming and southern Montana. As shown in Figure 1-1, the proposed Ludeman Project is located approximately 16 km [10 mi] northeast of Glenrock, Wyoming, in Converse County; and the Willow Creek ISR Project is located in Johnson and Campbell Counties, Wyoming, at the base of the Pumpkin Buttes. The licensed Willow Creek CPP is located at the Irigaray site and would be used to process ion exchange resin from the Ludeman Project into yellowcake. The proposed one-way truck route for resin shipments to and from the Ludeman site to the Willow Creek CPP is approximately 221 km [137 mi].

Surface ownership within the proposed Ludeman ISR Satellite Project area consists of a majority of privately owned land and a small amount of state land. The concept of a split estate, where different entities own the surface rights and subsurface rights (such as the rights to develop minerals) for a piece of land, is described in the NRC's GEIS (NRC, 2009). This divided ownership pattern occurs within the proposed Ludeman ISR Satellite Project area, where the federal and state government owns subsurface mineral rights for portions of land for which surface rights are owned by private landowners. Uranium One stated in its license amendment application that within the project area are "excluded areas" (see EA Figure 2-1) where ISR activities would not take place. Surface ownership of the excluded areas is held by BLM (federal ownership) and Chapman University (private ownership) (Uranium One, 2013a). Table 3-1 of this EA provides the amounts of surface land and subsurface mineral ownership rights within the proposed project area (amounts in the table and throughout the EA do not include the previously described "excluded areas"). Figures 2.1-2 and 2.1-3 of the revised TR (Uranium One, 2017d) show the land and mineral ownership rights within the proposed project area.

2.1.2 Description of the In Situ Leach Process

During the ISR process, an oxidant-charged solution, called a lixiviant, is injected into the production zone aquifer (uranium ore body) through dual-purpose injection/production wells. When used to introduce lixiviant into the uranium mineralization, a dual-purpose well is considered an injection well; when used to extract uranium-bearing solutions, it is considered a production well. Typically, a lixiviant uses native groundwater (from the production zone aquifer), carbon dioxide, and sodium carbonate/bicarbonate, with an oxygen or hydrogen peroxide oxidant. Uranium One plans to use oxygen as the primary oxidant, but may also use hydrogen peroxide (Uranium One, 2017e). As it circulates through the production zone, the lixiviant oxidizes and dissolves the mineralized uranium, which is present in a reduced chemical state. As noted in GEIS Section 2.4.1.1, the principal geochemical reactions caused by the lixiviant are the oxidation and subsequent dissolution of uranium and other metals from the orebody (NRC, 2009). The resulting uranium-enriched pregnant lixiviant is drawn to production wells by pumping and then transferred to a processing facility via a network of pipes buried just below the ground surface for uranium extraction by ion-exchange. At the Ludeman satellite plant, which would be equipped with pressurized, down-flow ion-exchange columns, the extracted uranium would be loaded onto ion-exchange resins. These resins would be transported to the Willow Creek CPP. Once at the Willow Creek CPP, the uranium would be recovered from the solution. The uranium recovered from the solution is processed, dried into yellowcake, packaged into NRC- and U.S. Department of Transportation



Note: Construction or uranium recovery operations within Wellfield 2 will not be included in this license amendment, but is evaluated as practicable in this EA because of its inclusion in the licensee's license amendment request. NRC's conclusions provided in Chapter 4 are considered bounding.

Figure 2-1. Conceptual Site Layout of the Ludeman ISR Satellite Project (Uranium One, 2017e)

(U.S. DOT)-approved 205-liter (L) [55-gallon (gal)] steel drums, and trucked offsite to a licensed uranium conversion facility.

During production, the uranium recovery solution continually moves through the production aquifer from outlying injection wells to internal production wells. These wells can be arranged in a variety of geometric patterns, depending on ore body configuration, aquifer permeability, and operator preference. Wellfields are often designed in five- or seven-spot patterns, with each recovery (i.e., production) being located inside a ring of injection wells. There are multiple five- or seven-spot patterns in a wellfield. Overlying and underlying aquifers are separated from the production zone aquifer by aquitards (i.e., geologic layers that restrict water movement), which reduce the potential for vertical lixiviant migration. Monitoring wells surround the wellfield pattern area, terminating in the production zone aquifer, as well as in both the overlying and underlying aquifers. These monitoring wells are screened in appropriate stratigraphic horizons to detect lixiviant that could migrate out of the production zone. If lixiviant migrates out of the production zone, this is termed an excursion.

As described in GEIS Section 2.4.3, the production wells at an ISR facility extract slightly more water than is reinjected into the host aquifer to create a net inward flow of groundwater into the wellfield, which minimizes the potential movement of lixiviant and its associated contaminants out of the wellfield (e.g., excursions) (NRC, 2009). At the Ludeman ISR Satellite Project area, lateral confinement of ISR lixiviant would be accomplished by maintaining a 0.5 to 1.5 percent bleed from the production wells (Uranium One, 2017e). Uranium One is required by license condition to install monitoring wells above, below, and around the perimeter of the wellfields (NRC, 2016a). Additionally, NRC requires Uranium One to have a set of corrective actions and reporting procedures that can be implemented, in the event that an excursion is detected [Title 10 of the *Code of Federal Regulations* (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," Criterion 5D].

The ISR process generates radiological and nonradiological air emissions and liquid and solid wastes that must be managed in accordance with applicable regulations to ensure safety and protection of the environment. Detailed descriptions of the effluents and waste management activities associated with the proposed action are provided in the revised ER (Uranium One, 2017e) and are summarized in EA Section 2.1.7.

2.1.3 Construction and Wellfield Design

The Ludeman ISR Satellite Project area encompasses 7,633 hectares (ha) [18,861 acres (ac)] (Uranium One, 2017e). The licensee estimates that the total land disturbed under the preferred liquid waste disposal option, as discussed in EA Section 2.1.7, would be approximately 372 ha [920 ac] (Uranium One, 2017e). These estimates include proposed project facilities, pipeline installation, access roads, and impoundments.

Uranium One plans to construct a satellite building in the northwest corner of the Ludeman ISR Satellite Project area (EA Figure 2-1). Under Uranium One's proposal, the NRC staff expect that construction of the project facilities and construction of the first wellfield are anticipated to begin in 2018 (see EA Figure 2-2; Uranium One, 2017d). The Ludeman satellite building would house the ion exchange columns, water treatment equipment, resin transfer facilities, pumps for injection of the lixiviant, a small laboratory, and an employee break room. The building would occupy approximately 1,412 square meter (m^2) [15,200 square feet (ft^2)] and would serve

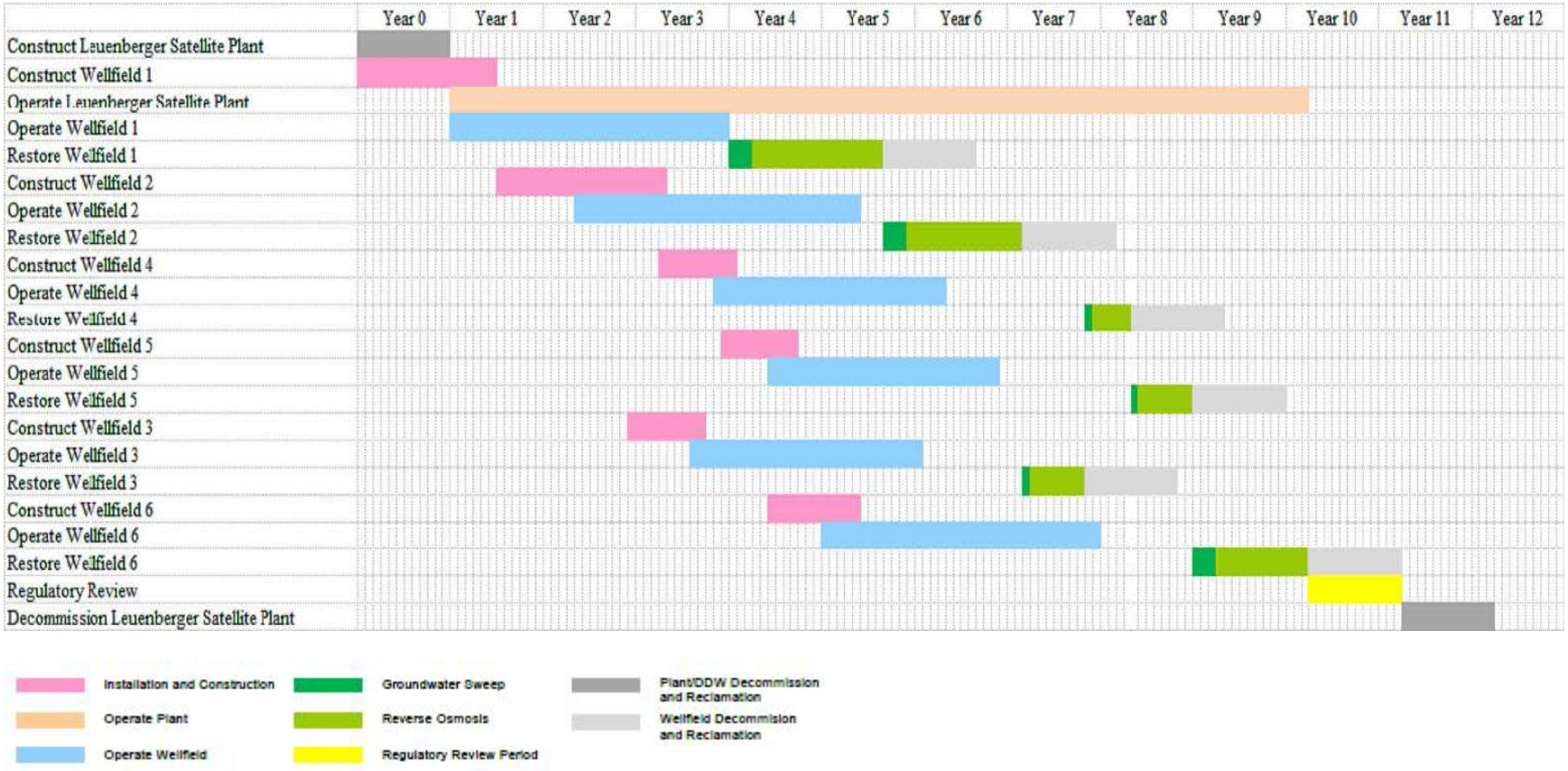


Figure 2-2. Proposed Project Schedule for Ludeman ISR Satellite Project (Uranium One, 2017e)

six wellfields (Wellfields 1 through 6) planned for the Ludeman ISR Satellite Project (EA Figure 2-1; Uranium One, 2017e). The ion-exchange system would be designed to operate with a maximum through-flow of approximately 34,000 liters per minute (Lpm) [9,000 gallons per minute (gpm)] during production operations. Bulk carbon dioxide and oxygen gas would be stored in compressed gas cylinders adjacent to the building. Gaseous carbon dioxide would be added to the lixiviant as the fluid is piped from the satellite building to the wellfield and header houses.

As wellfields and supporting infrastructure are developed and constructed over the life of the project, the total disturbed area would vary slightly. The controlled area (e.g., the area of the project with restricted access) of the Ludeman satellite building, adjacent structures, impoundments, and six wellfields (Wellfields 1 through 6) under Uranium One's preferred liquid waste management option is estimated to be 533 ha [1,318 ac] (Figure 2-1; Uranium One, 2017e). These areas would be fenced to exclude livestock and wildlife and control access to the proposed project area.

Some of the proposed waste management facilities and equipment would depend on which liquid waste management option is implemented by Uranium One, as discussed further in EA Section 2.1.7. Under the licensee's preferred liquid waste management option, an evaporation pond with four cells would be constructed northeast of the proposed satellite building that would disturb approximately 27.8 ha [68.8 ac] of land (Uranium One, 2017e). Additionally, to support the proposed surface water discharge of treated aquifer restoration effluent under this option, the licensee would construct a permeate pond with four cells in an area adjacent and south of the proposed satellite building. The licensee estimates that the permeate pond would disturb approximately 5.4 ha [13.4 ac] of land (Uranium One, 2017e). Uranium One may also install up to six Class I deep disposal wells at locations adjacent to the proposed wellfields throughout the proposed project area and would be linked to the satellite plant using pipelines. Uranium One estimates that six Class I deep disposal well pads would disturb an additional 2.4 ha [6.0 ac], and the associated pipelines would disturb an additional 1.6 ha [3.9 ac] of land (Uranium One, 2017e).

Although information about Wellfield 2 was provided in the licensee's revised TR and ER (Uranium One, 2017d,e), aquifer confinement in Wellfield 2 has not been sufficiently demonstrated by Uranium One; therefore, potential impacts to groundwater at Wellfield 2 cannot be adequately evaluated. The NRC staff has, therefore, determined that the licensee has not provided a satisfactory characterization of the ore zone in Wellfield 2 to enable its inclusion in this licensing action. If NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will not include authorization for construction or uranium recovery operations within Wellfield 2. However, the information provided for impacts to other resource areas from Wellfield 2 in the licensee's revised ER and TR cannot practicably be separated from the information provided evaluating the overall impacts of the requested license amendment. Therefore, this EA includes the potential impacts from Wellfield 2 to resource areas other than groundwater. The NRC staff concluded that these additional impacts bound, (i.e., increase but do not reduce) the potential impacts of the proposed action.

Wellfields

Uranium One plans to operate up to six wellfields in the Ludeman ISR Satellite Project area. When the project is fully operational, up to five uranium wellfields would be in operation at a time. Wellfield installation and testing would take between 10 months and 2 years based on the proposed schedule (Uranium One, 2017e). Based on Uranium One's estimated schedule, uranium recovery in each wellfield would generally last approximately 3 years, followed by approximately 1 to 2 years of wellfield groundwater restoration and a year of decommissioning. Uranium One expects to conduct ISR operations at the Ludeman ISR Satellite Project area over a 12-year period.

Uranium One would adjust the locations and boundaries at each wellfield as more detailed stratigraphic and ore-occurrence data are collected during wellfield construction. Uranium One may alter well patterns to fit the size, shape, and boundaries of individual ore bodies. Each well would be connected to the respective injection or production manifold in a nearby header house. The manifolds route lixiviant and uranium-bearing solutions in the pipelines to and from the satellite plant. Meters and control valves in individual well lines would monitor and control flow rates and pressures for each well. The wellfield piping would be high-density polyethylene pipe, polyvinyl chloride, and/or steel. Individual well lines and trunk lines to the satellite plant would be buried to prevent freezing of the transferred solutions.

Injection and Production Wells and Monitoring Wells

A Wyoming Department of Environmental Quality (WDEQ)-administered Underground Injection Control (UIC) program regulates the design, construction, testing, operations, and closure of injection wells, pursuant to WDEQ Land Quality, Chapter 11 regulations (WDEQ, 2013a). Injection wells for uranium extraction are classified under UIC as Class III wells; these wells are located in the aquifer(s) containing the uranium that would be recovered. The proposed operation requires the applicant to obtain a permit from WDEQ to use Class III injection wells. WDEQ regulates monitoring well design, construction, and abandonment pursuant to WDEQ Water Quality, Chapter 26 regulations (WDEQ, 2012a).

At the proposed Ludeman ISR Satellite Project, the injection and production wells would be configured with a typical 5-spot pattern where one recovery well is surrounded by four injection wells. The dimensions of the patterns would vary, depending on the characteristics of the ore zone, but injection wells are anticipated to be spaced between 15 and 46 meters (m) [75 and 100 feet (ft)] apart (Uranium One, 2017e).

The licensee would install production zone monitoring wells at the periphery of each production wellfield area approximately 152 m [500 ft] from the pattern area with approximately 152 m [500 ft] of spacing between monitoring wells (Uranium One, 2017e). This perimeter-monitoring well "ring" would be used for early detection of horizontal excursions from within the sand unit or aquifer where production is occurring. The monitoring well network would include wells completed in the overlying and underlying aquifer. Production zone monitoring well spacing would be based on the aquifer characteristics determined from hydrologic modeling and aquifer testing, while the overlying and underlying monitoring wells would be installed on the approximate basis of one well per 1.6 ha [4 ac] of wellfield (Uranium One, 2017e). An excursion at a monitoring well is declared when the concentrations of certain indicator parameters exceed upper control limits (UCLs) established by the license and verified by the NRC or the state. The purpose of the monitoring well ring is to ensure that groundwater quality in aquifers outside exempted zones is not affected by ISR operations (NRC, 2009).

Well Completion

Injection, production, and monitoring wells would be constructed using the same techniques. First, a pilot hole for the well would be drilled to the top of the target depth with a small rotary drilling unit using native mud and a small amount of commercial drilling fluid additive for viscosity control. The hole then would be logged and reamed and the casing set and cemented to isolate the completion interval from all other aquifers. The cement would be placed by pumping it down the casing and forcing it out the bottom of the casing and back up the casing drill hole annulus. The purpose of the cement is to stabilize and strengthen the casing and to plug the annulus of the hole to prevent vertical migration of mining solutions.

After the well is cemented to the surface and the cement has set, the well would be drilled out and completed either as an open hole or fitted with a screen assembly (slotted liner), which may have a sand filter pack installed between the screen and the underlying formation. The well would then be air lifted for about 30 minutes to remove any remaining drilling mud and/or cuttings. A small submersible pump is frequently run in the well for final cleanup and sampling.

Well Integrity Testing

Uranium One would perform a mechanical integrity test (MIT) on each well prior to its use in the wellfield, in accordance with WDEQ procedures (Uranium One, 2017e). The purpose of the MIT program is to ensure that fluids injected and recovered during mining are not lost from the well because of casing failure. In the integrity test, the bottom of the casing adjacent to or below the overlying confining stratigraphic layer is sealed with a plug, downhole packer, or other suitable device. The top of the casing is then sealed in a similar manner or with a threaded cap, and a pressure gauge is installed to monitor the pressure inside the casing.

The well must maintain 90 percent of the test pressure (test pressure is 120 percent of the maximum allowable injection pressure), which is based on the formation fracture pressure, for 10 minutes to pass the test. Wells not passing the MIT are reworked and tested again. Any failed well casing that cannot be repaired to pass the integrity test would be appropriately plugged and abandoned. In accordance with WDEQ and U.S. Environmental Protection Agency (EPA) requirements, Uranium One would repeat MITs once every 5 years for all wells used for injection of lixiviant or injection of fluids for restoration operations (Uranium One, 2017e). Additionally, an MIT would be conducted whenever a downhole drill bit or hole enlargement tool is used to repair an injection well. Uranium One would perform a new MIT for any injection well with evidence of suspected subsurface damage prior to returning the well to service (Uranium One, 2017e).

Hydrogeologic Wellfield Data Packages

The licensee's delineation drilling results and pumping test data would be included in hydrogeologic wellfield data packages, which would describe the wellfield, including (i) production and injection well patterns and location of monitoring wells; (ii) documentation of wellfield geology (e.g., geologic cross sections and isopach maps of production zone sand and overlying and underlying confining units); (iii) pumping test results; (iv) sufficient information to demonstrate that perimeter production zone monitoring wells adequately communicate with the production zone; and (v) data and statistical methods used to compute Commission-approved background water quality. The wellfield hydrogeologic data packages would be maintained onsite and available for NRC review.

2.1.4 Operation Activities

Once wellfield operations begin, uranium-rich solution would be routed from the wellfields to the planned satellite building. In the satellite building, the solution would be pumped into a series of ion exchange columns where the uranium (as uranyl carbonate complexes) would be adsorbed onto resin beads in the columns. The resulting uranium-poor (i.e., “barren”) lixiviant (which contains normally less than two parts per million of uranium) would then exit the ion-exchange columns, be recharged with additional oxidizing and complexing agents, and then be reinjected in the wellfields.

Once the majority of the ion-exchange sites on the ion-exchange column resin are filled with uranium, the uranium-loaded resin would be transferred from the satellite plant to a truck for transport to the Willow Creek CPP for further processing. At the CPP, the uranium would be stripped (i.e., eluted) from the resin beads with a concentrated solution of sodium chloride. The stripped resin beads would then be returned by truck to the Ludeman satellite plant where they would be loaded back onto the ion-exchange columns.

Uranium One anticipates that the wellfields will support a maximum production rate of approximately 34,000 Lpm [9,000 gpm]. As noted in EA Section 2.1.2, Uranium One proposes to apply an approximate bleed rate between 0.5 and 1.5 percent of production flow during operations (Uranium One, 2017c). Production bleed would be treated by single-stage reverse osmosis (RO), and the resulting permeate (treated water) would be mixed with bicarbonate to reformulate lixiviant for injection back into the wellfield or reinjected into an aquifer undergoing restoration. The concentrated wastewater resulting from the RO treatment of the production bleed (called reject) would be disposed in an evaporation pond with four cells or in Class I deep disposal wells. During periods of combined production and restoration, the concentrated wastewater resulting from RO treatment of production bleed would undergo a secondary course of RO treatment to further concentrate the waste stream prior to disposal in an evaporation pond or Class I deep disposal well, as stated before, while the resulting permeate (treated water) would be reinjected into a wellfield undergoing restoration.

Operational monitoring of the wellfields and environment are discussed in Section 6 of this EA.

2.1.5 Aquifer Restoration Activities

The purpose of aquifer restoration is, per NRC requirement, to return wellfield water quality parameters to the standards in 10 CFR 40, Appendix A, Criterion 5(B)(5) (NRC, 2009). Before ISR operations can begin, the portion of the aquifer designated for uranium recovery must be exempted as an underground source of drinking water, in accordance with the Safe Drinking Water Act. Groundwater adjacent to the exempted portion of the aquifer, however, must still be protected and aquifer restoration in the exempted portion of the aquifer serves this purpose. In addition to the NRC requirements, the State of Wyoming’s rules for in situ mining require that the exempted aquifer be restored to its pre-mining class of use after the operations are complete (WDEQ, 2013a). This requirement is more stringent than EPA’s rules, which only require that groundwater protection standards be met at the aquifer-exemption boundary (i.e., contaminants cannot migrate from an exempted aquifer to the surrounding underground source of drinking water).

Prior to conducting uranium recovery operations in a wellfield, Uranium One is required by license condition 10.3 of SUA–1341 to collect baseline groundwater quality data from the wells completed in the planned production zone, and from these data, to determine and set

post-mining restoration criteria. Aquifer restoration criteria for the site-specific baseline constituents would be determined for each wellfield (Uranium One, 2017d).

To restore wellfield groundwater to acceptable levels, Uranium One would employ a series of techniques that include groundwater transfer, groundwater sweep, permeate injection, and groundwater treatment (Uranium One, 2017d). Groundwater sweep involves pumping groundwater from a wellfield without injection. This pumping causes uncontaminated, native groundwater to flow into the ore body, thereby flushing the contaminants from areas that have been affected by the horizontal and vertical spreading of the lixiviant in the affected zone during uranium recovery. In this way, waters unaffected by mining "sweep" the mining-affected portion of the aquifer, resulting in a lowering of parameter concentrations. Uranium One proposes that the water removed from the aquifer during the sweep first pass through an ion-exchange system to recover the uranium and then treated by two stages of RO (Uranium One, 2017d). The resulting treated water (permeate) may be directed to a permeate pond and surface discharged while the concentrated brines from the RO treatment would be disposed either in an evaporation pond or in a WDEQ permitted Class I deep disposal well.

Following groundwater sweep, Uranium One may conduct additional rounds of groundwater treatment. In this process, water recovered from the wellfield would again be processed by ion exchange to remove uranium, and then RO treatment would be used to remove other dissolved solids. However, a portion of the resulting treated water (permeate) may be directed to a permeate pond and surface discharged and the remainder would be reinjected into the aquifer undergoing restoration while the concentrated brines from the RO treatment would be disposed either in an evaporation pond or in a WDEQ permitted Class I deep disposal well. If required, this treatment process would be used in conjunction with the injection of a biological or chemical reductant. The reductant is intended to re-establish reducing conditions in the aquifer, thereby immobilizing metals like arsenic, molybdenum, selenium, uranium, and vanadium. Finally, treated aquifer restoration water could again be circulated through the aquifer to reduce the dissolved solids introduced during the reductant phase.

The success of restoration would be determined following the completion of a stability monitoring period. Groundwater quality in the exempted ore-bearing aquifer would be restored, in accordance with 10 CFR Part 40, Appendix A, Criterion 5B(5), to (i) a Commission-approved background (CAB) concentration; (ii) the maximum contaminant levels (MCLs) listed in 10 CFR Part 40, Appendix A, Table 5C, for constituents listed in Table 5C and if the background level of the constituents fall below the listed value; or (iii) an alternate concentration limit (ACL) established by the Commission, if the constituent background level and the values listed in Table 5C are not reasonably achievable. These groundwater quality standards would be implemented as part of the aquifer restoration phase to ensure public health and safety. Based on sampling results during previous pilot operations within the Ludeman ISR Satellite Project area and from the Willow Creek ISR sites, Uranium One expects that the range of post-mining groundwater quality concentrations at the Ludeman ISR Satellite Project area would be similar to other Uranium One mining operations within the Powder River Basin (Uranium One, 2017e).

2.1.6 Decontamination, Decommissioning, and Reclamation Activities

Uranium One would be required to perform decommissioning activities at the Ludeman ISR Satellite Project prior to termination of License SUA–1341. The NRC has approved a decommissioning plan for the Irigaray and Christensen Ranch facilities. If a license amendment were approved to allow activities at the Ludeman Project, NRC would add a license condition to require decommissioning plans for each wellfield and the entire Ludeman ISR Satellite Project

area. The new decommissioning plans would be submitted to the NRC and WDEQ to reflect site changes consistent with applicable license termination criteria at the time of decommissioning. The NRC would review the decommissioning plan from a safety and environmental impact perspective. Additionally, Uranium One must provide (and recalculate annually) financial surety for restoration, decommissioning, and reclamation for the overall project, including the Ludeman ISR Satellite Project area, which is maintained in documentation acceptable to the NRC and WDEQ, such as a letter-of-credit in favor of the State of Wyoming.

Following the completion of restoration and concurrence from the NRC and WDEQ that groundwater has been adequately restored, Uranium One would plug and abandon all production, injection, and monitoring wells in the wellfield, in accordance with WDEQ rules and regulations (Uranium One, 2017e). Such practices could include (i) removal of all pumps and tubing; (ii) plugging of the well with an appropriately formulated abandonment gel or slurry; (iii) cutting the well casing below the ground surface; (iv) placing a cement plug to seal the well; and (v) backfilling, smoothing, and leveling the area to blend in with the surrounding terrain.

In addition, buried wellfield lines and pipelines would be removed and the affected surface areas appropriately reclaimed. Affected areas would be leveled and reseeded with a WDEQ-approved seed mixture (Uranium One, 2017e). Uranium One stated that all lands disturbed by the proposed project would be restored to their pre-mining land use of livestock grazing and wildlife habitat unless an alternate use is approved by the State and the landowner (e.g., a rancher who wishes to retain access roads and/or buildings) (Uranium One, 2017e). Uranium One plans to keep soil disturbances caused by construction activities to a minimum (see Section 2.1.3 that describes construction activities). Topsoil would be salvaged from building sites (e.g., the satellite building), chemical storage areas, primary and secondary access roads, ponds, pipeline installations, and wellfield infrastructure (e.g., well pads and header houses), in accordance with WDEQ requirements (Uranium One, 2017e). The salvaged topsoil would be stockpiled. The topsoil stockpiles would have a temporary seed mix applied as soon as practicable, or as required by WDEQ regulations, to protect against topsoil loss because of wind and/or water erosion. Based on information provided in the ER, Uranium One indicates that salvage depths could range from 0 to 1.5 m [0 to 5 ft] with an estimated average salvage depth of 0.65 m [2.13 ft] (Uranium One, 2017e).

Revegetation practices would be conducted in accordance with WDEQ regulations and Uranium One's WDEQ mine permit (Uranium One, 2017e). Following top soiling for final reclamation, an area would normally be seeded with a permanent seed mix that may contain a nurse crop (Uranium One, 2017e). If the area in question is to be disturbed again prior to final decommissioning, Uranium One may apply a WDEQ-approved long-term temporary seed mix. Typical seed mixes contain one or more native wheatgrasses (e.g., Western wheatgrass, thick spike wheatgrass) and applied at a seeding rate of 5 to 6 kg [12 to 14 lbs] of pure live seed per 0.4 ha [1 ac].

As part of the reclamation following the end of mining operations in the proposed Ludeman ISR Satellite Project area, the satellite building would need to be decommissioned. In doing so, process equipment could either be dismantled and sold to another licensed facility or decontaminated in accordance with the applicable NRC guidance. Materials that could not be decontaminated to acceptable levels would be disposed in a licensed disposal facility. Decontaminated materials having no resale value, such as building foundations, may be buried onsite.

After the equipment, buildings, foundations, piping, and associated support facilities are removed, gamma radiation surveys would be conducted over those areas. In the wellfields themselves, gamma surveys would also be conducted during the decommissioning of each wellfield. Material with contamination levels requiring disposal in a licensed facility would be removed, packaged as needed, and shipped to a licensed disposal facility.

2.1.7 Effluents and Waste Management

Throughout the duration of the proposed Ludeman ISR Satellite Project, airborne effluents, as well as liquid and solid wastes would be generated. Waste generated by the proposed project that contains radioactive materials is defined as byproduct material by NRC. Byproduct material can be in liquid or solid form. This section describes these effluents and waste streams and the licensee's proposed waste management activities.

Gaseous or Airborne Particulate Emissions

During construction, operations, aquifer restoration, and decommissioning, the Ludeman ISR Satellite Project would produce both nonradiological and radiological airborne emissions, including:

- Fugitive dusts
- Combustion engine exhausts
- Radon gas emissions from lixiviant circulation and evaporation ponds

To ensure that the air quality of the State of Wyoming is adequately protected, in addition to addressing all NRC regulatory requirements pertaining to radiological emissions, NRC applicants and licensees must comply with all applicable state and federal air quality regulatory requirements. The regulatory requirements and framework applicable to air quality are described in detail in the NRC's GEIS (NRC, 2009). An air quality permit is required by WDEQ (WDEQ, 2018a) prior to facility construction that would include conditions deemed necessary to comply with state and federal air quality requirements.

Nonradiological air emissions are classified into two main categories: (i) fugitive dust, and (ii) combustion emissions. Fugitive dust, the primary emission expected at the proposed project, would be generated by travel on unpaved areas (e.g., roads and wellfields) and from disturbed land associated with the construction of wellfields, roads, and support facilities. The licensee estimates the peak year particulate matter PM_{10} emissions at approximately 133.0 metric tons [146.6 short tons] (EA Appendix B, Table B–2). The licensee has committed to use dust suppression on unpaved roads and to reclaim disturbed land as soon as practicable (Uranium One, 2016c). Combustion emissions are primarily attributed to mobile sources, such as passenger vehicles, trucks, construction equipment, and drill rigs. Peak year combustion emission levels range between 2.2 and 35.1 metric tons [2.4 to 38.7 short tons] for the pollutants other than carbon dioxide. During the peak year, activities may generate 6,085 metric tons [6,708 short tons] of carbon dioxide. The licensee has committed to using newer drill rigs and construction equipment with engines that meet certain emission standards mandated by the federal government and that produce lower pollutant levels relative to older engines.

Appendix B of this EA provides information on the nature and duration of estimated nonradiological air emissions from the proposed Ludeman ISR Satellite Project, including the mitigation incorporated into the estimates.

Radon gas is released into the air during operations and aquifer restoration. Pressurized processing systems may contain most of the radon in solution; however, radon may escape from the processing circuit in the central processing plant and wellfields through vents or leaks, from bleed water (i.e., nominally 1 percent of process flow rate) used to maintain an inward hydraulic gradient in wellfields, and during ion exchange resin transfers. Radon releases can migrate downwind from processing facilities and wellfields.

Liquid Wastes

Liquid byproduct material is expected to be generated during the operations and aquifer restoration phases of the proposed Ludeman ISR Satellite Project. Project-generated liquid byproduct material would include bleed water from the production wells, groundwater generated during aquifer restoration, process solutions (e.g., resin transfer water and brine generated from the elution and precipitation circuits), and plant washdown water (Uranium One, 2017e). The licensee is required to manage and dispose of liquid byproduct material in compliance with applicable state and federal regulations, as established by license and permit. In its amendment application, Uranium One proposes three options to dispose of liquid byproduct material streams using methods previously applied at other NRC licensed ISR facilities and described by NRC in the GEIS (NRC, 2009): (i) Disposal of concentrated brines in lined evaporation ponds, and surface water discharge of treated groundwater restoration permeate (Uranium One's preferred option); (ii) adding up to six Class I deep disposal wells to Uranium One's preferred option (Option 1); and (iii) only using up to six Class I deep disposal wells and two surge ponds (Option 2).

Evaporation Ponds

The liquid waste management options proposed by Uranium One include use of an evaporation pond with four cells and a treatment and disposal process that is described in Section 2.1.8 of the revised ER (Uranium One, 2017e). The design criteria for an evaporation pond system are contained in 10 CFR Part 40, Appendix A, Criteria 5A and 5E. The NRC regulations address pond location and design and construction of the necessary clay or geosynthetic pond liner systems and embankments (NRC, 2003a; NRC, 2008). The NRC regulations also establish criteria for pond inspection and maintenance (10 CFR Part 40, Appendix A, Criteria 7, 7A, and 8A). NRC guidance in Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities" (NRC, 2008) recommends considering applicable EPA regulations, including the requirements of 40 CFR 264.221, in any impoundment design. All pond areas would be fenced with posted signs and given enough freeboard to prevent the overtopping of waves caused by high winds (Uranium One, 2017d). The ponds would be designed and reclaimed in accordance with NRC and WDEQ regulations.

Surface Discharge and Permeate Ponds

Uranium One's liquid waste management options also include managing treated aquifer restoration water using surface water discharge and storage in a permeate pond with four cells, as described in EA Section 2.1.5. Surface discharge of liquid byproduct material would require Uranium One to obtain and comply with a Wyoming Pollutant Discharge Elimination System (WYPDES) permit. A WYPDES permit, if granted by the WDEQ, would specify any necessary permit conditions, including surface discharge effluent limits, to ensure that water quality standards are maintained. Discharge of treated aquifer restoration water would need to meet the NRC release standards in 10 CFR Part 20, Subparts D, "Radiation Safety Requirements," and K, "Waste Disposal," Appendix B to CFR Part 20, "Annual Limits on Intakes (ALIs) and

Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," and the provisions of 10 CFR Part 40, Appendix A. The regulations at 10 CFR 20.2007 require compliance with other applicable federal, state, and local regulations. This includes the WDEQ WYPDES permitting requirements for surface water discharge of treated aquifer restoration water (WDEQ, 2015a).

Class I Deep Disposal Wells and Surge Ponds

Uranium One also proposes disposal of liquid byproduct material in up to six Class I deep disposal wells and by implementing a system of treatment, storage, and injection into the wells that is described in Uranium One's revised ER (2017e). The licensee would need an authorization by the WDEQ to drill, complete, and operate the Class I deep disposal wells at the proposed project area, and thereby inject radionuclide-bearing liquid waste streams into a subsurface geologic region (Uranium One, 2017d). The Class I deep disposal well design and construction must meet WDEQ requirements (WDEQ, 2015c) and applicable permit conditions (WDEQ, 2015b). The WDEQ permit would prohibit injection of any material defined as hazardous waste, as defined by EPA Resource Conservation and Recovery Act (RCRA) regulations in 40 CFR 261.3. Typically, the WDEQ permit would require well performance monitoring to verify that operations are within expectations. Additionally, if the NRC license amendment is granted for the Ludeman ISR Satellite Project, the NRC would require compliance with the NRC waste disposal standards in 10 CFR Part 20, Subpart K.

To support the operation of the six Class I deep disposal wells, Uranium One may also construct two surge ponds that would disturb approximately 0.7 ha [1.8 ac] of land (Uranium One, 2017e). Surge ponds would meet the safety and engineering design standards set forth in 10 CFR Part 40, Appendix A, Criteria 5A, and 5E and WDEQ Rules and Regulations, Water Quality Chapter 11, for lined wastewater storage ponds. Operational stability, surveillance, inspection, and testing of the surge ponds would meet the recommendations of NRC Regulatory Guide 3.11 (NRC, 2008).

Sanitary wastes from the restrooms and lunchroom at the satellite facility would be disposed in an approved septic system. Uranium One's septic system is subject to continued approval by WDEQ.

Solid Wastes

All phases of the proposed ISR facility lifecycle would generate solid wastes. These separate waste streams include materials that are classified as nonhazardous solid waste, byproduct material, and RCRA hazardous wastes. The largest volumes of solid wastes requiring disposal would be generated during facility decommissioning (NRC, 2009).

During operation and groundwater restoration, Uranium One proposes to collect nonhazardous solid waste daily from work areas and dispose in trash receptacles located within the restricted area but near a primary access road for convenient access for a waste disposal contractor (Uranium One, 2017e). Occasionally, it will be necessary to dispose of sludge material collected in the Ludeman septic system holding tanks. Uranium One proposes to dispose of these sludges and other nonhazardous solid waste in accordance with WDEQ rules and regulations (Uranium One, 2017e).

Solid byproduct material (e.g., rags, trash, packing material, worn or replaced parts from equipment, piping, and sediments removed from process pumps and vessels) must be disposed

at a licensed facility unless the material is suitable to remain onsite or to be released offsite for unrestricted use. Soils in areas where ISR operations occur would be included in decommissioning surveys when operations end, and any contaminated soils that exceed NRC release limits at 10 CFR Part 40, Appendix A, Criterion 6 would be removed and disposed as byproduct material. Some RCRA hazardous wastes (e.g., fluorescent lights, waste oil, and batteries) would be generated at the proposed Ludeman ISR satellite, thereby requiring disposal at a facility approved for RCRA hazardous wastes.

2.1.8 Transportation

Primary transportation activities would involve shipments by truck and personnel commuting. The licensee does not anticipate using railroad transportation for any of the proposed project operations. A variety of truck shipments are planned to support proposed activities during all phases of the proposed action, including moving equipment, supplies, wastes, and ion exchange resins during the lifecycle of the facility. Uranium from ion exchange resins would be transported and subsequently processed at the Willow Creek CPP located in Johnson County, Wyoming. Figure 1-1 shows the location of highways and interstates in the vicinity of the Ludeman ISR Satellite Project area. Transportation conditions for the roadways that workers would use to access the Ludeman site from Gillette, Casper, Glenrock, and Douglas are provided in EA Section 3.2, and potential transportation impacts are discussed in EA Section 4.3.

2.2 No-Action Alternative (Alternative 2)

Under the provisions of NEPA, one alternative that must be considered in each environmental review is the No-Action Alternative. The No-Action Alternative is included to provide a basis for evaluating the potential impacts compared to the proposed action. In this case, the No-Action Alternative would mean that the NRC would not approve the addition of the Ludeman ISR Satellite Project area to the existing SUA–1341 license. The No-Action Alternative would result in the licensee not constructing or operating the proposed Ludeman ISR Satellite Project. ISR activities at Willow Creek would continue to occur within the currently approved SUA–1341 project area.

Evaluation of the potential environmental impacts for the addition of the Ludeman ISR Satellite Project to the Willow Creek ISR license can be found in EA Chapter 4. An evaluation of the potential environmental impacts from the No-Action Alternative is also included within each resource area section of Chapter 4. Although impacts may exist, they may not be significant. An impact that is not significant does not equate to no impact (NRC, 2003b).

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The proposed Ludeman In Situ Recovery (ISR) Satellite Project is a proposed expansion of the Willow Creek (WC) ISR Project, for which Uranium One received its license renewal in 2013. The Willow Creek ISR Project and the area covered in the proposed Ludeman amendment to the Willow Creek ISR Project license are located in the Powder River Basin (PRB) in Campbell, Converse, and Johnson Counties, Wyoming. Currently, the Willow Creek ISR Project has surface facilities at the noncontiguous Irigaray and Christensen Ranch sites in Campbell and Johnson Counties, Wyoming. The Ludeman ISR Satellite Project would add approximately 7,633 hectares (ha) [18,861 acres (ac)] of land in Converse County for wellfields to the overall production area covered under the Willow Creek ISR license SUA–1341. The proposed Ludeman ISR Satellite Project would consist of six wellfield production areas, the Ludeman satellite building (ion exchange building), storage ponds, deep disposal wells (DDWs), and auxiliary buildings and pipelines. The processing of uranium resin extracted from wellfields at the proposed project into yellowcake would occur at the Willow Creek central processing plant (CPP) located at the Irigaray site in Johnson County, Wyoming [Environmental Assessment (EA) Figure 1-1].

As discussed in EA Chapter 2, the proposed Ludeman ISR Satellite Project and the existing Willow Creek ISR Project are both located within the southern portion of the PRB; however, the Willow Creek CPP and the Ludeman project boundary are approximately 109 kilometers (km) [68 miles (mi)] apart following a straight line, and approximately 221 km [137 mi] apart if traveled by road. In many instances, ISR satellite plants are located close to the parent project (Uranerz, 2014) where similar environmental conditions exist and similar potential impacts would be experienced. This provides the U.S. Nuclear Regulatory Commission (NRC) staff with a baseline of environmental conditions at a proposed satellite project and allows the NRC staff to rely on or tier from the preceding analysis conducted for the parent project. However, in this case, the proposed satellite and the licensed facility are located further apart; thus, the NRC staff is not able to reasonably rely on environmental characteristics previously described for the Willow Creek ISR Project for the purpose of the analysis in this EA. Therefore, this EA includes a site-specific description of the environmental conditions for the proposed Ludeman ISR Satellite Project area, resulting in a more detailed analysis than what is typically provided in an NRC EA for an ISR project expansion.

This chapter describes the existing environmental conditions at the proposed Ludeman ISR Satellite Project (e.g., the Ludeman Project or proposed project) site. In some sections of this chapter, in addition to describing the site itself, an additional buffer around the site appropriate to the resource area is also described. The resource areas described in this chapter include (i) land use, (ii) transportation, (iii) geology and soils, (iv) water resources, (v) ecology, (vi) meteorology, (vii) climatology and air quality, (viii) noise, (ix) historic and cultural resources, (xi) scenic and visual resources, (xii) socioeconomics, (xiii) public and occupational health, and (xiv) waste management practices. The descriptions of the affected environment are based on information provided in (i) the licensee's revised environmental report (ER) (Uranium One, 2017e) and revised technical report (TR) (Uranium One, 2017d); (ii) the licensee's responses to the NRC staff's requests for additional information and information provided in response to public meetings (Uranium One, 2012; Uranium One, 2013a,b,c; Uranium One, 2014; Uranium One, 2015a,b; Uranium One, 2016a,b,c; Uranium One, 2017a,b,c); (iii) NUREG–1910, "Generic Environmental Impact Statement for In Situ Leach Uranium Milling Facilities—Final Report" (GEIS) (NRC, 2009); (iv) the information gathered during the NRC staff site visits in August 2012 (NRC, 2012) and a tribal consultation site visit in November 2017 (EA

Section 3.8.2); and (v) multidisciplinary discussions held among the NRC staff and various stakeholders.

3.1 Land Use

This section describes land use at the proposed Ludeman ISR Satellite Project site and the area within 3.2 km [2 mi] of the proposed project boundary. The proposed project area covers approximately 7,633 ha [18,861 ac] (Uranium One, 2017e). Land within and surrounding the proposed project area is used primarily for rangeland and, to a lesser extent, for non-irrigated cropland. South of the proposed project area and within 3.2 km [2 mi] of the site, land use also includes irrigated cropland, which is concentrated near the North Platte River (Uranium One, 2017e).

Although the PRB as a whole contains major deposits of coal, coalbed methane (CBM), and petroleum resources, the southern portion of the PRB, which includes the proposed project area, has limited coal, CBM, and oil and gas production. Many of the wells associated with oil and gas development have been plugged and abandoned (WOGCC, 2017).

Surface ownership within the Ludeman ISR Satellite Project area consists of a majority of privately owned land and a smaller amount of state owned land (EA Table 3-1). Within the project area are “excluded areas” (see Figure 2-1) where ISR activities would not take place. Surface ownership of the excluded areas is held by Bureau of Land Management (BLM) (federal ownership) or Chapman University (private ownership) (Uranium One, 2013a). Subsurface ownership of the minerals within the Ludeman ISR Satellite Project area is divided among private, federal, and state ownership (Uranium One, 2017d Figures 2.1-2 and 2.1-3). The concept of a split estate, where different entities own the surface rights and subsurface rights (such as the rights to develop minerals) for a piece of land, is described in the NRC’s GEIS Section 3.1.2.2 (NRC, 2009). This divided ownership pattern occurs at the proposed project where the federal and state government owns subsurface mineral rights to portions of land for which surface rights are owned by private landowners. The proposed Ludeman ISR Satellite Project area encompasses approximately 7,633 ha [18,861 ac] of land located in all or portions of the following land sections:

- Township 34 North, Range 74 West, Sections 12, 13, 14, 22, 23, and 24
- Township 34 North, Range 73 West, Sections 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 34, 35, and 36
- Township 34 North, Range 72 West, Sections 19 and 30
- Township 33 North, Range 73 West, Sections 1, 2, and 3 (EA Figure 2-1) (Uranium One, 2017e)

One residence is located within the proposed Ludeman ISR Satellite Project area (Uranium One, 2017e). There is also an unplatted subdivision, Negley, located within 3.2 km [2 mi] of the proposed Ludeman ISR Satellite Project area and contiguous with the northwest proposed project boundary. The subdivision consists of 13 residences (Uranium One, 2013a). Uranium One predicts that future expansion of residential development in the area is unlikely due to the private land ownership and lack of public services infrastructure (Uranium One, 2017d).

Table 3-1. Distribution of Surface and Mineral Ownership Within the Proposed Ludeman ISR Satellite Project Area				
Ownership Type	Surface Ownership		Mineral Ownership	
	Hectare [Acre]	Percent of Project Area	Hectare [Acre]	Percent of Project Area
Private	7,034 [17,383]	92.2	2,355 [5,820]	30.9
State	598 [1,478]	7.8	598 [1,478]	7.8
Federal	0 [0]	0.0	4,679 [11,563]	61.3
Total	7,633 [18,861]	100.0	7,633 [18,861]	100.0
Source: Uranium One, 2017e				

3.1.1 Land Use Classification

Most of the land within the Ludeman ISR Satellite Project area is classified as agricultural land (EA Table 3-2). Agricultural land is defined in this EA as noncultivated land with potential for mixed agricultural use, such as rangeland for livestock grazing, haying for forage crops, and wildlife habitat. No commercial crop production takes place within the proposed project area. Land use within 3.2 km [2 mi] of the project boundary is predominantly rangeland used for livestock grazing, with some areas classified as cropland. The U.S. Department of Agriculture (USDA) National Agriculture Statistics Service estimated 74,950 head of cattle and 65,000 sheep and lambs in Converse County in 2012 (USDA, 2012). In 2012, Converse County had 410 farms and ranches totaling 990,447 ha [2,447,448 ac]. Of the land included as farms and ranches in Converse County, 95.8 percent was classified as pasture/rangeland (USDA, 2012).

Table 3-2. Land Use Within and Surrounding the Proposed Ludeman ISR Project Area		
Land Use Classification	Within Project Area ha [ac]	Within 3.2 km [2 mi] of the Project Boundary ha [ac]
Irrigated Cropland	2.9 [7.1]	1,775.5 [4,387.4]
Nonirrigated Cropland	123.5 [305.2]	235.5 [582.0]
Rangeland	7,924.3 [19,582.2]	17,733 [43,821.5]
Water Resource	19.5 [48.1]	161.5 [399.1]
Source: Uranium One, 2017e		

3.1.2 Hunting and Recreation

The primary recreational activity within 3.2 km [2 mi] of the proposed project boundary is hunting (Uranium One, 2017e). However, hunting and any other recreational activities are limited inside the proposed project boundary because (i) hunting on private land only occurs by permission of the land owner, and (ii) Uranium One has stated that hunting will be restricted for the life of the project within the project area on private land to protect project workers (Uranium One, 2017e). State-owned land within the proposed Ludeman ISR Project area (approximately 598 ha [1,478 ac] or 7.8 percent of the project area) is only accessible to the public using public access points (e.g., public roads or waterways.). However, state-owned portions of land will not be readily accessible, because they are surrounded by private land, where owner permission for access must be obtained. In addition, some of the state-owned land in the Ludeman project area would be restricted because of Ludeman operations. For lands outside the project

boundary but within 3.2 km [2 mi], some hunting may occur but would be limited due to similar access restrictions (Uranium One, 2017e).

3.1.3 Minerals and Energy

The proposed project area is located in the southern PRB, which contains deposits of coal, CBM, oil and gas, and uranium, but not to the extent as those found in the northern portion of the PRB. There are no current or historic coal mines within the proposed project area or within 3.2 km [2 mi] of the project area (Uranium One, 2017d). Furthermore, there are no CBM facilities within the proposed project area or within 3.2 km [2 mi] of the proposed Ludeman Project boundary (Uranium One, 2017e).

Within Converse County, there are 1,060 wells currently producing oil and gas (DrillingEdge, 2017) under 62 operators (WOGCC, 2017). However, there is limited gas production within and surrounding the Ludeman site (Uranium One, 2017e). There are three producing oil wells within the proposed project boundary (Uranium One, 2016a; Uranium One, 2017e). Within 3.2 km [2 mi] of the proposed project boundary, there are an additional four producing oil and gas wells and one disposal (or injector) well that has been shut down (Uranium One, 2016a, Uranium One, 2017e). All of the producing oil and gas wells are wells within the project boundary, and three of the four oil and gas wells within 3.2 km [2 mi] of the project boundary produce oil and gas from the Niobrara Formation at depths ranging from 3,659 to 3,932 m [12,004 to 12,900 ft] (Uranium One, 2016a). The other oil and gas well within 3.2 km [2 mi] of the project boundary produces oil from the Morrison Formation at a depth of 3,295 m [10,809 ft]. The disposal well within 3.2 km [2 mi] of the project boundary is completed in the Frontier Formation at a depth of 4,166 m [13,670 ft] (Uranium One, 2016a).

The southern portion of the PRB has high potential and sufficient commercial-scale infrastructure to support wind energy. There are three wind power facilities located within 40 km [25 mi] of the proposed project area. These facilities are:

- PacifiCorp's Glenrock, Glenrock III, and Rolling Hills Wind Projects provide power in the Wyoming PRB. Construction was completed on Glenrock's 66 1.5-megawatt (MW) turbines in 2008, on another 26 1.5-MW turbines for Glenrock III in 2009, and for 66 1.5-MW turbines for Rolling Hills in 2009. The wind farm cluster is located on 121 ha [300 ac] of the reclaimed Dave Johnston Coal Mine, approximately 16 km [10 mi] northwest of the Ludeman ISR Project, generating up to 237 MW of energy (PacifiCorp, 2011a,b,c).

- Duke Energy (through its subsidiary, Three Buttes Windpower, LLC) completed the Campbell Hill Windpower Project and began commercial operations in December 2009. The Campbell Hill Windpower Project is located approximately 24 km [15 mi] northwest of the Ludeman ISR Project and consists of 66 wind turbines generating 99 MW (PacifiCorp, 2015).

- Duke Energy built the Top of the World Wind Energy Project, a 200-MW wind farm consisting of 110 turbines. Some turbines associated with this project are located approximately 2.4 km [1.5 mi] northwest of the proposed Ludeman ISR Project area, and others extend as far as approximately 14 km [8.5 mi] away from the proposed project area. The project began commercial operation in 2010 (Duke Energy, 2017).

Several licensed and proposed ISR facilities are located within the southern PRB Uranium District. The closest operational ISR facility to the proposed Ludeman ISR Project is at the Smith–Highland Ranch ISR site, located approximately 8.7 km [5.4 mi] northwest of the Ludeman Project. EA Section 5.1.2.1 describes other ISR facilities located in the PRB.

Overhead power lines associated with mineral and energy development exist within the proposed Ludeman ISR Satellite Project area and the area within 3.2 km [2 mi] of the proposed project. In addition, some oil and gas pipelines occur within the proposed Ludeman Project area and the area within 3.2 km [2 mi] of the proposed project site. Railroad lines parallel both sides of the North Platte River south of the proposed project area within 3.2 km [2 mi] of the project site.

3.2 Transportation

This section describes the transportation infrastructure and conditions in the region surrounding the proposed Ludeman ISR Project. As described in Chapter 2 of this EA, the licensee has proposed road transportation to move workers, equipment, supplies, and produced materials, including wastes, during the lifecycle of the proposed action. Therefore, the road transportation infrastructure is the focus of this section. The licensee does not anticipate using other modes of transportation, such as rail, for proposed operations.

The proposed Ludeman ISR Satellite Project site is located in Converse County approximately 66 km [41 mi] west of Casper, Wyoming. Access to the proposed project is via State Route 95, which intersects the private road that will provide access to the Ludeman satellite building (Uranium One, 2017e). The private access road is an existing improved, unpaved, all-weather road that is approximately 9.1 m [30 ft] wide. Within the proposed project boundary, Leuenberger Lane (Converse County Road 26) extends south from State Route 95 (EA Figure 2-1) and is an improved, unpaved, all-weather road maintained by Converse County, located in the western half of the site.

The NRC staff expects that the Ludeman ISR Satellite Project workforce would be comparable to other ISR workforces (NRC, 2009), in that they would be dispersed throughout the region and would travel on various routes to the proposed project area. During operations, the licensee expects that the proposed resin shipments between the Ludeman site and the Willow Creek processing facilities would follow State Routes 95 and 93 east and south to northbound I-25, pass through Casper, and travel north to State Route 259 and 387, then travel east on State Route 387 from Midwest to State Route 192 north to Streeter and Irigaray Roads (Uranium One, 2017e). Additionally, the licensee expects that solid byproduct material shipments from the proposed Ludeman Project to the Pathfinder Shirley Basin disposal facility would follow State Route 95 west to I-25 north to State Routes 220 and 487 southwest of Casper to the disposal facility (Uranium One, 2017e).

Regional traffic data collected by the Wyoming Department of Transportation (WYDOT) was summarized by the licensee (Uranium One, 2017e) and reviewed by the NRC staff. Based on the magnitude of traffic generated by the proposed project (Uranium One, 2017e), the NRC staff focused its description of the affected environment on low-traffic roads that would experience the most noticeable changes to traffic from the proposed project (NRC, 2009). While available data on low-traffic roads is limited, the annual average daily traffic count was measured by WYDOT on State Route 93 west of Douglas (Orpha) in 2010 at 338 vehicles, and on State Route 387 near Pine Tree Junction in 2015 at 1,540 vehicles (Uranium One, 2017e). For comparison, the annual average daily traffic on these same roads as documented in the GEIS

for years 2005 and 2006 were 340 and 970 to 3,130, respectively (NRC, 2009). Therefore, the currently available traffic data for these roads are comparable to the data evaluated in the GEIS. All other roads evaluated had measured annual average daily traffic counts in excess of 1,000 vehicles per day. State Route 95 east of Glenrock (Rolling Hills), also notable for its close proximity to the site, had an annual average daily traffic count of 1,441 vehicles in 2010 (Uranium One, 2017e).

3.3 Geology, Seismicity, and Soils

This section describes geology, seismicity, and soils at the proposed Ludeman ISR Satellite Project and in the region surrounding the proposed Ludeman ISR Project. The Ludeman Project is located in east-central Wyoming on the southwestern edge of the PRB; the regional geologic structure dips toward the north-northeast in the direction of the basin center. The following subsections discuss the geology and soils of the PRB and proposed project area.

3.3.1 Regional Geology of the Powder River Basin, Wyoming

The PRB is a north-northwest trending structural and topographic basin paralleling the Rocky Mountain range that spans an area of approximately 5.6 million ha [14 million ac]. The 160-km [100-mi]-wide PRB is an asymmetric synclinal basin (i.e., its geologic units are arranged in a concave fold) that is bounded by the Hartville Uplift and the Laramie Mountain Range to the south, the Black Hills Uplift to the east, the Miles City Arch to the north, and the Bighorn Mountains Uplift and Casper Arch to the west. The PRB comprises marine and continental strata ranging in age from recent (Holocene) to early Paleozoic (i.e., approximately 11,700 years to 540 million years ago) that were deposited above Precambrian igneous and metamorphic rocks. A generalized stratigraphic chart for the sedimentary sequence of the PRB is illustrated in EA Figure 3-1.

Sediment thicknesses range from 4,900 to 5,200 m [16,000 to 17,000 ft] in the proposed Ludeman ISR Satellite Project area because of its close proximity to the deepest part of the basin, which has a maximum thickness of approximately 5,500 m [18,000 ft] (Uranium One, 2017e; Sonnenberg and Taylor, 2017). The Mississippian Madison Limestone and overlying Pennsylvanian Tensleep Sandstone (Minnelusa Formation sands) are approximately 4,500 m [15,000 ft] below ground surface in the Ludeman Project area (EA Figure 3-1; Uranium One, 2017e). The Madison Limestone is up to 640 m [2,100 ft] thick (Peterson, 1984). In some parts of the PRB, the Madison Limestone produces oil, while in others it supplies large quantities of groundwater. The Tensleep Sandstone, which is up to 76 m [250 ft] thick, is also a major oil reservoir rock or groundwater aquifer in parts of the PRB.

The Upper Cretaceous Frontier Formation and Cody Shale (EA Figure 3-1) produce oil at depths from 3,000 to 4,000 m [9,800 to 13,100 ft] below ground level in Converse County (NRC, 1978; Anna, 2010). Oil producers target the Frontier Formation in the north-central portion of Converse County as well as in a sector that stretches from east to south relative to the location of the Ludeman ISR Satellite Project (de Bruin, 2007). The Cody Shale consists of the Smoky Hill Member of the Niobrara Formation and the younger Sussex Sandstone, both of which are significant oil plays in the PRB.

The Upper Cretaceous Mesaverde Formation (EA Figure 3-1) consists of, from bottom to top, the Parkman Sandstone Member, an unnamed shale member, and the Teapot Sandstone Member (Anna, 2010). Its two primary sandstone units (i.e., the Parkman and Teapot) are approximately 2,600 to 2,700 m [8,500 to 9,000 ft] below ground surface in the Ludeman ISR

ERA	SYSTEM, SERIES AND OTHER SUBDIVISIONS			STATIGRAPHIC UNIT		HYDROGEOLOGIC UNIT
Cenozioc	Quaternary			Alluvium		Not Included As An Aquifer System
	Tertiary	Pliocene	Upper	(Absent in Powder River Basin)		
		Miocene				
		Oligocene	Lower	White River Formation		
		Eocene		Wasatch Formation		Lower Tertiary Aquifers
		Paleocene		Fort Union Formation		
Mesozoic	Cretaceous		Upper	Lance Formation		Upper Cretaceous Aquifers
				Fox Hills Sandstone		
				Lewis Shale		Confining Unit
				Mesaverde Formation		
				Steele Shale		
				Cody Shale		
				Frontier Formation*		
				Mowry Shale		
			Lower	Muddy Sandstone*		
				Thermopolis Shale		
				Inyan Kara Group	Fall River Formation	Lower Cretaceous Aquifers
					Lakota Formation	
	Jurassic			Morrison Formation		Confining Unit
				Sundance Formation*		
				Gypsum Spring Formation		
	Triassic			Chugwater Formation		
Paleozoic	Permian			Goose Egg Formation		
	Pennsylvania			Tensleep Sandstone	Minnelusa Formation	Upper Paleozoic Aquifers
				Amsden Formation		
	Mississipian			Madison Formation		

* Can be a local source of groundwater where permeable

Figure 3-1. Generalized Sedimentary Sequence in the Western Powder River Basin, Wyoming (Modified from Uranium One, 2017d). The Niobrara Formation and Sussex Sandstone are Part of the Cody Shale.

Satellite Project area (Uranium One, 2017e). The Parkman Member is up to 107 m [350 ft] thick (Keroher, 1966). Generally, the thickness of the Teapot Member north of Casper, Wyoming, ranges from 107 to 120 m [350 to 395 ft] (Curry, 1976). The Parkman Member was identified by the licensee as a secondary target formation for screening Class I DDWs (Uranium One, 2017d). Oil is produced from both the Parkman and Teapot sandstones at leases in the sector that stretch from north to east relative to the location of the Ludeman ISR Satellite Project in Converse County (de Bruin, 2007; Sonnenberg and Taylor, 2017).

The Lewis Shale, with its lower Teckla Sandstone Member, overlies the Mesaverde Formation (EA Figure 3-1); the Lewis is predominately marine shale with sandy shale zones and lenses of fine-grained sandstone (Hodson et al., 1973; Anna, 2010). The Lewis Shale is approximately 140 to 150 m [450 to 500 ft] thick in the southwest part of the PRB (Uranium One, 2017e). The Teckla Sandstone was identified by the licensee as another secondary target formation for screening Class I DDWs (Uranium One, 2017e). Oil producers are targeting the Lewis Shale in the sector that stretches from northeast to east relative to the location of the proposed Ludeman ISR Satellite Project in Converse County (de Bruin, 2007).

The Upper Cretaceous Fox Hills Sandstone (EA Figure 3-1) is 71 m [233 ft] thick along the trace of the API No. 928354 lateral oil well (Uranium One, 2016a) and consists of fine- to medium-grained sandstone bodies, sometimes several miles wide and hundreds of miles long (Weimer, 1961). The Fox Hills Formation is generally considered to be the deepest fresh water aquifer in the PRB (Uranium One, 2017e).

The Upper Cretaceous Lance Formation (EA Figure 3-1) consists of 300 to 900 m [1,000 to 3,000 ft] of thinly bedded, very fine to fine-grained lenticular, clayey, calcareous sandstone, shale, coal, and lignite beds (Uranium One, 2017e). Near the Ludeman ISR Satellite Project, the Lance Formation has a thickness of approximately 760 m [2,500 ft], with approximately 274 m [900 ft] of sand (Uranium One, 2017d). The upper Lance Formation contains minor carbonaceous shales and thin coal seams (Arizona Public Service Company, 1980; Uranium One, 2017e). The licensee identified Lance Formation sandstone as the preferred target formation for screening Class I DDWs at the Ludeman Project (Uranium One, 2017d). The Lance Formation is a minor oil-producing reservoir near the proposed project, with recent extraction efforts focused in a zone southeast of Douglas, Wyoming (de Bruin, 2007).

The Paleocene Fort Union Formation (EA Figure 3-1) conformably overlies the Lance Formation and consists of poorly consolidated continental and shallow non-marine deposits of interbedded mudstone, silty claystones, sandy siltstones, relatively clean fine- to coarse-grained sandstone channels, carbonaceous shale, occasional thin limestone, and subbituminous coal and lignite beds (Teton, 1980). The total thickness of the Fort Union Formation varies between 600 and 1,100 m [2,000 and 3,500 ft] (Sharp and Gibbons, 1964; Arizona Public Service Company, 1980).

The Tertiary Wasatch Formation unconformably overlies the Fort Union Formation (Uranium One, 2017e) and this geologic contact traverses through the proposed Ludeman site from Wellfield 1 eastward to just south of Wellfield 3 (Uranium One, 2017d; EA Figure 2-1). The Wasatch Formation is lithologically similar to the Fort Union Formation, and contains thick lenses of coarse, cross-bedded, arkosic sandstones deposited in high-energy fluvial (river) environments along with fine sandstones, siltstones, claystones, and coal deposited in alluvial (loose, unconsolidated) and paludal (marshy) environments. The Wasatch Formation contains numerous beds of sandstone that may be correlated over wide areas (Uranium One, 2017e), and its thickness varies from 0 to 488 m [0 to 1,600 ft] in the PRB (Sharp and Gibbons, 1964). Except in isolated areas of the PRB, the Wasatch–Fort Union contact is arbitrarily set at the top of thick coal beds or a thick sequence of clays and silts. A definitive marker bed is not present at the proposed Ludeman ISR Satellite Project (Uranium One, 2017e).

3.3.2 Site Geology

The Lebo Member of the Fort Union Formation contains significant uranium resources and hosts the uranium ore bodies for which Uranium One is proposing to conduct ISR operations. The uranium ore zones at the proposed Ludeman site are typical PRB roll-front deposits (Uranium One, 2017e) that are generally associated with fluvial sandstones and conglomerates. Uranium ore is found on one side of the naturally occurring chemical boundary between reduced and oxidized sandstone facies. Accumulation of uranium in the Lebo Member of the Fort Union Formation probably resulted from a continual process of dissolution, migration, and deposition of uranyl ions into Paleocene channel deposits since late Tertiary time (Teton, 1980). Within the proposed project area, uranium mineralization is found within 15- to 30-m [50- to 100-ft]-thick sandstones that extend over two townships and ranges (Uranium One, 2017e). On a regional scale, uranium mineralization is localized and controlled by facies changes, including

sand thickening and thinning, grain-size variations, and clay and organic content variations (Sharp and Gibbons, 1964). The southern two-thirds (approximately) of the proposed Ludeman ISR Satellite Project site is capped by the Lebo Member of the Fort Union Formation, whereas the northern third is capped by the Wasatch Formation and minor Quaternary sands (Uranium One, 2017d).

Uranium ore-bearing host rocks at the proposed Ludeman site are a stacked sequence of arkosic channel sandstones that have calcite and clays as the dominant cementing material. Montmorillonite clay dominates (i.e., 50 percent of total), with lesser amounts of illite (25 percent), and kaolinite (25 percent) present, and trace amounts of chlorite. Uranium coatings are often associated with calcite or clay cement and occasionally with woody lignite fragments (Uranium One, 2017e). Little crystalline uranium has been identified in samples collected at the proposed Ludeman site, with the exception of occasional uraninite. Other associated minerals include minor to very abundant pyrite, magnetite, ilmenite, and almandine garnet. The ore-bearing arkosic sandstones are flat- to cross-bedded, carbonaceous, cherty, and poorly sorted, with grain sizes ranging from fine to very coarse, averaging coarse (Uranium One, 2017e).

3.3.3 Site Ore Zones and Ore Bodies

The Ludeman ISR Satellite Project site hosts more than eight roll-front ore body deposits for which Uranium One has proposed to conduct ISR operations at six wellfields (i.e., Wellfields 1 through 6, EA Figure 2-1). Uranium One provided geologic cross sections and isopach maps that illustrate the stratigraphy of the host sands, ore bodies, and shale-confining units in each wellfield. The sands that occur within the proposed Ludeman ISR Satellite Project area are identified with decreasing numbers at increasing depths, as shown in EA Table 3-3. The intervening shales are identified by the overlying and underlying sand labels separated by a slash (e.g., the shale separating the 90 and 100 Sands is the 100/90 Shale). Across the proposed project site, the 90 through 120 Sands and intervening shales are occasionally to significantly eroded (EA Table 3-3; Uranium One, 2017d). A direct comparison of Uranium One's revised TR Addendum Figures 2.6A-1, 2.6A-40, and 2.6A-41 (i.e., surface geological map and isopach maps) suggests that the 120 Sand and the 120/110 Shale are Wasatch Formation units (Uranium One, 2017d).

The licensee has proposed to conduct ISR operations in economically viable ore zones at the proposed Ludeman ISR Satellite Project. Characteristics of the viable ore zones at each wellfield at the proposed project site are provided in EA Table 3-4. Uranium was deposited in 1.5- to 9.1-m [5- to 30-ft]-thick, c-shaped roll fronts at the proposed Ludeman site. The ore zone thickness is a fraction of the total thickness of each sand unit and rarely exceeds 6 m [20 ft]. Ore-bearing sand units at the proposed Ludeman site generally dip at low angles toward the northeast, away from the North Platte River (Uranium One, 2017e). The license amendment application describes roll fronts to be a few to 150 m [500 ft] wide and kilometers in length (Uranium One, 2017d).

Table 3-3. Stratigraphy at the Proposed Ludeman ISR Satellite Project				
Sand or Shale	Thickness (m) [ft]		Notes	Mineralization
	Mean	Range		
120		0–44.8 [0–147]	Eroded, except for WF3*	
120/110		0–30.5 [0–100]	Eroded/Partially Eroded at all Wellfields	
110 (O_2)	19.8 [65]	0–42.4 [0–139]	Eroded at/near WF2, 4,5,6	
110/100		0–36.3 [0–119]	Partially Eroded at WF6	
100 (O_1)	13.7 [45]	0–53.6 [0–176]	Partially Eroded at WF6; Discontinuous at WF1, 2	Trace
100/90		0–48.8 [0–160]	Partially Eroded/Thin at WF6; Discontinuous at WF4	
90 (N)	27.4 [90]	0–48.8 [0–160]	Discontinuous	Economically viable
90/80		0–50.6 [0–166]	Thin at WF5; Discontinuous at WF6	
80 (M)	12.2 [40]	0–49.1 [0–161]	Discontinuous at WF2, 3	Economically viable
80/70		0–42.7 [0–140]	Discontinuous-to-Thin near WF4,-5,-6	
70	15.2 [50]	0–50.0 [0–164]	Discontinuous near WF2	Economically viable
70/60		0–30.2 [0–99]	Discontinuous at WF3, 4	
60	10.7 [35]	0–48.8 [0–160]	Discontinuous near WF3, 6	Economically viable
60/50		0–34.4 [0–113]	Discontinuous at/near WF4, 5	
50		0–48.2 [0–158]	Discontinuous at WF1	Trace
50/40		0–37.5 [0–123]	Discontinuous near WF3	
40		0–48.8 [0–160]	Discontinuous at WF4	Trace
Sources: Teton, 1980; Uranium One, 2017d *WF# = Wellfield #				

3.3.4 Soils

In 2008, Uranium One inventoried and mapped 8,048 ha [19,888 ac] within the boundaries of the proposed Ludeman site (Uranium One, 2017e). The licensee exposed and described the physical and chemical properties and topsoil salvage depths of 56 soil profiles (Uranium One, 2017e) and categorized and distributed local soils into 48 soil series map units based on National Resources Conservation Service (NRCS) standards (USDA, 1993; Uranium One, 2017e).

General topography of the proposed Ludeman Project site ranges from nearly level uplands to very steep hills, ridges, and breaks of dissected shale plains (Uranium One, 2017e). Soils are typical for semi-arid grasslands and shrublands in the western United States. Parent material includes colluvium, residuum, and alluvium, and most Ludeman soils are classified taxonomically as Ustic Torriorthents, Ustic Haplargids, or Ustic Torrifluvents.

Table 3-4. Economically Viable Ore Zones Proposed for Mining			
Host Sand (Wellfield)	**Thickness (m) [ft]**	**Percent U_3O_8**	**Mean Depth/Range (m) [ft]**
Wellfield 1*			
90 (1)	2.5 [8.3]	0.090	104/88–107 [342/290–350]
80 (1)	2.9 [9.5]	0.130	135/133–140 [442/435–460]
Wellfields 3 and 4			
70 (3)	3.2 [10.6]	0.074	175/168–201 [575/550–660]
70 (4)			154/155–162 [507/510–530]
Wellfields 5 and 6			
70 (5)	1.4 [4.6]	0.093	101/101–104 [331/330–340]
80 (5)			80/73–82 [262/240–270]
90 (6)			44/21–85 [145/70–280]
Sources: Uranium One, 2017d,e *Wellfield 2 is not included in this table			

Soils have a well-drained, sandy loam or coarse texture throughout upland areas and a fine, clay texture in or near drainages (Uranium One, 2017e). Deep soils occur on nearly level upland areas, and shallow to very shallow soils are found on steep hills, ridges, and breaks. Given the dominantly coarse texture of the surface horizons, soils at the Ludeman Project site are more susceptible to wind than to water erosion (Uranium One, 2017e).

The licensee estimates that the topsoil salvage depth for the proposed project would range from 0 to 1.5 m [0 to 5 ft], with an average depth of 0.65 m [2.13 ft] below ground surface (Uranium One, 2017e). Almost all soil map units expected to be disturbed within the proposed project area have some suitable topsoil for plant growth, except for Kishona and Keeline loams (Uranium One, 2017e). Topsoil suitability determinations were generally influenced by physical limiting factors such as texture (sand or clay) and saturation percentages. In addition, chemical limiting factors include selenium and calcium carbonate content (based on field test observations with positive indicators for these components), sodium adsorption ratio, electrical conductivity, and pH. Following Wyoming Department of Environmental Quality [(WDEQ) 1994a] guidelines (i.e., Guideline No. 1), the licensee noted that marginal material for plant growth was found in 37 soil profiles and unsuitable material (due to sodium adsorption ratio and electrical conductivity) was found in 3 of 56 soil profiles (Uranium One, 2017e). Based on NRCS standards, Uranium One identified no prime farmland within the proposed project area (USDA, 1993; Uranium One, 2017e).

3.3.5 Seismicity

The seismically active region nearest the Ludeman Project is the western U.S. Intermountain Seismic Belt, which runs in a northerly direction from Arizona to British Columbia. It is characterized by shallow earthquake foci 16 to 40 km [10 to 25 mi] in depth and normal faulting. Part of this seismic belt extends along the Wyoming–Idaho border, more than 200 km [124 mi] west of the PRB (NRC, 1983). Historic earthquakes have, therefore, mainly occurred in the west-northwestern portion of Wyoming.

The proposed Ludeman ISR Satellite Project, located in Converse County, east-central Wyoming, has a low-to-moderate level of earthquake activity compared to the rest of the State. Twelve magnitude 3.0 or greater earthquakes have been recorded since 1947 in Converse County (Uranium One, 2017e). Of these, a magnitude 3.8 earthquake occurred on August 29, 2004, approximately 10 miles north-northwest of Douglas, but no damage was

reported. The largest to occur in this east-central region during the past 100 years was a magnitude 5.1 earthquake in Johnson County on September 7, 1984. The last earthquake strong enough to cause significant damage to the region (Intensity VII on the modified Mercalli scale) occurred near Casper, Wyoming, in 1897 (NRC, 1978).

The proposed Ludeman ISR Satellite Project would be located more than 6.4 km [4 mi] from the nearest fault and would be situated over stable geologic formations that are not conducive to seismic activity (Uranium One, 2013a; Uranium One, 2017d). No faulting at or within a 3.2-km [2-mi] area around the project site is evident from geophysical log interpretations (Teton, 1980, p. 63). No capable faults have mapped surface expressions within or near the proposed Ludeman ISR Satellite Project; therefore, no fault-specific analysis was possible. Instead, Uranium One provided a floating or random earthquake analysis and reported that the largest floating earthquake for the province where Converse County is located would have an average magnitude of 6.25. If this earthquake were placed within 15 km [9.32 mi] of any structure in Converse County, it would create an acceleration of 15 percent of gravity [0.15 g], which is a Level VI earthquake, and it would be expected to create light to moderate damage (Uranium One, 2017e).

Recent U.S. Geological Survey (USGS) probabilistic seismic hazard maps for Wyoming were published in 2008. These maps illustrate the 500-, 1,000-, and 2,500-year probability of occurrence of peak ground accelerations for Wyoming near the Ludeman Project (Uranium One, 2017d). Based on these maps, Uranium One estimates that the peak horizontal ground acceleration for Converse County ranges from a relatively low intensity of 3 to 6 percent of gravity for the 500-year map; 5 to 9 percent of gravity for the 1,000-year map; and 9 to 19 percent of gravity for the 1,000-year map. As shown in the licensee's revised technical report (TR) Addendum Table 2.6A–1, these accelerations are equivalent to Level IV, V, VI, and VII earthquakes; associated damage would be very light to moderate, as summarized in the licensee's revised TR Addendum Table 2.6 A–2.

3.4 Water Resources

This EA section describes surface water (Section 3.4.1), groundwater (Section 3.4.2), and water uses (Section 3.4.3) at the proposed Ludeman ISR Satellite Project that may affect or be affected by proposed ISR activities.

3.4.1 Surface Water and Wetlands

The proposed Ludeman ISR Satellite Project is located in the north-central portion of the Pathfinder to Guernsey sub-basin of the North Platte River basin (Uranium One, 2017e). The proposed Ludeman Project and a 3.2-km [2-mi] buffer around the project site illustrated in EA Figure 3-2 lie within the northeastern Middle North Platte–Casper Basin. The 3.2-km [2-mi] buffer includes the North Platte River and major watersheds that discharge directly into the North Platte River, which lies approximately 1.6 km [1 mi] south of the Ludeman Project boundary (Uranium One, 2017e). With headwaters in Jackson County, Colorado, the North Platte River flows across eastern Wyoming, draining the southern PRB. From Wyoming, the North Platte River flows southeast into Nebraska, where the confluence of the North and South Platte Rivers form the Platte River that flows east into the Missouri River. The river is approximately 1,152 km [716 mi] in length through Colorado, Wyoming, and Nebraska.

Watersheds, Ephemeral Channels, Peak Flow Estimates, and Runoff Calculations

Drainages that occur within the Ludeman site and a 3.2-km [2-mi] buffer around the project site are ephemeral in nature and transmit measurable flow only in response to snow melt during the spring and early summer or after large rain storms (Uranium One, 2017e). On an August 2012 field visit, the NRC staff verified the lack of flow in several drainages within the proposed project area. Ephemeral streams on the Ludeman site drain into the North Platte River.

The Ludeman Project area and the land within a 3.2-km [2-mi] buffer around the project site occur within six watersheds (EA Figure 3-2). Of these, the proposed satellite building and wellfields lie within the (i) Little Sand Creek watershed to the far west (satellite building and Wellfields 1 and 2), (ii) the Sage Creek watershed to the north and east (Wellfields 3 and 4), and (iii) the Running Dutchman Ditch watershed to the far south (Wellfields 4, 5, and 6) (EA Figure 3-3).

There are no automated stream gauge stations within the proposed Ludeman ISR Satellite Project boundary or 3.2-km [2-mi] buffer around the project. In the absence of stream discharge data, Uranium One estimated peak flows in drainage channels in two major watersheds in the license area, Little Sand Creek and Sage Creek (EA Figure 3-2), using the Hydrologic Modeling System (HEC-HMS) software program developed by the U.S. Army Corps of Engineers. HEC-HMS estimates peak surface water flow with a hydrograph model for a watershed using its drainage area, longest reach of the main channel, average stream slope, total rainfall, and curve number. HEC-HMS is a well-established, accepted method listed in both NUREG–1623, “Design of Erosion Protection for Long-Term Stabilization” and WDEQ guidelines. To support the HEC-HMS analysis, Uranium One used the Soil Conservation Service (SCS) Unit Hydrograph Runoff Method, which is suitable for the watersheds in the license area (Uranium One, 2017d).

The licensee modeled peak runoff rates for 50-yr and 100-yr recurrence intervals and 24-hour duration SCS Type II storms (Uranium One, 2017d). At the confluence of the Little Sand Creek drainage channel with the North Platte River, the peak runoff flowrate was estimated to be 134 m^3/s [4,726 cfs] for a 100-yr event and 105 m^3/s [3,694 cfs] for the 50-yr event. At the confluence of the Sage Creek drainage channel with the North Platte River, the peak flow was estimated to be 164 m^3/s [5,794 cfs] for the 100-yr event and 130 m^3/s [4,591 cfs] for the 50-yr event. Uranium One stated, however, that runoff in the license area primarily would consist of overland sheet flow (Uranium One, 2017e).

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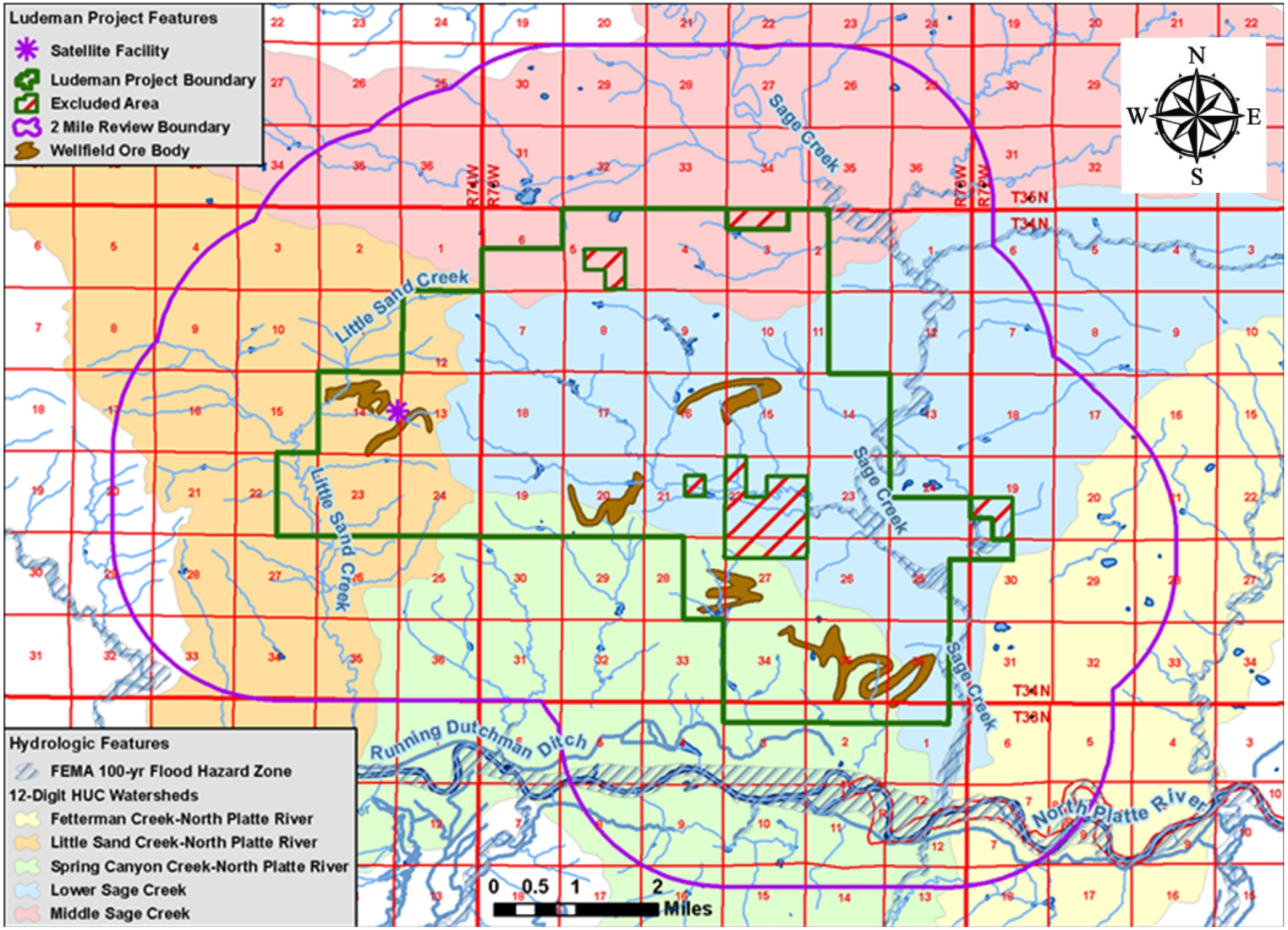

Figure 3-2. **Watersheds and Surface Water Features in the Proposed Ludeman ISR Project Area and 3.2-km [2-mi] Buffer (Modified from Uranium One, 2017d)**

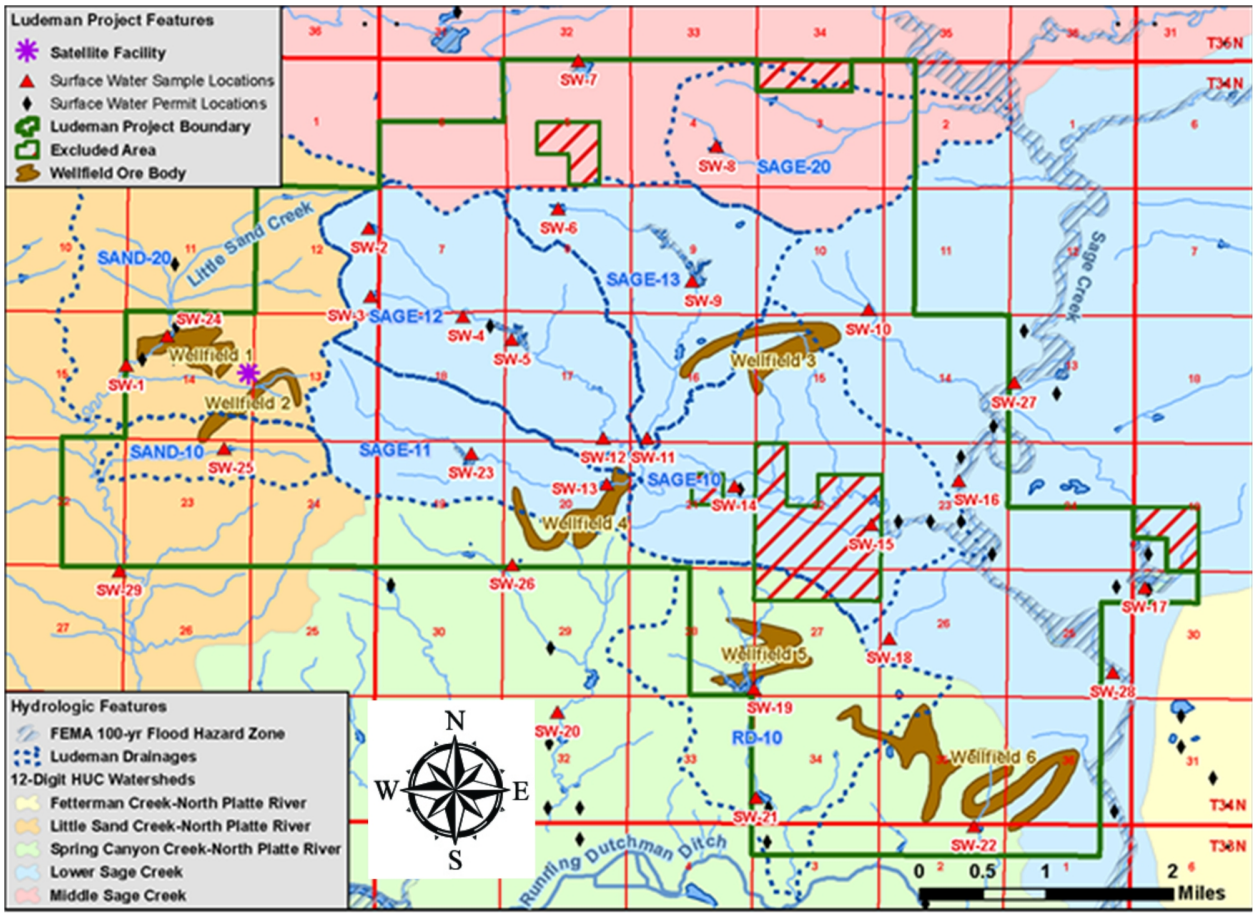

Figure 3-3. Subwatersheds, Surface Water Features, FEMA 100-year Flood Hazard Zones, Surface Water Rights and Sampling Locations at the Proposed Ludeman ISR Project (Modified from Uranium One, 2017d).

Water Bodies and Wetlands

The largest surface water bodies and wetlands that occur within the proposed Ludeman project area, as well as within the 3.2-km [2-mi] buffer, are illustrated in EA Figure 3-2. Based on licensee surveys, approximately 24.1 ha [59.6 ac] (or 0.3 percent of the proposed project area) consists of 233 individual wetlands, and approximately 11.9 ha [29.3 ac] (or 0.15 percent of the project area) consists of 195 water bodies (Uranium One, 2017e). The wetlands met determination criteria in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (USACE, 2008). Surface water bodies are either in depressions or behind dikes in ephemeral drainages (stock ponds), or within playas, and range in size from 2.6 m^2 to 2.1 ha [28 ft^2 to 5.1 ac] (Uranium One, 2017e); the areal extent of the water bodies varies seasonally. Groundwater is pumped into several depressions via windmills to provide water to livestock. Of the wetlands and surface water bodies identified, the licensee classified 11.7 ha [29 ac] consisting of 43 wetlands and 4 water bodies as jurisdictional (Uranium One, 2017e) with final determinations to be made by U.S. Army Corps of Engineers. The 3.1 ha [7.7 ac] Hildebrand reservoir, located at proposed Wellfield 5, has a maximum depth of 2.7 m [9 ft], an average depth of 1.5 m [5 ft], and a

capacity of 47,489 m^3 [38.5 ac·ft] (Bishop, 1909; Wyoming Water Division No. 1, 1918; True, 1919).

Two large wetlands are located within the proposed project boundary (Uranium One, 2017e). Gilbert Lake is a shallow, diked water body in the eastern portion of the license area (Uranium One, 2017e). When surveyed in 2008, its area was approximately 6.5 ha [16 ac], its water depth was approximately 15 centimeters (cm) [6 inches (in)], and it had more than 5 percent vegetation cover (Uranium One, 2017e). Another large, unnamed wetland occurs near the northern boundary of the proposed Ludeman site in a natural, isolated playa (Uranium One, 2017e). Its areal extent was approximately 1.9 ha [4.8 ac], its water depth was approximately 30 cm [12 in], and it also contained more than 5 percent vegetation cover (Uranium One, 2017e).

Flood-Induced Inundation

The locations of eight licensee-defined sub-watersheds within the proposed Ludeman ISR Project area in relation to the Federal Emergency Management Agency (FEMA) 100-year flood (Zone A) inundation map are illustrated in Figure 3-3 (Uranium One, 2017d). The Sage-10 sub-watershed has significant floodplains on the eastern portion of the Ludeman site; less extensive flooding is possible at locations on the SAGE-11, -12, -13 and RD-10 sub-watersheds, as well as at wetlands within the Ludeman Project boundary (Uranium One, 2017d). A portion of Wellfield 5 around a surface impoundment identified as WB-43 (also referred to as the Hildebrand reservoir) on the RD-10 sub-watershed is located within the 100-year flood zone (Uranium One, 2017e).

Surface Water Quality

A 42-year-long time series of surface water quality data is available for the North Platte River from a USGS stream gage located near Orin, Wyoming, 64 km [40 mi] downstream of the proposed project (Uranium One, 2017d); water quality data were last collected there on October 30, 2008.

The licensee sampled surface water over six quarters during 2008 and 2009 at 25 monitoring stations to establish preoperational baseline water quality for the proposed license area (Uranium One, 2017e). Surface water sampling locations are shown in EA Figure 3-3. The sampling locations were located either at livestock ponds or within drainages where ponding occurs. Ten surface water quality sampling sites were located upstream of the proposed satellite building or wellfield areas, and the others were located downstream of either the satellite building or a wellfield area. Solute concentrations detected in the Ludeman area surface water are documented in Table 2.7A–6 of Uranium One's revised TR (Uranium One, 2017d). The licensee did not evaluate seasonal variability or trends in flow and water quality due to the ephemeral (and dry) nature of streams on the project site (Uranium One, 2013a).

Surface water within the proposed Ludeman Project area is generally of the calcium-bicarbonate or calcium-sulfate type (Uranium One, 2017d). Total dissolved solids are highly variable with maximum concentration of 8,650 mg/L [8,667 parts per million (ppm)], minimum concentration of 46 mg/L [46 ppm], and mean concentration of 626 mg/L [627 ppm] (Uranium One, 2017e). Total dissolved solids concentrations were positively correlated with sodium and sulfate concentrations and with electrical conductivity (Uranium One, 2017e). Based on NRC staff evaluation of the average surface water quality at each sampling site, the average surface water quality at some sampling sites exceeded U.S. Environmental Protection Agency

(EPA) primary and secondary and Wyoming domestic use standards. EPA drinking water standards were exceeded for arsenic {0.01 mg/L [0.01 ppm]} at two sites, cadmium {0.005 mg/L [0.005 ppm]} at four sites, lead {0.015 mg/L [0.015 ppm]} at one site, uranium {0.03 mg/L [0.03 ppm]} at two sites, and gross alpha {555 Bq/m^3 [15 pCi/L]} at four sites. The Wyoming domestic use standards were exceeded for total dissolved solids (TDS) {500 mg/L [500 ppm]} at 11 sites, sulfate {250 mg/L [250 ppm]} at 8 sites, iron {0.03 mg/L [0.03 ppm]} at 11 sites, and manganese {0.05 mg/L [0.05 ppm]} at 16 sites. Radium-226 was detected at every surface water quality sampling location but at levels well below the EPA drinking water standard of 185 Bq/m^3 [5.0 pCi/L]. Radium-226 surface water samples had a maximum value of 20.7 Bq/m^3 [0.56 pCi/L], a minimum value of 3.7 Bq/m^3 [0.10 pCi/L] detected at multiple locations, and a mean value of 10.4 Bq/m^3 [0.281 pCi/L] (Uranium One, 2017e). Several surface water sample locations had anomalously high average values for constituents including TDS, chloride, manganese, sulfate, uranium, and gross alpha. These locations included SW-1 and SW-29 on the west side of the proposed project area and SW-16 and SW-28 on the east side of the proposed project area (EA Figure 3-3).

3.4.2 Groundwater

This section describes aquifer system characteristics and associated groundwater resources within the Ludeman ISR Project area and surrounding region that may affect or be affected by project activities. The Ludeman site lies above the Northern Great Plains Aquifer System (Whitehead, 1996), which contains overlapping aquifers in the Lower Tertiary, Upper and Lower Cretaceous, and Upper and Lower Paleozoic units (Uranium One, 2017e). A stacked sequence of confining layers in the Cretaceous units isolate the deep Lower Cretaceous and Upper Paleozoic aquifers from the near-surface aquifers that would be affected by the proposed Ludeman Project ISR operations (EA Figure 3-1). Recharge to the Tertiary aquifers generally occurs along the southwestern and western edges of the PRB where the formations crop out in association with the Casper Arch and Laramie Mountain uplifts (Uranium One, 2011b). Groundwater quality in the PRB generally ranges from excellent in the permeable near-surface to very poor in less permeable, deep aquifers.

Deep Aquifers

As described in EA Section 3.3.1, the Paleozoic Madison Limestone and Tensleep Sandstone are approximately 4,500 m [15,000 ft] below ground surface in the Ludeman Project area (EA Figure 3-1; Uranium One, 2017e). The Madison Limestone and Tensleep Sandstone produce large well discharge rates. Wells in the Madison Limestone flow at several thousand liters per minute (Lpm) [gallons per minute (gpm)] in some areas (Crist and Lowry, 1972), and wells in the Tensleep Sandstone flow at hundreds of Lpm [gpm]. The water quality of these deep aquifers is poor.

The Upper Cretaceous Teapot and Parkman Sandstones of the Mesaverde Formation (EA Figure 3-1) are the next hydrologically significant geologic units. Water quality samples from three wells screened in the Parkman Sandstone in Johnson County near the outcrop of this formation exhibited TDS concentrations from 1,360 to 3,060 mg/L [1,363 to 3,066 ppm] (Whitcomb et al., 1966; Uranium One, 2017e). Water quality in the Teapot and Parkman sandstone aquifers decreases as the distance from the outcrop areas increases; therefore, the potential use of these aquifers for drinking water decreases as the distance from the recharge zones increases. Water quality samples from area wells exhibited TDS concentrations exceeding 10,000 mg/L [10,020 ppm] and benzene–toluene–ethyl-benzene–xylene (BTEX) compounds (from oil and gas production) at concentrations that exceed drinking water

standards (Uranium One, 2017e). The overlying Upper Cretaceous Lewis Shale, with the exception of its lower Teckla Sandstone Member, is one of the major aquitards between the Upper and Lower Cretaceous aquifer systems in the PRB. Uranium One combines the Teckla Sandstone Member with the aforementioned Parkman and Teapot sandstones into one unit.

Above the Lewis Shale aquitard, the Upper Cretaceous Lance Formation has a recharge zone that outcrops a few miles southwest of the proposed Ludeman ISR Project (Uranium One, 2017e). Due to low permeability and low yields, the Lance Formation in the region surrounding the proposed Ludeman Project area is not used as a groundwater resource. TDS concentrations within the Lance Formation range from approximately 200 to 2,800 mg/L [200 to 2,805 ppm], but more typically from 500 to 1,500 mg/L [501 to 1,503 ppm] with a mean of 1,200 mg/L [1,202 ppm] (Hodson et al., 1973; Lowry and Wilson, 1986). Because of these characteristics, Uranium One anticipates that Lance Formation groundwater contains constituents exceeding Wyoming Class I, II, and III groundwater standards, including TDS, chloride, ammonia, trace metals, organic compounds, oil, and grease (Uranium One, 2017e). Given that its water chemistry is unsuitable for producing potable water, the Lance Formation was identified by the licensee as the preferred target formation for Class I DDWs at the Ludeman site (Uranium One, 2017e).

The overlying Fox Hills Sandstone is the basal aquifer within the Lower Tertiary/Upper Cretaceous aquifer sequence in the PRB. This formation may yield over 750 Lpm [200 gpm], although lower yields from 19 to 190 Lpm [5 to 50 gpm] are typical in the western part of the basin (Hodson et al., 1973). TDS concentrations within the Fox Hills Sandstone are generally higher in the western side of the basin than the eastern side, ranging from 1,000 to 2,000 mg/L [1,002 to 2,004 ppm] (Uranium One, 2017e).

Near-Surface and Production Aquifers

Near-surface and production zone aquifers and overlying and underlying monitoring aquifers in the Ludeman Project area are generally sand units of the Lebo Member of the Paleocene Fort Union Formation (Uranium One, 2017e; Uranium One, 2017d). Water-supply aquifers of the Lebo Member have maximum yields on the order of 568 Lpm [150 gpm]; in the Ludeman area; however, aquifer yields typically range from 8 to 151 Lpm [2 to 40 gpm] (Uranium One, 2017e). TDS concentrations within the Fort Union Formation range from 200 mg/L [200 ppm] to greater than 3,000 mg/L [3,000 ppm], but more typically range from 500 to 1,500 mg/L [500 to 1,500 ppm] (Hodson et al., 1973). Sodium bicarbonate and sodium sulfate are its dominant groundwater types (Uranium One, 2017e).

Surficial Aquifers

The proposed Ludeman site is on an aquifer recharge zone where several of the Fort Union Formation sands and a Wasatch Formation sand crop out at land surface. Surficial aquifers are, from shallowest to deepest, the 120, 110, and 100 Sands. The 120, 110, and 100 Sands supply domestic well water to the Negley Subdivision located northwest of the proposed project area (Uranium One, 2017e). The 120 Sand is thought to be part of the Wasatch Formation; however, it may be almost entirely vadose zone at the Ludeman site. TDS concentrations within the Wasatch Formation range from 200 mg/L [200 ppm] to greater than 8,000 mg/L [8,000 ppm], but more typically range from 500 to 1,500 mg/L [500 to 1,500 ppm] and sodium sulfate and sodium bicarbonate are its dominant water types (Uranium One, 2017e). More detailed assessments of surficial aquifers at the Ludeman site will be included in each wellfield hydrogeologic data

package (EA Section 2.1.3) (Uranium One, 2017e), including additional water quality data and a map of the depth to the top of the surficial aquifer above the production zone for each mine unit that extends laterally to the edge of the 3.2-km [2-mi] buffer around the Ludeman project area. The licensee also commits to develop a groundwater monitoring network (i.e., a guard-well system) north-northwest of the proposed satellite building, between it and the Negley Subdivision (Uranium One, 2013b), which would serve to further characterize the local surficial aquifer in that area.

In the absence of detailed surficial aquifer characterization, geologic cross sections suggest that the unconfined surficial aquifer at most wellfields is the 110 Sand. The licensee did not prepare a geologic cross section for the satellite building area; however, adjacent cross sections suggest that the proposed satellite building may be located where the 120 Sand is the surficial aquifer. Where the 120 Sand and 120/110 Shale are present in northwestern and north-central areas, the 110 Sand aquifer is confined by the overlying shale. Where the 120 Sand, 120/110 Shale and 110 Sand have been eroded from the southeastern part of the site, principally by the downcutting of the North Platte River (i.e., at Wellfield 6), the surficial aquifer is either the 100 Sand or the 90 Sand (where the 100 Sand is absent due to erosion) (Uranium One, 2017d).

Production Zone Aquifers

The production zone aquifers are, from shallowest to deepest, the 90, 80, and 70 Sands (EA Table 3-4). The 70, 80, and 90 Sands are fully confined aquifers. Each production zone sand is discontinuous in certain areas of the Ludeman site; for example, the 90 Sand, which hosts ore bodies at Wellfields 1 and 6, pinches out in areas far from proposed wellfields. At Wellfield 1, the 90 Sand only consists of one ore-bearing layer; whereas at Wellfield 6, it consists of at least two ore-bearing sand layers (Uranium One, 2017d). The 80 Sand, which hosts ore bodies in a single sand layer at Wellfields 1 and 5, is discontinuous south of Wellfield 3 where it might otherwise locally be a designated overlying monitoring aquifer (Uranium One, 2017d). The 90/80 and 80/70 Shales fuse together where the 80 Sand is absent. The 70 Sand, which hosts ore bodies in one to three sand layers at proposed Wellfields 3, 4, and 5, is in close proximity to the underlying 60 Sand in some areas of the southeastern and east-central portions of the site. For this reason, the NRC staff verified that the 70/60 Shale is at least 3 m [10 ft] thick along geologic cross sections for Wellfields 3, 4, and 5 (Uranium One, 2017d), which suggests these mine units would be physically isolated by the competence of the 70/60 Shale. The 70/60 and 60/50 Shales fuse together where the 60 Sand is absent. Sand and shale thicknesses vary over the ranges given in EA Table 3-3, as demonstrated by the licensee's isopach maps (Uranium One, 2017d).

No direct tests of aquitard properties have been undertaken at the Ludeman site. In the absence of site-specific shale data, Uranium One hypothesizes that the hydraulic conductivity of the shale-confining units at the Ludeman Project site are similar to those measured in the Wasatch Formation, given its similar depositional environment. Wasatch shale hydraulic conductivities range from 10^{-7} to 10^{-11} cm/s [10^{-8} to 10^{-12} in/s] (Uranium One, 2017e). The NRC staff reviewed the available offsite aquitard property data combined with onsite multiwell pump test results and found them sufficient to demonstrate confinement. Aquifer confinement would be further verified by the licensee at each wellfield during required wellfield multiwell pump tests, and documentation would be contained in subsequent wellfield hydrogeologic data packages.

Groundwater Quality

Historical investigations of the ore bodies located at proposed Wellfield 1 (Teton, 1980) determined that groundwater in these 80 and 90 Sands exceeded EPA's maximum contaminant level (MCL) standards for drinking water, primarily due to radium-226 concentrations that exceeded the 185 Bq/m^3 [5 pCi/L] standard. Baseline averages for other water quality parameters and constituents (specifically, for manganese) were within or near drinking water standards. The previous investigations also revealed that (i) the groundwater quality of the overlying 110 Sand (and a drinking water source to the Negley Subdivision) was similar to that of the ore zone aquifers, except that the radium-226 concentrations were below EPA's 185 Bq/m^3 [5 pCi/L] MCL for drinking water, and (ii) water quality of the underlying 70 Sand aquifer was potable (NRC, 1983).

To establish preoperational baseline groundwater quality in the 60, 70, 80, 90, 100, and 110 Sands within the proposed Ludeman ISR project area, Uranium One collected and analyzed water samples quarterly from 25 monitoring wells, two private wells (OW-1 and OW-9), and eight aquifer test wells between 2008 and 2009 (Uranium One, 2017d). Sampling dates and results for all measured constituents at these wells are documented in Tables 2.7B–9 through 14 in Uranium One's revised TR Addendum 2.7–B (Uranium One, 2017d). The locations of the monitoring wells and aquifer test wells are shown in Figure 2.7B–3 in Uranium One's revised TR Addendum 2.7–B (Uranium One, 2017d).

The NRC staff calculated the average concentration of selected constituents in the 60, 70, 80, 90, 100, and 110 Sands. Average TDS concentrations ranged from 316 mg/L [316 ppm] in the 60 Sand to 599 mg/L [599 ppm] in the 100 Sand. For major cations, anions, and other constituents of concern (e.g., arsenic, cadmium, and selenium), the average water quality in all the sand aquifers was good (i.e., concentrations did not exceed EPA drinking water standards). However, the average concentrations of radionuclides exceeded EPA drinking water standards for radium-226 {185 Bq/m^3 [5 pCi/L]} in the 60, 70, 80, 90, and 100 Sands; for gross alpha activity {555 Bq/m^3 [15 pCi/L]} in the 60, 70, 80, 90, 100, and 110 Sands; and for uranium {0.03 mg/L [0.03 ppm]} in the 60, 90, and 100 Sands.

Uranium One provided Piper diagrams of major cations and anions in the 60, 70, 80, and 90 Sands in Figure 2.7B–13 in revised TR Addendum 2.7–B (Uranium One, 2017d). Based on an evaluation of the Piper diagrams, the NRC staff find that groundwater within the license area is of the calcium-sulfate type in the upper aquifers (i.e., the 90 Sand) and trends toward the sodium-bicarbonate type in the deeper aquifers (i.e., the 60 and 70 Sands). Uranium One also provided Piper diagrams of major cations and anions in selected wells in each of the sand aquifers for four quarters in 2008 in Figure 2.7B–14 in revised TR Addendum 2.7–B (Uranium One, 2017d). Based on these diagrams, no significant seasonal trend in water quality (i.e., the concentrations of major cations and anions) was observed by the NRC staff.

Uranium One sampled 12 livestock wells within and around the proposed Ludeman Project area in 2008 and 2009 for the constituents listed in Table 2.7.3-1 in NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications," (NRC, 2003a). Sampling dates and results for all measured constituents in the stock wells are provided in Table 2.7B–15 in Uranium One's revised TR Addendum 2.7–B. The NRC staff's review of these results found that radionuclide concentrations in some of the livestock wells exceeded EPA drinking water standards. Specifically, EPA drinking water standards were exceeded for gross alpha activity {555 Bq/m^3 [15 pCi/L]} in eight wells and for uranium {0.03 mg/L [0.03 ppm]} in two wells.

Uranium One also sampled 23 private wells outside the proposed Ludeman Project area, mainly within the adjacent Negley Subdivision. The wells were sampled quarterly between November 2008 and September 2009 for the constituents listed in Table 2.7.3-1 in NUREG–1569 (NRC, 2003a). Uranium One provided average constituent concentrations in the Negley wells in Tables 3, 4, and 5 in the report entitled, "Assessment of the Hydraulic Relationship of the Negley Subdivision to the Ludeman ISR Uranium Project," dated February 2011 (Uranium One, 2011a). The NRC staff calculated the average concentration of selected constituents from the Negley wells. For radionuclides, the EPA primary drinking water standards were exceeded for gross alpha {555 Bq/m^3 [15 pCi/L]} in all of the Negley Subdivision wells; for uranium {0.03 mg/L [0.03 ppm]} in nine wells; and for radium-226 and radium-228 {185 Bq/m^3 [5.0 pCi/L]} in four wells. The EPA primary drinking water standard was also exceeded for selenium {0.05 mg/L [0.05 ppm]} in two wells and for manganese {0.05 mg/L [0.05 ppm]} in nine wells. The Wyoming domestic use standard was exceeded for TDS {500 mg/L [500 ppm]} in 20 wells and for sulfate {250 mg/L [250 ppm]} in 10 wells.

3.4.3 Water Use

This section describes surface water and groundwater uses occurring regionally and within the Ludeman ISR Project area. This section also describes groundwater wells in the vicinity of the Ludeman ISR Project site that may affect or be affected by project activities (Uranium One, 2017d) provided estimates for Converse County, Wyoming, surface water and groundwater use for years 1995 and 2000 in revised TR Addendum Table 2.7A–4.

Surface Water

Surface water classes and use designations for the State of Wyoming are documented by Uranium One (2017d) in revised TR Addendum Table 2.7A–7. The North Platte River has designated uses for drinking water, game and nongame fisheries, fish consumption, other aquatic life, recreation, wildlife, agriculture, industry, and scenic value.

Surface water use on the Ludeman site is limited to irrigation and livestock watering purposes (Uranium One, 2017e). Under WDEQ Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards, Sage Creek, Sand Creek, and all other channels onsite are identified as Class 3B surface waters with designated uses for recreation, other aquatic life, wildlife, agriculture, industry, and scenic value. The individual water classifications for surface waters and their use designations are listed in the Wyoming Surface Water Classification List (WDEQ, 2013b). Class 3B surface waters are incapable of supporting fish populations or drinking water supplies due to their ephemeral characteristics [see WDEQ Rules and Regulations, Chapter 1, Section 4(c)(ii)]. WDEQ Rules and Regulations, Chapter 1, also identifies water quality standards relevant to Class 3B surface waters. With respect to radiological standards, the total radium-226 concentration in Class 3B surface waters shall not exceed 2,220 Bq/m^3 [60 pCi/L] [see Chapter 1, Section 22(b)]. Furthermore, in all Wyoming surface waters (including Class 3B waters), radioactive materials attributable or influenced by the activities of man shall not be present in the water or in the sediments in amounts that could cause harmful accumulations of radioactivity in plant, wildlife, livestock, or aquatic life [see Chapter 1, Section 22(c)].

Groundwater

Of the total permitted groundwater rights in the Pathfinder to Guernsey sub-basin, agricultural uses account for 53 percent, industrial uses for 25 percent, municipal uses for 20 percent, and

domestic uses for approximately 3 percent (Trihydro, 2006). Agricultural wells are typically screened in Quaternary or Lower Tertiary aquifers (Uranium One, 2017e). Quaternary aquifers supply large quantities of water, but because some potentially are connected to the North Platte River (Uranium One, 2017d), they may be contaminated (Uranium One, 2011b). Industrial wells that supply groundwater for power, mining, and petroleum industries primarily use Quaternary aquifers. The Lower Tertiary aquifer has potential for future industrial, stock, and domestic groundwater development (Uranium One, 2011b). As described in EA Section 3.4.2, the deep Paleozoic aquifer that potentially could be developed for municipal water supply has not been characterized for that purpose (Trihydro, 2006).

Local groundwater use on and within 4.8 km [3 mi] of the Ludeman site primarily involves the supply of domestic well water to ranch houses; water to livestock and wildlife via windmill-driven or electrically pumped wells; and water for monitoring, industrial, or miscellaneous purposes (Uranium One, 2011a; Uranium One, 2017d,e). As of January 2014, there were 81 Wyoming State Engineer's Office (WSEO)-permitted wells located on the Ludeman site (Uranium One, 2017d). These include 64 monitor, four miscellaneous, 12 stock, and a miscellaneous/stock water-supply well (Uranium One, 2017d,e). There are also nine other stock water-supply wells on the Ludeman site that are not in the WSEO database; their depths range from 27 to 104 m [90 to 340 ft] (Uranium One, 2017e). In January 2014, there were 225 WSEO-permitted wells located within a 4.8-km [3-mi] radius beyond the Ludeman site boundary (Uranium One, 2017d). These include 50 domestic, 32 domestic/stock, and 65 stock water-supply wells; 2 industrial, 69 monitor, six miscellaneous, and a miscellaneous/stock water-supply well (Uranium One, 2017d,e). The domestic and domestic/stock wells range from 1.5 to 110 m [5 to 360 ft] in depth; the stock water-supply wells range from 4 to 219 m [14 to 720 ft] in depth; and the industrial, monitor, miscellaneous, and miscellaneous/stock wells range from 73 to 188 m [240 to 617 ft] in depth (Uranium One, 2017e).

Private Groundwater Wells Near and On the Ludeman Project Site

Uranium One provided a summary of groundwater rights on and located within 4.8 km [3 mi] of the Ludeman site in revised TR Addendum Tables 2.7B–5 and –6 and Figure 2.7B–11. One residence is located within the Ludeman Project boundary in the same section as Wellfield 1 and the eastern extent of Wellfield 2 (Uranium One, 2017d). This residence relies on a stock well (identified as P9823.0W and known as the JS well) for domestic water use. This well is located at an estimated distance of 1,670 m [5,475 ft] from Wellfield 1. The NRC staff reviewed the WSEO permit for this well and found it is reported as deepened to 49-55 m [160-180 ft]. NRC staff evaluated the closest boring log (3473-18-1004) to this well, which is shown on cross section C-C' in revised TR Addendum Figure 2.6A–7 (Uranium One, 2017d). At this depth and location, cross section C-C indicates that the well is most likely completed in the 110 or 100 Sand, which overlies the 80 and 90 Sand ore bodies in Wellfield 1.

Local domestic and stock groundwater from private wells within 2 km [1.2 mi] of Wellfields 1 and 2 (including groundwater supplied to the Negley Subdivision) is typically sourced from shallow aquifers (e.g., 100, 110 and 120 Sands) (Uranium One, 2011a). HKM et al. (2002) reported general water yields of 4 to 227 Lpm [1 to 60 gpm] (Uranium One, 2011a) for the Lower Tertiary aquifers, and previous investigations conducted near Wellfield 1 suggest the more limited range of 11 to 95 Lpm [3 to 25 gpm] (Teton, 1980). Permitted yields for the Negley wells were documented by Petrotek in 2011 (see Uranium One, 2011b, Addendum 3.4-F). If the permitted rate of consumptive use occurred, the total extraction rate from all of its Lower Tertiary aquifers would be 29.2 Lpm [7.1 gpm]; however, seven Negley wells are generally unused (Uranium One, 2011b). Pumping rates for stock wells in these sands were unreported.

Water Use From the North Platte River

Uranium One reported that portions of Wellfields 5 and 6 are located in the hydrologic region covered under the Modified North Platte River Decree and; therefore, all water use from these wellfields, whether surface water or groundwater, must be approved by WSEO to meet the requirements of the decree. Uranium One performed an evaluation of the WSEO stream flow depletion from groundwater withdrawals based upon provisions of the Modified North Platte Decree and the Platte River Recovery Implementation Program (Uranium One, 2017e). These provisions establish methods designed to assess for the potential of a "hypothetical connection" related to groundwater usage on stream flow depletion. Based on the distance of proposed Wellfields 5 and 6 from the North Platte River, the depth and confined nature of the aquifers targeted for proposed ISR activities and the proposed time frame of ISR activities, Uranium One concluded (Uranium One, 2017e) and WSEO determined (WSEO, 2015) that ISR activities would have little to no effect on stream flow depletion of the North Platte River in the vicinity of the Ludeman Project area. WSEO further determined that Wellfields 5 and 6 are not considered hydrologically connected, and water from these wellfields would not be subject to the Modified North Platte River Decree.

3.5 Ecology

This section describes the ecological environment within the proposed Ludeman ISR project area that may affect or be affected by project activities.

Vegetation

The general description of the ecologic conditions in the Wyoming East Uranium Milling Region is available in the GEIS Section 3.3.5.1 (NRC, 2009). GEIS Section 3.3.5.1 describes the PRB ecoregion of the Northwestern Great Plains, where the proposed Ludeman Project is located, as rolling prairie and dissected river breaks surrounding the Powder, Cheyenne, and Upper North Platte Rivers. The PRB has less precipitation and less available water than the neighboring regions (NRC, 2009). Vegetation within this region is composed of sagebrush and mixed-grass prairie dominated by blue grama (*Bouteloua gracilis*); western wheatgrass (*Elymus smithii* syn. *Pascopyrum smithii*); prairie junegrass (*Koeleria macrantha*); Sandberg Bluegrass (*Poa secunda*); needle-and-thread grass (*Stipa comata*); rabbitbrush (*Chrysothamnus nauseosus*); fringed sage (*Artemisia frigida*); and other forbs, shrubs, and grasses (Chapman et al., 2004). Native grasslands and some woodlands persist in the region, especially in areas of steep or broken topography (Chapman et al., 2004).

The licensee's contractor, BKS Environmental Associates, Inc. (BKS), conducted baseline vegetation studies of the proposed Ludeman Project area and a 0.8-km [0.5-mi] buffer around the project area in summer and fall of 2008, in accordance with the WDEQ guidelines for noncoal permit areas (Uranium One, 2017e; WDEQ, 2014).

Six vegetation communities were identified within the survey area that include big sagebrush shrubland, lowland grassland, silver sagebrush shrubland, upland grassland, upland grassland rough breaks complex, and crested wheatgrass field shown on the vegetation map in Uranium One's revised ER (Uranium One, 2017e). Approximately 89 percent of the proposed project area is composed of the three following vegetation communities: upland grassland (40 percent), big sagebrush shrubland (29 percent), and upland grassland rough breaks complex (20 percent). The lowland grassland vegetation community encompasses about 6.5 percent of the project area, and both the crested wheatgrass field and silver sagebrush shrubland

encompass 1.6 percent. Approximately 1.6 percent of the project area is disturbed land with no particular vegetation community characteristics. Annual grasses, native cool season grasses, and introduced perennial grasses dominate the vegetation species found in all of the vegetation communities identified within the Ludeman project area. Perennial full and half/subshrub species were more prevalent, but not dominant, in the big sagebrush shrubland and silver sagebrush shrubland communities. Detailed vegetative data, including maps and photographs collected during the baseline vegetation assessment, are provided in Uranium One's revised ER (Uranium One, 2017e).

Wyoming-designated noxious weeds and Converse County-declared weeds were identified during baseline vegetation surveys conducted for the Ludeman Project (Uranium One, 2017e). Weed species observed include two State-designated weeds [field bindweed (*Convolvulus arvensis)* and Russian olive (*Elaegnus angustifolia*)] and five county-declared weeds [cheatgrass *(Bromus tectorum)*, curlycup gumweed (*Grindelia squarrosa)*, showy milkweed (*Asclepias speciosa*), wavyleaf thistle *(Cirsium undulatum*), and wild licorice (*Glycyrrhiza lepidota*)] (Wyoming Weed and Pest Council, 2017).

The Wyoming Game and Fish Department (WGFD) describes selenium indicator plant species as plant species that may selectively concentrate selenium in their tissue and/or be tolerant of high selenium concentrations in the soil. Primary selenium-indicator species identified within the proposed Ludeman Project area in 2010 included two-grooved milkvetch (*Astragalus bisulcatus*) and woolly locoweed (*Astragalus pectinatus)* (WDEQ, 2014; Uranium One, 2017e). Western wheatgrass, a secondary selenium indicator plant (USDA, 2006), was observed in all of the plant communities within the proposed project area. These indicator species, when grazed bylivestock, may produce toxic reactions known as selenium poisoning (WDEQ, 2014; USDA, 2006). Livestock grazing is a prevalent land use within the proposed project area (Uranium One, 2017e).

No federally threatened, endangered, or candidate plant species were observed during baseline vegetation surveys conducted for the Ludeman Project (Uranium One, 2011b). The U.S. Fish and Wildlife Service (FWS) Information for Planning and Conservation online tool (FWS, 2017a) indicated that Ute ladies'-tresses (*Spiranthes diluvialis*) and Western prairie fringed orchid *(Platanthera praeclara*), which are both federally-listed threatened plant species, have the potential to be affected by the proposed Ludeman Project. According to the FWS, the Western prairie fringed orchid is not known to occur in Wyoming (FWS, 2017d); however, downstream riverine habitats of the North Platte River in Nebraska could be adversely affected by water depletions in the North Platte River system resulting from project-related activities. However, as discussed in EA Section 3.4.3, water to be used in well-drilling operations would be obtained from sources within the Ludeman Project area that are not hydrologically connected to the North Platte River. Nine known occurrences of Ute ladies'-tresses have been reported in Wyoming, three being in northern Converse County in the Antelope Creek sub-basin (Heidel, 2007). Further, an assessment of suitable habitat for the Ute ladies'-tresses was conducted within the Ludeman Project area in August 2008 (Uranium One, 2017e). This species was not observed by BKS, although potentially marginal habitat for the Ute Ladies'-tresses occurs within the Ludeman site.

Wildlife

The licensee's contractor, Jones & Stokes Associates, Inc., conducted wildlife surveys of the Ludeman site in the summer and fall of 2008. The wildlife survey area includes the accessible portions of the Ludeman Project site and a 1.6-km [1-mi] buffer for raptor nests and Greater

sage-grouse leks, and a 0.8-km [0.5-mi] buffer for other species, including black-tailed prairie dog colonies and mountain plovers. No formal surveys were conducted for other wildlife species except for federally listed species and species of concern; however, observations were made of other wildlife during the wildlife surveys, including birds on the FWS Migratory Bird Species of Management Concern list for noncoal mine-related projects and the Bureau of Land Management (BLM) Vertebrate Sensitive Species list (Uranium One, 2011b).

Cottontails (*Sylvilagus* spp.), white-tailed jackrabbit (*Lepus townsendii),* thirteen-lined ground squirrel (*Spermophilus tridecemlineatus)*, black-tailed prairie dog (*Cynomys ludovicianus)*, deer mouse (*Peromyscus maniculatus*), coyote (*Canis latran*), pronghorn antelope (*Antilocapra americana*), and mule deer (*Odocoileus hemionus*), were the only mammalian species observed on the Ludeman site or within the 0.8-km [0.5-mi] buffer around the site during the 2008 surveys (Uranium One, 2017e). One dead swift fox (*Vulpes velox)* was observed east of the project area along State Highway 93, which appeared to have been struck by a vehicle. The swift fox is the only mammalian BLM sensitive species observed during baseline surveys. The Ludeman site and 0.8-km [0.5-mi] buffer lies within habitat designated by the WGFD as winter/yearlong and yearlong range for pronghorn and mule deer but is not considered crucial big game habitat (Uranium One, 2011b; NRC, 2011c). An occupied black-tailed prairie dog (*Cynomys ludovicianus*) (*Cynomys leucurus)* colony about 4.5 ha [11 ac] in size is present adjacent to the southern edge of the proposed Ludeman Project area (Uranium One, 2017e). Black-tailed prairie dog is a FWS species of concern in Converse County (FWS, 2017b).

The proposed project area provides habitat for a number of avian species during different life stages, including nesting and rearing of young. Over 40 species of birds were seen within the Ludeman Project area during the 2008 baseline wildlife surveys. Five BLM sensitive bird species were observed during the Ludeman Project baseline wildlife surveys: Loggerhead shrike (*Lanius ludovicianus),* ferruginous hawk (*Buteo regalis),* bald eagles *(Haliaeetus leucocephalus)*, burrowing owl *(Athene cunicularia)*, and Greater sage-grouse (*Centrocercus urophasianus*) (Uranium One, 2017e). Bald eagle and Greater sage-grouse are also FWS species of concern in Converse County (FWS, 2017a). Loggerhead shrikes*,* which nest in shrubs and low trees, were seen on several occasions during the summer in isolated trees throughout the Ludeman Project area (Uranium One, 2017e). Thirty-two intact raptor nests were observed within the project boundaries during baseline wildlife surveys either built by or used by great horned owl (*Bubo* virginianus), red-tailed hawk (*Buteo jamaicensis*), golden eagle (*Aquila chrysaetos)*, and ferruginous hawk; however, the majority of the nests belong to ferruginous hawks. Three bald eagles *(Haliaeetus leucocephalus)* were observed within 1.6 km [1 mi] to the south of the project area. No bald eagle winter roost sites are known to occur in or within 1.6 km [1 mi] of the proposed project area (Uranium One, 2011b; BLM, 2015a). Two adult burrowing owls were observed in the eastern portion of the Ludeman site, but no nests or nesting behavior was observed during baseline wildlife surveys. Greater sage-grouse (*Centrocercus urophasianus*) were not observed during the baseline wildlife surveys, and no leks are present within the 3.6 km [2 mi] of the proposed project area (Uranium One, 2017e; WGFD, 2016). Projects located within 3.2 km [2 mi] of an occupied lek outside core population areas or Priority Habitat Management Areas (PHMAs) are expected to follow Wyoming recommendations for avoiding and minimizing impacts. The nearest sage-grouse lek is approximately 4.4 km [2.75 mi] northwest of the proposed project area. The proposed Ludeman Project site is located outside the Greater sage-grouse core population areas, PHMAs, and connectivity areas (Mead, 2015).

As described in Section 3.4.1 of this EA, surface water at the proposed project site consists of two primary tributaries: (i) Little Sand Creek in the western portion of the project area, and

(ii) Sage Creek in the eastern portion. Two man-made irrigation ditches, Gilbert Ditch in the east and the Running Dutchman Ditch in the south, also pass through the project area. Numerous ephemeral drainages, stock tanks, and reservoirs occur in the project area. Surface water found in the Ludeman Project area is generally ephemeral and provides insufficient deep water to support aquatic species; however, there are downstream areas that provide suitable habitat for amphibians. The only amphibian that was encountered during surveys taken in the proposed project area was the boreal chorus frog *(Pseudacris triseriata).* One bullsnake *(Pituophis melanoleucas)* was observed in the western portion of the proposed project area, and dry land species such as the eastern shorthorned lizard *(Phrynosoma douglassi)* and prairie rattlesnake *(Crotalus viridis)* are likely to occur in the proposed project area. No fish were sampled or observed incidentally in the North Platte River during baseline wildlife surveys for the proposed project.

The FWS indicated that the proposed project, which is located within the Platte River System, may affect downstream populations of three bird species: (i) the endangered whooping crane (*Grus americana*), (ii) the endangered least tern (*Sterna antillarum*), and (iii) the threatened piping plover (*Charadrius melodus*); as well as one fish species, the endangered pallid sturgeon (*Scaphirhynchus albus*) (FWS, 2017b). As previously noted, no federally threatened, endangered, or candidate species, including these species, were observed during wildlife surveys conducted for the Ludeman Project (Uranium One, 2011b).

The whooping crane depends on wetlands, marshes, mudflats, wet prairies, and shallow portions of rivers and reservoirs, while the least tern and piping plover prefer gravel or beaches along rivers, and salt flats (PRRIP, 2016). The pallid sturgeon requires a firm sand bottom and strong currents in large, turbid rivers, which are not present within the Ludeman Project area. As indicated in Section 3.4.3, water to be used in well-drilling operations would be obtained from sources within the proposed Ludeman Project area that are not hydrologically connected to the North Platte River.

3.6 Meteorology, Climatology, and Air Quality

This section describes the meteorology, climatology, and air quality at and around the proposed Ludeman ISR Satellite Project. In addition, this section includes a discussion of climate change and greenhouse gases. The proposed Ludeman Project is located in the Wyoming East Uranium Milling Region, as defined in the GEIS (NRC, 2009). Although both the Willow Creek ISR Project and the proposed Ludeman Project are located in the Wyoming East Uranium Milling Region, they are located approximately 109 km [68 mi] apart following a straight line. Therefore, the information in EA Section 3.6 and Appendix B should be considered the initial presentation of the meteorology, climatology, and air quality for the proposed Ludeman Project rather than an update of information associated with the Willow Creek site.

3.6.1 Meteorology and Climatology

The proposed Ludeman ISR Satellite Project is located in a semiarid or steppe climate that is characterized seasonally by cold harsh winters, hot dry summers, relatively warm moist springs, and cool autumns. Summer nights are usually cool, although daytime temperatures may be quite high. The fall, winter, and spring can experience rapid changes with frequent variations from cold to mild periods.

The licensee established a weather station in the western portion of the Ludeman project area just to the east of the proposed satellite building and Wellfield 1. Information collected during the

baseline year from February 2014 through January 2015 at the onsite weather station included temperature, precipitation, wind speed, and wind direction. Onsite data were supplemented with data from National Weather Service meteorological stations located in the City of Douglas to provide a historical perspective. Tables B–7, B–8, and B–9 in EA Appendix B contain summary meteorological data from both the onsite and the City of Douglas weather stations. Douglas is located about 24.1 km [15 mi] southeast of the proposed project area. The representativeness of the long-term data collected at the Ludeman meteorological station is addressed in the NRC staff's safety analysis rather than the environmental analysis in this EA. The Douglas temperature and precipitation data were collected over a 30-year period from 1981 to 2010, while the wind speed and direction data were collected over a 10-year period from 2003 to 2012.

The average annual onsite temperature for the baseline year (i.e., February 2014 to January 2015) was 7.40°C [45.3°F], and the mean monthly temperature ranged from −7.35°C [18.8°F] in February to 21.6°C [70.9°F] in July (Uranium One, 2017a). Temperatures from the onsite and Douglas weather stations are similar with nearly identical annual values (EA Table B–7). The total annual onsite precipitation for the baseline year was 20.17 cm [7.94 in] (Uranium One, 2017a). The proposed Ludeman site received less precipitation during the baseline year than Douglas experienced on average over a 30-year period from 1981 to 2010 (EA Table B–8). The average annual onsite wind speed for the baseline year was 22.7 km/hr [14.1 mi/hr] (Uranium One, 2017a). The average annual and monthly winds experienced at the Ludeman site over the baseline year were higher than the 10-year average (i.e., 2003 to 2012) experienced at the Douglas site (EA Table B–9). The wind rose that Uranium One provided as Figure 3.6-18 of the revised ER (Uranium One, 2017e) shows that the predominant winds at the Ludeman site are from the west along with strong contributions from the west-northwest and west-southwest. From late spring to early fall, the Ludeman site experiences a strong secondary component from the east-southeast. Wind direction at the Douglas station follows a similar pattern to the onsite station, although with some slight distinctions. The predominant winds for the Douglas station are typically from the northwest rather than the west. Also, around summertime in Douglas, the winds from the southeast are actually stronger than the winds from the northwest.

As discussed in GEIS Section 3.3.6.1, pan evaporation rates for the Wyoming East Uranium Milling Region range from about 102 to 127 cm/yr [40 to 50 in/yr] (NRC, 2009). Pan evaporation rates can be used to estimate the evaporation rate of other bodies of water, such as lakes or ponds. The Ludeman meteorological station did not monitor for pan evaporation rates. Instead, onsite values for solar radiation, wind speeds, daily high/low temperatures, and daily high/low relative humidity were used to estimate the annual evapotranspiration at 152 cm [60 in] (Uranium One, 2017e). Evapotranspiration accounts for the transfer of moisture from the earth to the atmosphere by evaporation from the soil and other surfaces as well as transpiration from plants.

For the location of the proposed project, severe weather events mostly consist of either hail or damaging winds with an occasional tornado (Uranium One, 2017e). This section describes the occurrence of storm events for Converse County, as documented in the National Centers for Environmental Information Storm Events Database. The time periods for which data are available vary by storm event type. Events for the year 2015 were reported through August. Converse County experienced 100 hail storms from 1959 to 2015 (NOAA, 2015). The Storm Events Database records events for which the hail size was at least 1.9 cm [0.75 in] in diameter. This database reports two types of wind events for Converse County: (i) high winds and (ii) thunderstorm winds. High winds are defined as (i) sustained nonconvective winds of

64.4 kph [40 mph] or greater and lasting for 1 hour or longer or (ii) winds (sustained or gusts) of 93.3 kph [58 mph] for any duration on a widespread or localized basis. Thunderstorm winds are defined as (i) winds arising from convection (occurring within 30 minutes of lightning being observed or detected) with speeds of at least 93.3 kph [58 mph] or (ii) winds of any speed {nonsevere thunderstorm winds below 93.3 kph [58 mph]} producing a fatality, injury, or damage (e.g., damage from lightning, hail, and flash flooding). Converse County experienced 75 high-wind events from 2009 to 2015 and 19 thunderstorm wind events from 1984 to 2015 (NOAA, 2015). From 1955 to 2015, 41 tornadoes occurred in Campbell County (NOAA, 2015). Over this 60-year period, only one tornado was strong enough to be rated by the Fujita or Enhanced Fujita scale (F-scale) as an F2 (NOAA, 2015). Converse County experienced three flash floods between 1998 and 2015 (NOAA, 2015).

3.6.2 Air Quality

3.6.2.1 Nongreenhouse Gases

In 40 CFR Part 50, National Primary and Secondary Ambient Air Quality Standards, the EPA established the National Ambient Air Quality Standards (NAAQS) to promote and sustain healthy living conditions (GEIS Sections 1.7.2.2 and 3.3.6.2). Primary NAAQS are established to protect public health, and secondary NAAQS are established to protect public welfare by safeguarding against environmental and property damage. These standards define acceptable ambient air concentrations for six common air pollutants: (i) nitrogen dioxide (NO_2), (ii) ozone (O_3), (iii) sulfur dioxide (SO_2), (iv) carbon monoxide (CO), (v) lead (Pb), and (vi) particulates (PM_{10} and $PM_{2.5}$).

The EPA requires states to monitor ambient air quality and evaluate compliance with the NAAQS. Based on the results of these evaluations, EPA assigns areas to various NAAQS compliance classifications (e.g., attainment or nonattainment) for each of the six criteria air pollutants. These classifications characterize the air quality within a defined area. These defined areas range in size from portions of cities to large air quality control regions composed of many counties. An air quality control region is a federally designated area for air quality management purposes. The NAAQS attainment status for Wyoming is found in 40 CFR 81.351. The proposed Ludeman ISR Satellite Project is located in the Casper Intrastate Air Quality Control Region, which is made up of Converse, Fremont, and Natrona Counties, Wyoming. The Casper Intrastate Air Quality Control Region is classified as an attainment area for each criteria pollutant (40 CFR 81.351). Based on this attainment classification, the air quality in and around the proposed site is considered good.

EA Table 3-5 contains the pollutant concentrations that reflect the existing ambient air concentrations at the five WDEQ monitoring stations within 80.5 km [50 mile] of the proposed Ludeman ISR site. Not all stations are monitored for all pollutants. The nearest nonattainment area is the City of Sheridan, about 230 km [142.9 mi] northwest of the proposed Ludeman ISR Project area. The only other nonattainment area in Wyoming is the Upper Green River Basin located in Sublette County and portions of Lincoln and Sweetwater Counties. The Upper Green River Basin is about 280 km [174.0 mi] southwest from the proposed project area. The pollutant of concern in Sheridan is PM_{10}, whereas the pollutant of concern in the Upper Green River Basin is ozone.

Table 3-5. Ambient Air Quality Data for National Ambient Air Quality Standards (NAAQS) Pollutants from Monitoring Stations Inside the Region of Influence*

Pollutant†	Averaging Time	Units‡	Monitoring Station§	Monitoring Results Over a 3 Year Period‖		
				2014	2015	2016
Nitrogen Dioxide	1 hour	ppb	Antelope Site 7	na¶	34.9	29.9
			Casper - Gaseous	38.0	42.3	39.1
			Converse County	na	7.7	8.2
			Converse County - Mobile	23.6	23.6	na
Nitrogen Dioxide	Annual	ppb	Antelope Site 7	na	3	2
			Casper - Gaseous	4	5	4
			Converse County	na	0	0
			Converse County - Mobile	3	3	na
Ozone	8 hours	ppm	Casper - Gaseous	0.061	0.060	0.061
			Converse County	na	0.060	0.059
			Converse County - Mobile	0.059	0.060	na
Particulate Matter $PM_{2.5}$	24 hours	$\mu g/m^3$	Antelope Site 7	na	18.5	9.6
			Casper	14.1	14.7	11.0
			Converse County	8.0	9.9	na
Particulate Matter $PM_{2.5}$	Annual	$\mu g/m^3$	Antelope Site 7	na	4.2	2.8
			Casper	4.6	4.9	4.3
			Converse County	2.3	6.9	na
Particulate Matter PM_{10}	24 hours	$\mu g/m^3$	Casper	30	59	46
			Converse County	na	42	62
			Converse County - Mobile	36	71	na
Particulate Matter PM_{10}	Annual¶	$\mu g/m^3$	Casper	14	15	13
			Converse County	na	7	6
			Converse County - Mobile	8	8	na

Source: Modified from WDEQ (2017c)
*The region of influence is the 80-km [50 mi] radius around the proposed Ludeman site.
†Only those pollutants that were monitored by WDEQ at monitoring stations within the region of influence are listed in this table. No measurements were taken for carbon monoxide, lead, and sulfur dioxide at these monitoring stations.
‡ppm is parts per million; ppb is parts per billion; and to convert µg/m3 to oz/yd^3, multiply by 2.7×10^{-8}.
§Not all monitoring stations analyzed for all pollutants.
‖na stands for not available.
¶There is no longer an annual PM_{10} particulate matter NAAQS. This limit represents Wyoming's supplemental standard.

States may develop standards that are stricter or supplement the NAAQS. Wyoming has a supplemental particulate matter PM_{10} annual standard at 50 micrograms per cubic meter ($\mu g/m^3$) {1.35×10^{-6} ounce/cubic yard [oz/yd^3]} (WDEQ, 2016b). Compliance with this annual standard is determined by whether the 3-year average of the annual mean is below the

50 μg/m^3 threshold. The most recent 3-year time period of monitoring results (2013 to 2015) reveals that the entire state is in compliance with the PM_{10} annual standard (WDEQ, 2017c).

The locations of residences relative to the Ludeman site are illustrated in EA Figure 2-1. One residence is located within the project boundary about 0.80 km [0.50 mi] east of proposed Wellfield 2 and about 1.6 km [1 mi] east of the proposed satellite building (Uranium One, 2017e). The predominant wind direction would transport emissions from proposed Wellfields 1 and 2 as well as the proposed satellite building toward this one residence inside the project boundary. About a dozen residences in the Negley Subdivision are located next to the northwest corner of the proposed site, with the nearest one located 76.5 m [251 ft] from the boundary. Several of these residences located next to the northwest corner of the site boundary are closer to the proposed Wellfield 1, the satellite building, and the ponds than the single residence located within the proposed project boundary. Winds are also common from the east-southeast (EA Section B2). Winds from this direction would transport emissions from the satellite building, ponds, as well as Wellfields 1 and 2 toward the residences along the northwest corner of the site boundary.

The EPA also established Prevention of Significant Deterioration (PSD) thresholds (40 CFR 52.21), which place limits on the allowable increases in ambient pollutant levels above baseline conditions in attainment areas for nitrogen dioxide, particulate matter $PM_{2.5}$, particulate matter PM_{10}, and sulfur dioxide. Under this regulation, certain national park and wilderness areas are designated as Class I areas and provided the highest levels of protection. The rest of the country is designated as Class II areas and provided a lower level of protection. The proposed site is located in a Class II area. The nearest Class I area is Wind Cave National Park in South Dakota located about 193.1 km [120 mi] northeast of the proposed Ludeman site.

3.6.2.2 Greenhouse Gases and Climate Change

Based on assessments by the U.S. Global Climate Research Program (GCRP), the International Panel on Climate Change, and the National Research Council, the EPA administrator determined that greenhouse gas in the atmosphere may reasonably be anticipated to endanger public health and welfare (74 FR 66496). The Federal Register notice also states that these assessments indicate that ambient concentrations of greenhouse gases do not cause direct adverse health effects (e.g., respiratory or toxic effects), but rather cause indirect effects from the associated changes in climate. Based on the EPA's determination, the NRC recognizes that greenhouse gases may contribute to climate change and that climate change may have an effect on health and the environment.

Greenhouse Gases

Greenhouse gases, which can trap heat in the atmosphere, are produced by numerous activities, including the burning of fossil fuels and agricultural and industrial processes. Greenhouse gases include carbon dioxide (CO_2), methane, nitrous oxide, and certain fluorinated gases. These gases vary in their ability to trap heat and in their atmospheric longevity. Greenhouse gas emission levels are expressed as CO_2 equivalents (CO_2e), which is an aggregate measure of total greenhouse gas global warming potential described in terms of CO_2, and accounts for the heat-trapping capacity of different gases. Long-term carbon dioxide levels (extending back 800,000 years) have ranged between 170 and 300 ppm (GCRP, 2014). Present-day carbon dioxide concentrations are about 400 ppm, and GCRP estimates that by the end of the century these levels will range somewhere between 420 and 935 ppm (GCRP, 2014).

The EPA is promulgating rules to address greenhouse gas emissions under the Clean Air Act permitting programs. The EPA finalized a rule that used a phased approach and focused on the nation's largest stationary source greenhouse gas emitters (EPA, 2012). New and existing sources with the potential to emit 90,718 metric tons [100,000 short tons] per year of CO_2e, became subject to the EPA air permitting process. Modifications to facilities that increase greenhouse gas emissions by at least 68,039 metric tons [75,000 short tons] per year of CO_2e also became subject to the EPA air permitting process under the rule.

Climate Change

Temperature and precipitation are two parameters that can be used to characterize climate change. Average U.S. temperatures have increased between 0.72 to 1.06 °C [1.3 to 1.9 °F] since 1895, and temperatures in the U.S. are expected to continue to rise (GCRP, 2014). From 1991 to 2012, the average temperature in the region where the proposed Ludeman Project is located increased by up to 0.83 °C [1.5 °F] compared to the 1901 to 1960 baseline (GCRP, 2014). The average temperature in this region is projected to increase between 2.22 and 5.00 °C [4 and 9 °F] by the latter part of this century (GCRP, 2014). Average U.S. precipitation has increased since 1990; however, some areas in the U.S. experienced increases greater than the national average, while other areas experienced decreased precipitation levels. From 1991 to 2012, the annual precipitation totals in the region where the proposed Ludeman Project is located varied between −5 and 5 percent compared to the 1901 to 1960 baseline (GCRP, 2014). By the latter part of this century, GCRP forecasts a 0 to 10 percent decrease in precipitation during the summer and a 0 to 20 percent increase in precipitation for the fall, winter, and spring for this region (GCRP, 2014). The GCRP predicts increases in the frequency and intensity of extreme precipitation events for all regions of the United States. From 1958 to 2012, the amount of rain falling during the most intense one percent of storms has increased by 16 percent in the region where the proposed Ludeman Project is located (GCRP, 2014).

3.7 Noise

This section characterizes the noise sources at and in the area of the proposed Ludeman ISR Satellite Project. Because of the rural location of the proposed Ludeman ISR Satellite Project, the existing noise sources include county and local road traffic, livestock operations, and wind. The existing ambient noise within 3.2 km [2 mi] of the proposed project is dominated by traffic noise from State Highway 95 and 93 and surrounding oil and gas operations. The low population density of the area surrounding the proposed site location and lack of noise from existing sources form a generally low background noise level (Uranium One, 2017e).

In undeveloped rural areas of the Wyoming East Uranium Milling Region, existing ambient noise levels range from 22 to 38 decibels (dBA), depending on wind and traffic (NRC, 2009). The BLM (2012c) reported that levels of noise close to industrial facilities and transportation corridors in the PRB are likely to be in the range of 50 to 70 decibels (dBA). Rail lines running parallel to the North Platte River located south of the proposed project area but within the 3.2 km [2 mi] are used for shipping coal from mining operations in the PRB and are considered distant from the proposed project area. Noise levels ranging from 75 to 85 dBA are typical of a train traveling at approximately 80 kph [50 mph] on grade at a distance of 30 m [100 ft] (FRA, 2010).

Noise associated with the proposed activities is considered because it may affect persons residing in the surrounding area. The proposed satellite building is located approximately 0.8 km [0.5 mi] from the Negley Subdivision and approximately 1.6 km [1 mi] from the Leuenberger

Ranch house located within the proposed project area (EA Figure 2-1). The Leuenberger Ranch house is the only residence within the proposed project area, and 13 residences are located in the Negley Subdivision, which is within 3.2 km [2 mi] of the proposed project boundary (EA Section 3.1).

As described in EA Section 3.1.2, recreational activities in and around the proposed Ludeman site are limited. Parcels of state-owned land within the proposed project area have limited access, and, therefore, offer limited potential for recreational activities such as hunting. Nearby recreational attractions that could be sensitive to noise impacts include the Child's Cutoff, Fort Fetterman historic site, the Bozeman Trail, and similar sites. Child's Cutoff runs south of the proposed project boundary, and the Bozeman Trail crosses the proposed project boundary in small segments on the eastern boundary line. The Fort Fetterman site is located approximately 6.8 km [4.25 mi] southeast of the proposed Ludeman site and is not expected to be a noise receptor from project activities.

Noise associated with project activities can displace wildlife and interfere with wildlife breeding habits. As described in EA Section 3.5, the proposed project area supports many medium to small mammals (e.g., squirrels, cottontail, white-tailed jackrabbit, and coyote), over 40 varieties of avian species, and big game species (e.g., pronghorn antelope and mule deer). More information on the species and populations of wildlife within the proposed Ludeman ISR Satellite Project is provided in EA Section 3.5.

The Federal Highway Administration (FHWA) and the WYDOT have noise impact assessment procedures and criteria to help protect public health and welfare from excessive vehicular traffic noise. FHWA-established Noise Abatement Criteria are described in Table 3-6, according to land use, recognizing that different areas are sensitive to noise in different ways. A person is considered to be impacted by noise according to WYDOT procedures when existing or expected future sound levels approach [within 1 decibels (dBA)] or exceed the Noise Abatement Criteria or when expected future sound levels exceed existing sound levels by a substantial amount (15 dBA). These criteria were used to assess potential noise impacts at the proposed Ludeman ISR Satellite Project in EA Section 4.8.

Table 3-6. Noise Abatement Criteria: 1-Hour, A-Weighted Sound Levels in Decibels (dBA)

Activity Category	$L_{eq}(h)$*	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purposes.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	—	Undeveloped lands.
E	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

*$L_{eq}(h)$ is an energy-averaged, 1-hour, A-weighted sound level in decibels (dBA).
Source: 23 CFR Part 772

3.8 Cultural and Historical Resources

This section describes the historic properties that may be affected by the proposed Ludeman ISR Satellite Project. The National Historic Preservation Act (NHPA) requires federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places (NRHP). The criteria for eligibility are listed in 36 CFR 60.4 and include (A) association with significant events in history; (B) association with the lives of persons significant in the past; (C) embodiment of distinctive characteristics of type, period, or construction; and (D) sites or places that have yielded or are likely to yield important information (ACHP, 2012). The historic preservation review process (NHPA Section 106) is outlined in regulations the Advisory Council on Historic Preservation (ACHP) issued in 36 CFR Part 800, "Protection of Historic Properties."

The issuance of a source materials license or license amendment is a federal action (undertaking) that could affect either known or undiscovered historic properties located on or near the proposed Ludeman Project site. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the area of potential effect (APE). The APE for this review is an area that may be impacted by construction, operations, aquifer restoration, and decommissioning activities associated with the proposed action. If historic properties are present or affected, the NRC is required to document identification efforts and findings with the Wyoming State Historic Preservation Office (WY SHPO), and to assess and resolve possible adverse effects of the undertaking before proceeding with licensing. These efforts and findings are discussed in the next sections.

The Ludeman project encompasses approximately 7,633 ha [18,861 ac] of which 890 ha [2,200 ac] would be directly impacted by project activities. The potential for direct impacts is limited to the 890 ha [2,200 ac] area where proposed ground disturbing construction activities could occur. Indirect impacts are considered for the entire area within 3.2 km [2 mi] of the Ludeman Project.

3.8.1 Class III Cultural Resource Report

Between June and October 2008, Ethnoscience, Inc. of Billings, Montana, completed a Class III Cultural Resource Inventory for the Ludeman Project area. The inventory was conducted of 8,048 ha [19,888 ac], which includes approximately 421 ha [1,040 ac] of land within the Ludeman project area that are not going to be used by Uranium One (2010; Uranium One, 2015a). From this inventory, 26 prehistoric sites, 25 historic sites, and one multicomponent site were identified. Two previously recorded prehistoric sites and one previously recorded historic site within the Ludeman project area were not found during the inventory. In addition, 59 prehistoric isolates were recorded, which are not eligible for listing on the NRHP. A list of the prehistoric and historic sites within the Ludeman project area is provided in Table 3-7, including the three previously recorded sites that Ethnoscience, Inc. did not identify.

Forty of the sites were recommended not eligible for listing on the NRHP. Ethnoscience, Inc., stated that 10 sites required further investigation to ascertain eligibility status; thus, the NRHP eligibility recommendations for those sites were unevaluated.

A segment of the NHRP-listed historic Bozeman Trail (site 48CO0165) crosses the far eastern portion of the Ludeman Project site. Ethnoscience, Inc., stated that the segment of the trail within the project area was identified during the Class III survey; however, it did not retain sufficient integrity to be recommended as a contributing element of the larger Bozeman Trail.

Table 3-7. Prehistoric and Historic Sites Within the Proposed Ludeman Project Area			
Site ID	**Period**	**Site Type**	**NRHP Eligibility Recommendation***
48CO0165	Historic	Trail (Bozeman)	Eligible, non-contributing
48CO0393	Prehistoric	Culture material scatter	Not eligible
48CO0394	Prehistoric	Lithic scatter	Not eligible
48CO0398	Multicomponent	Stone feature	Not eligible
48CO0803	Historic	Farmstead (Leuenberger Ranch)	Unevaluated
48CO2492	Prehistoric	Lithic scatter	Not eligible
48CO2908	Historic	Telegraph line	Eligible, non-contributing
48CO3007	Prehistoric	Stone feature	Unevaluated
48CO3008	Prehistoric	Stone feature	Unevaluated
48CO3009	Prehistoric	Stone feature	Not eligible
48CO3010	Historic	Farmstead	Not eligible
48CO3011	Prehistoric	Stone feature	Not eligible
48CO3012	Historic	Depression, etc.	Not eligible
48CO3013	Historic	Farmstead	Not eligible
48CO3014	Historic	Farmstead	Not eligible
48CO3015	Historic	Farmstead	Not eligible
48CO3016	Historic	Windmill	Not eligible
48CO3017	Historic	Windmill	Not eligible
48CO3018	Prehistoric	Stone feature	Unevaluated
48CO3019	Prehistoric	Lithic scatter	Unevaluated
48CO3020	Prehistoric	Lithic scatter	Not eligible
48CO3021	Historic	Foundations	Not eligible
48CO3022	Historic	Depression	Not eligible
48CO3023	Historic	Windmill	Not eligible
48CO3024	Historic	Foundation	Not eligible
48CO3025	Prehistoric	Stone feature	Not eligible
48CO3026	Prehistoric	Stone feature	Not eligible
48CO3027	Historic	Windmill	Not eligible
48CO3028	Prehistoric	Stone feature	Not eligible
48CO3029	Prehistoric	Lithic scatter	Unevaluated
48CO3030	Prehistoric	Stone feature	Not eligible
48CO3031	Prehistoric	Culture material scatter	Not eligible
48CO3032	Prehistoric	Stone feature	Unevaluated
48CO3033	Prehistoric	Lithic scatter	Unevaluated
48CO3034	Historic	Farmstead	Not eligible
48CO3035	Prehistoric	Stone feature	Not eligible
48CO3036	Prehistoric	Stone feature	Eligible†
48CO3037	Prehistoric	Stone feature	Eligible†
48CO3038	Historic	Windmill	Not eligible
48CO3039	Historic	Stone feature, historic debris	Not eligible
48CO3040	Historic	Foundation, culture material scatter	Not eligible
48CO3041	Historic	Depression	Not eligible
48CO3042	Historic	Culture material scatter	Not eligible
48CO3043	Historic	Culture material scatter	Not eligible
48CO3044	Historic	Culture material scatter	Not eligible
48CO3045	Prehistoric	Stone feature	Not eligible
48CO3046	Prehistoric	Stone feature	Not eligible
48CO3047	Prehistoric	Stone feature	Not eligible
48CO3048	Prehistoric	Stone feature	Unevaluated
48CO3049	Historic	Culture material scatter	Not eligible
48CO3050	Historic	Cairn	Not eligible
48CO3275	Prehistoric	Lithic scatter	Not eligible

*SHPO concurrence for the previously recorded sites is not provided.
† SHPO eligibility concurrence provided on May 23, 2018 (WY SHPO, 2018a).

In addition, a segment of a previously recorded historic telegraph line (site 49CO2908) may occur within the Ludeman Project area; however, Ethnoscience, Inc. did not identify its location during the inventory. The telegraph line was previously recommended as eligible for listing on the NRHP. Because no evidence for this site was found during the Class III survey, Ethnoscience, Inc. recommended this site no longer exists within the survey area.

3.8.2 Section 106 Consultation

The NRC staff made a reasonable and good faith effort to identify Native American Tribes for inclusion in the Section 106 consultation process and to provide the identified Native American Tribes a reasonable opportunity to participate in the Section 106 consultation process, as required by 36 CFR 800.2(c)(2)(ii)(A).

The NRC staff initially contacted 22 Native American Tribes on August 8, 2012, to initiate consultation and request any information regarding cultural resources potentially affected by the proposed Ludeman project (EA Table A–1). Follow-up calls were made to the Tribes, and by January 25, 2013, 17 of the 22 Tribes had expressed interest in continued consultation, and 16 of those Tribes were interested in site tours and in-person meetings.

Following the NRC staff's requests for additional information (RAIs) and Uranium One's responses submitted between 2012 and 2015, the NRC staff transmitted the Class III Cultural Resource Survey to the Tribes on June 5, 2015 (EA Table A–1). A response to the Class III Survey report from the Northern Arapaho on June 17, 2015, noted concern that traditional cultural properties (TCPs) were not addressed as a resource type during the survey, in addition to concerns about the potential impacts to the three sites identified in the survey. The Northern Cheyenne Tribe expressed similar concerns about the lack of consideration of TCPs in a response on June 22, 2015.

Following receipt of Uranium One's revised amendment application in June 2017, the NRC staff resumed consultation with Native American Tribes in August 2017 and supplied a revised version of the Class III Cultural Resource Survey report and area of potential effects (APE) on September 19, 2017. Follow-up calls were made to Tribes on November 2 and 3, 2017, and a Tribal webinar was held on November 8, 2017, to discuss the proposed Ludeman project and the Class III Cultural Resource Survey findings. Webinar attendees included NRC staff, NRC contractors, representatives from Uranium One, and representatives of three Tribes: the Northern Cheyenne, Chippewa Cree, and Rosebud Sioux. Several Tribal members raised concerns regarding the importance of stone feature sites to Tribes, the limited nature of testing conducted during the Class III Cultural Resource Survey, and the lack of testing prior to making "Not Eligible" recommendations for the stone feature sites. All three Tribes expressed interest in a site visit, which had been previously scheduled for November 14, 2017.

Follow-up calls were conducted on November 13, 2017, and the site visit was held in Casper, Wyoming, at the proposed Ludeman project site on November 14, 2017. Representatives from one tribe, the Northern Cheyenne, were able to attend, in addition to NRC staff and contractors and representatives from Uranium One and their consultants. Following a morning meeting in which the project and report were discussed, a field visit to five stone feature sites was conducted, including 48CO3036 and 48CO3037, which are within the direct APE. Tribal members noted that additional stone features were present on site in addition to several surface artifacts. Tribal members expressed interest in the stone feature sites identified during the Class III Cultural Resource Survey and expressed their desire that they be avoided by any direct impacts of the proposed project. By letter dated December 8, 2017, the NRC staff requested

that the Northern Cheyenne Tribe document their concerns in writing regarding the eligibility of sites visited as well as any preferred avoidance buffer. The Northern Cheyenne Tribe provided the requested comments and recommendations in a letter dated February 23, 2018. The Northern Cheyenne Tribe stated that both sites 48CO3036 and 48CO3037 are of significance to the Tribe and, therefore, recommended that both sites be determined eligible for listing on the NRHP under Criteria A and D due to their association with past events and their potential to yield information significant to prehistory. As a result of these comments, the NRC submitted revised site information and determinations that the two sites are eligible for listing on the NRHP under Criteria A and D to the WY SHPO on March 23, 2018 (NRC, 2018c). The WY SHPO concurred with the NRC's determinations of eligibility for sites 48CO3036 and 48CO3037 (WY SHPO, 2018a). The cultural resource sections of this document were posted to the NRC's public webpage on June 5, 2018, for public comment consistent with 36 CFR 800.4(d)(1). The 17 of the 22 Tribes that expressed interest in continued consultation (EA Table A–1) were notified that the document was available for comment. The comment period ended on July 5, 2018. No comments were received. On July 9, 2018, NRC sent the WY SHPO its determination of no effect (NRC, 2018d). The WY SHPO concurred with the NRC findings on July 17, 2018 (WY SHPO, 2018b).

3.9 Visual and Scenic Resources

This section provides a description of the visual and scenic resources that are applicable to the proposed Ludeman ISR Satellite Project. BLM evaluates the scenic or visual quality of the land it manages using the Visual Resource Inventory to assess the scenic value of a property and ensure that its value is preserved (BLM, 1986). Although private land is not required to be managed to protect scenic quality, public lands are inventoried and evaluated. The BLM Casper Field Office has inventoried the visual resources of all lands within the boundaries of the Casper Field Office, including private lands, with the Visual Resource Management (VRM) system (BLM, 2007). In compiling the inventory, BLM completed a scenic quality evaluation, a sensitivity-level analysis, and a delineation of distance zones for properties; each property or area is assigned to one of four VRM classes (BLM, 1984). Class I is most protective of visual and scenic resources, and Class IV is least restrictive. The key factors of landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modifications were evaluated and scored according to the rating criteria. The criteria for each key factor range from high- to moderate-to-low quality, based on the variety of line, form, color, texture, and scale of the factor within the landscape. A score was associated with each rating criteria, with a higher score applied to greater complexity and variety for each factor in the landscape.

Within the proposed project area, the landscapes are characterized by a flat to rolling topography with small ephemeral drainages and large, open upland grassland mixed with sagebrush shrubland. According to the GEIS (NRC, 2009), the proposed project area does not contain any Class I resources. There are few Class II resources listed within the Wyoming East Uranium Region with some Class III and Class IV resources within the project area and in the surrounding area (Uranium One, 2013a). The survey area for visual resources includes the proposed project area, a 3.2-km [2-mi] buffer, and a 40-km [25-mi] buffer. The BLM has inventoried the landscape in the proposed project area and the surrounding 3.2-km [2-mi] area and rated the areas as either VRM Class III or IV (Uranium One, 2011b). The results of the acreages of VRM classifications that the BLM inventoried are summarized in Table 3-8.

Table 3-8. VRM Classifications by Acreages for the Proposed Ludeman ISR Satellite Project and Surrounding Area			
VRM Classification Acreages			
Class	Within the Proposed Project Boundary	3.2 km [2 mi]	40 km [25 mi]
I	0	0	0
II	0	0	121,006
III	7,725	34,908	515,358
IV	11,125	27,741	1,039,069
Source: Uranium One, 2017e			

In 2008, the licensee conducted a field reconnaissance of visual resources to rate the scenic quality inventory of the Ludeman Project area based on methods provided in the BLM (1986) Manual—Visual Resource Inventory. The key factors of landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modifications were evaluated and scored according to the rating criteria. The scenic quality inventory is in EA Table 3-9.

Based on guidance provided in NUREG–1569 (NRC, 2003a), if the visual resource evaluation rating is 19 or less, no further evaluation is required. The field reconnaissance conducted in 2008 had a total score of 11 out of 32 for the scenic quality inventory of the proposed project area (Uranium One, 2017e). Therefore, under the NUREG–1569 guidance, no further evaluation is required for existing scenic resources.

Table 3-9. Scenic Quality Inventory and Evaluation		
Key Factor	Rating Criteria	Score
Landform	Flat to rolling terrain with some areas of steeper topography with large gullies cutting up to ridge lines. These areas are interesting but not dominant.	2
Vegetation	The majority of the site has very little variety in vegetation, which consists of grazed grassland with sage and other shrubs. There are a few large trees present on the site which offer some variety in form.	2
Water	Water is present and generally not evident as viewed from residences and roads, except for Gilbert Lake, which is visible from State Highway 93. The WYDOT 2007 traffic count for State Highway 93 at its intersection with State Highway 95 was 50 vehicles per day; therefore, exposure is minimal.	3
Color	Vegetation and soil colors have some subtle color variations but generally shift from green tones in the spring to tan tones throughout the remainder of the year.	2
Influence of adjacent scenery	Adjacent scenery is very similar to the proposed project area and provides no variety in line, form, color, and texture.	0
Scarcity	Landscape is common for the region.	1
Cultural modifications	Existing modifications consist of oil and gas production facilities and infrastructure, windmills and solar powered pumps, and one residence. The Bozeman Trail is present on private land near Gilbert Lake but is not visible to the general public.	1
Total		11
Source: Uranium One, 2017e		

3.10 Socioeconomics

This section describes current socioeconomic conditions and local community services within the region of influence (ROI) surrounding the proposed Ludeman ISR Satellite Project area that may be directly or indirectly affected by the proposed project activities. The socioeconomic ROI is defined as the area where employees and their families would reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. General socioeconomic factors associated with this region are described in GEIS Section 3.3.10 (NRC, 2009). Given that most employees would reside near the ISR facility, the greatest potential for socioeconomic impacts is likely to occur within 48 km [30 mi] of an ISR facility (NRC, 2009). The proposed project is located in a rural portion of south Converse County, Wyoming. Communities with the greatest potential for socioeconomic impacts from the proposed project are listed in EA Table 3-10. Within a 48-km [30-mi] radius of the proposed Ludeman Project site, the population is centered in the Wyoming communities of Glenrock and Douglas in Converse County and Casper and its surrounding communities in Natrona County. The communities of Rolling Hills and Orin in Converse County, and Meadow Acres, Homa Hills, Antelope Hills, Casper Mountain, Red Butte, Mills, Vista West, Bar Nunn, Evansville, and Brookhurst in Natrona County are also located within 48 km [30 mi] of the proposed Ludeman Project site. These communities have public services, such as schools, churches, medical care facilities, and commodities. Additional workers are expected to come from smaller communities within an 80-km [50-mi] radius of the proposed project site, including Lost Springs, Bessemer Bend, Edgerton, Midwest, Esterbrook, and Glendo, each with total populations between 4 and 404 people (NRC, 2009; USCB, 2017). Portions of southern Campbell County, western Niobrara County, northern Albany County, and southeast Johnson County are within an 80-km [50-mi] radius of the proposed project site, but there are no populated areas with available census data. Casper is the largest city in the region and is expected to be an important source of equipment, supplies, services, and workers.

In their amendment application, the licensee described demographics, income, housing, employment structure, local finance, education, and health and social services within the ROI (Uranium One, 2017e). The NRC staff reviewed the licensee's data and reviewed the most recently available census data. The populations of Converse and Natrona Counties grew between the census years 2000 and 2010 by about 15 and 13 percent, respectively (USCB, 2017). The population of Platte County declined about 1.5 percent. Growth forecasts in the region are uncertain because anticipating changes in the energy industry, which is a significant source of population growth in the region, is challenging (KLJ, 2014). Based on regional experience, the development of energy-related resources generally increases populations in or near incorporated cities and towns (Converse County, 2015).

Persons self-identified as minority individuals in Converse and Natrona Counties in 2010 composed between 8 and 11 percent of the population, respectively. Campbell and Platte Counties also have about 8 and 9 percent minority individuals, respectively. The 2010 minority populations in Albany and Carbon Counties (16.8 and 15.2 percent, respectively) are the highest of the 8 counties that are completely or partially within 80 km [50 mi] of the Ludeman ISR Project boundary, while Johnson and Niobrara Counties have the lowest minority percentages (3.2 and 5.0, respectively). The population of the State of Wyoming includes 5.2 percent minority individuals (USCB, 2017).

Table 3-10. Communities Within an 80-km [50-mi] ROI of the Proposed Ludeman ISR Satellite Project					
				Population Projections	
State/County/City	2000 Census	2010 Census	Percent Change 2000/2010	2020	2030
State of Wyoming	493,782	563,626	14.14	622,360	668,830
Converse County	12,052	13,833	14.78	15,950	17,270
Douglas	5,288	6,120	15.73	7,057	7,641
Glenrock	2,231	2,576	15.46	2,970	3,216
Rolling Hills	449	440	−2.00	507	549
Orin	121*	NA	NA	NA	NA
Lost Springs	1	4	300	5	5
Esterbrook	32	52	62.5	NA	NA
Natrona County	66,533	75,450	13.40	82,490	88,320
Casper	49,644	55,316	11.43	60,477	64,752
Meadow Acres	181	198	9.39	NA	NA
Homa Hills	214	278	29.91	NA	NA
Antelope Hills	88	97	10.23	NA	NA
Casper Mountain	298	401	34.56	NA	NA
Red Butte	439	449	2.28	NA	NA
Vista West	1,008	951	−5.65	NA	NA
Bar Nunn	936	2,213	136.43	2,419	2,590
Mills	2,591	3,461	33.58	3,784	4,051
Evansville	2,255	2,544	12.82	2,781	2,978
Brookhurst	192	185	−3.65	NA	NA
Edgerton	169	195	15.38	213	228
Midwest	408	404	−0.98	442	473
Bessemer Bend	170	199	17.06	NA	NA
Platte County	8,807	8,667	−1.59	8,780	8,880
Glendo	229	205	−10.48	208	210

Sources: WDAI, 2011; USCB, 2017
NA = Data not available
*Population estimate for 2006-2010 (2010 census total population data is not available)

The NRC staff reviewed the most recent estimates (2009 to 2013) for median household income and per capita income in Converse and Natrona Counties, both of which were above the Wyoming average. The percentage of families and individuals living below the poverty level in Converse and Natrona Counties is less than the percentage of families and individuals living below the poverty level in the State of Wyoming. The percentage of families living below the poverty level in the State of Wyoming is 7.7 percent, and the percentage of individuals living below the poverty level in the State of Wyoming is 11.5 percent (USCB, 2017). Employment in the mining industry in Converse County jumped from 2001 to 2013, accounting for 70 percent of the nonservice-related personal income and 30 percent of all personal income in 2013. In Natrona County, these numbers are slightly lower at 60 percent and 20 percent, respectively. In both counties, the mining industry is the largest nongovernment employer, followed by health care and social services in Natrona County, and transportation and warehousing in Converse County. Government is the third largest overall employer in the two counties followed by construction, which accounts for 8 to 9 percent of all labor categories (WDAI, 2015).

The NRC staff reviewed housing data for the 21 communities within 80 km [50 mi] of the proposed Ludeman ISR Satellite Project listed in EA Table 3-10 and found that, based on U.S. Census Bureau (USCB) 5-year estimates between 2009 and 2015, approximately 35,000 housing units exist, which include single-family homes, multifamily housing, mobile homes, and rental units. Of those, approximately 32,000 units or 91 percent were occupied and approximately 3,100 units or 9 percent were vacant.

Wyoming has a 4 percent sales tax. Wyoming does not impose a corporate income tax or personal income tax; therefore, local governments largely rely on property tax collections (WDOR, 2015). Converse and Natrona Counties have a 5 percent total sales and use tax (4 percent state tax and 1 percent general use county option tax). The majority of the property tax revenues are directed to Wyoming's public schools. The approximate 2015 taxable valuation for all State and locally assessed property in Converse and Natrona Counties was $1.83 billion and $1.46 billion, respectively (WDOR, 2015). From 2014 to 2015, the amount of total property taxes collected increased about 29 percent for Converse County and about 4 percent for Natrona County. The sharp increase in property taxes collected in Converse County is partly attributed to the value of mineral production that is taxed, which increased by $371 million between 2014 and 2015 (WDOR, 2015). Property taxes collected from all property types increased 29 percent between 2014 and 2015. Uranium One estimates that the proposed Ludeman ISR Satellite Project will generate approximately $17.2 million in state and local taxes over the life of the project (Uranium One, 2017e).

Converse and Natrona Counties, where the NRC staff and the licensee assume most workers and their families would reside during the life of the proposed Ludeman Project, encompass three school districts: (i) Converse County School District (CCSD) 1, (ii) CCSD 2, and (iii) Natrona County District 1. Natrona County District 1 is the largest, with 36 schools that serve about 12,859 students in the City of Casper and surrounding towns of Alcova, Bar Nunn, Edgerton, Evansville, Mills, Midwest, and Powder River (NCSD, 2015). CSSD 1 is second largest with a total of 10 schools (5 rural schools, 3 primary/elementary schools, 1 middle school, and 1 high school), and CSSD 2 is smallest with a total of 4 schools (2 elementary/rural, 1 middle/intermediate school, and 1 high school) (CCSD, 2017a,b).

Health care facilities in Converse and Natrona Counties include Memorial Hospital of Converse County in Douglas, the Oregon Trail Rural Health Clinic in Glenrock, and three facilities located in Casper, which are Wyoming Medical Center, Summit Medical Center, and Mountain View Regional Hospital. The hospitals offer a wider range of specialties and functions compared to the more restricted range of services offered by medical centers. Private and public municipal services offered to citizens in the two-county area include electricity, natural gas, water, wastewater treatment, and waste disposal.

3.11 Public and Occupational Health

This section describes the background radiation levels at and around the proposed Ludeman ISR Satellite Project. Background radiation levels for the Willow Creek Project where the licensee proposes to process the uranium-loaded resins extracted from the proposed Ludeman Project wellfields were previously described in the Willow Creek license renewal EA and supplemental EA (NRC, 2011c; NRC, 2013a) and are not further described here. The background radiation levels at the proposed Ludeman project area are known as "preoperational" or "baseline" radiological conditions and support the evaluation of environmental impacts. Additionally, unless otherwise noted, the baseline levels would be used by the NRC staff for evaluating any future changes to site conditions during operations and

potential reclamation obligations during eventual decontamination and decommissioning of the proposed Ludeman Project. This section also describes applicable safety criteria and radiation dose limits that have been established for protection of workers and the public.

Radiation dose is a measure of the amount of ionizing energy that is deposited in the body. Ionizing radiation is a natural component of the environment and ecosystem, and members of the public are exposed to natural radiation continuously. Radiation doses to the general public occur from radioactive materials found in the Earth's soils, rocks, and minerals. Radon-222 is a radioactive gas that escapes into ambient air from the decay of uranium (and its progeny, radium-226) found in most soils and rocks. Naturally occurring low levels of uranium and radium are also found in drinking water and foods. Cosmic radiation from outer space is another natural source of exposure and ionizing radiation dose. In addition to natural sources of radiation, there are artificial or manmade sources that contribute to the dose the general public receives. Medical diagnostic procedures using radioisotopes and x-rays are a primary manmade radiation source. The National Council on Radiation Protection and Measurements (NCRP) (NCRP, 2009) estimates the annual average dose to the public from all natural background radiation sources (terrestrial and cosmic) is 3.1 millisieverts (mSv) [310 milliroentgen equivalent man (mrem)]. Due to the increase in medical imaging and nuclear medicine procedures, the annual average dose to the public from all sources (natural and human made) is 6.2 mSv [620 mrem] (NCRP, 2009).

Baseline Radiological Conditions

In accordance with NRC regulations in 10 CFR Part 40, Appendix A, Criteria 7 and 7A, the licensee developed and implemented a preoperational monitoring program to establish baseline radiological conditions at the proposed Ludeman Project (Uranium One, 2017d). For this program, the licensee performed radiological surveys and sampling of soils, air, and biota at the site in 2008, then supplemented or revised surveys, as applicable, in response to NRC requests for additional information. The licensee followed guidance in NUREG–1569 (NRC, 2003a,b; NRC, 1982; NRC, 1980), as applicable (Uranium One, 2017d). Results of this baseline radiological monitoring are summarized in the following paragraphs.

Surface soil gamma radiation measurements at the Ludeman Project ranged from 2.3 to 12.7 nC/kg [8.9 to 49.1 μR/hr] with a mean of 3.97 nC/kg [15.4 μR/hr] (Uranium One, 2017d). An additional survey of land areas that were subsequently added to the proposed action in 2013 produced similar results (Uranium One, 2017d). For comparison, the preoperational background gamma radiation exposure measured at the proposed Highland-2 satellite of the Smith Ranch ISR facility {approximately 10 km [6 mi] north of the proposed Ludeman Project} ranged from 3.4 to 6.7 nC/kg [13 to 26 μR/hr] (NRC, 2007). While the range of gamma measurements at the proposed Ludeman Project included larger variation and some higher values, the licensee reported that less than 1 percent of the survey area had readings above 6.4 nC/kg [25 μR/hr] (Uranium One, 2017d). The licensee found statistically significant correlations between elevated gamma readings and measured soil concentrations of radium-226 and uranium.

The surface soil sampling {to a depth of 5 cm [2 in]} found that average concentrations of uranium, radium-226, thorium-230, and lead-210 were less than 0.037 becquerels per gram (Bq/g) [1.0 picocuries per gram (pCi/g)] with the exception of the average lead-210 concentration of 0.6 Bq/g [1.6 pCi/g] near the site of proposed wellfield 3 (Uranium One, 2017d). The NRC staff considers these results to be within the range of expected natural background radioactivity.

The subsurface soil sampling {to a depth of 0.1 m [0.3 ft]} found the average concentrations of uranium, radium-226, thorium-230, and lead-210 for all depth ranges were less than or equal to 0.06 Bq/g [1 pCi/g] (Uranium One, 2017d). The NRC staff considers these results to be within the range of expected natural background radioactivity.

The drainage basin sediment sampling found that the average concentrations of uranium, radium-226, and thorium-230 concentrations were within the range of expected background concentrations. Average lead-210 sediment concentrations were somewhat elevated at 0.11 Bq/g [3.0 pCi/g]. Uranium and lead-210 both had maximum values of 0.27 and 0.23 Bq/g [7.4 and 6.3 pCi/g], respectively, that were above natural background values. The licensee noted that the sediment results were higher when compared with measured surface soil concentrations but could not explain the reason for increased variability in the sediment sampling (Uranium One, 2017d). The NRC staff consider that the larger variability of radionuclide concentrations in drainages may be the result of drainage basins collecting runoff and deposition from broad areas of soil or that the increased erosion in drainages may expose and erode natural uranium outcrops.

The quarterly radon-222 air sampling found that the airborne radon-222 concentration ranged from 11 to 270 becquerels per cubic meter (Bq/m^3) [0.3 to 7.4 pCi/L], with an annual average of 30 Bq/m^3 [0.8 pCi/L] (Uranium One, 2017d). For comparison, the measured annual average radon concentration (outdoors) at the proposed Ludeman Project was below the average annual indoor radon concentration of 48 Bq/m^3 [1.3 pCi/L] for Wyoming, as well as the EPA safety standard for indoor radon of 150 Bq/m^3 [4 pCi/L] (EPA, 2005). Only the maximum quarterly measurement taken in the western portion of the site (near areas of elevated measured gamma radiation measurements) was above the EPA indoor safety standard.

The quarterly ambient gamma dose rate measurements ranged from 0.09 µSv/hr [0.009 mrem/hr] to 0.15 µSv/hr [0.015 mrem/hr] (Uranium One, 2017d). The licensee noted that the results are generally consistent with the exposure measurements from the surface soil gamma survey. For context, the NRC staff calculated that the dose that would result if an average adult individual were exposed to this dose rate during the annual time spent outdoors (the product of the dose rate and the exposure time) would range from 0.15 mSv [15 mrem] to 0.26 mSv [26 mrem]. This calculation is based on 281 minutes per day of adult outdoor time (EPA, 2011), which converts to 1,710 hr/yr (i.e., 281 min/day/60 min/hr × 365.25 days/yr). As previously noted, the annual average dose to the public from all natural background radiation sources (terrestrial and cosmic) is 3.1 mSv [310 mrem] (NCRP, 2009). The terrestrial radiation contribution to this annual average natural background dose is 0.19 mSv [19 mrem] (NCRP, 2009). Therefore, the NRC staff has determined that the measured Ludeman Project ambient gamma dose rate is within the range of the expected background dose rate.

The licensee's quarterly air particulate monitoring found that all airborne concentrations of uranium, radium-226, thorium-230, and lead-210 were well below the 10 CFR Part 20 effluent concentration limits (Uranium One, 2017d).

The monthly surface water sampling measurements from 26 sampling locations found that average concentrations of uranium, thorium-230, radium-226, polonium-210, and lead-210 in surface waters were below EPA MCLs (65 FR 76708); however, five sampling locations had individual measurements of uranium and combined radium-226 and radium-228 that exceeded EPA MCLs of 30 mg/m^3 [30 µg/L] and 180 Bq/m^3 [5 pCi/L], respectively (Uranium One, 2017d). The maximum surface water concentrations included uranium at 123 mg/m^3 [123 µg/L], radium-226 at 180 Bq/m^3 [5 pCi/L], and radium-228 at 110 Bq/m^3 [2.9 pCi/L]. The licensee noted

that the highest surface water uranium concentration occurred at the location where elevated uranium was measured in sediments (Uranium One, 2017d). The licensee hypothesized and the NRC staff also find that localized areas of elevated uranium and radium around the site (as indicated by gamma survey, soil sampling, and sediment sampling results) are likely contributing to the variability in measured surface water radionuclide concentrations. Additional information about surface water resources is provided in EA Section 3.4.1.

The quarterly regional baseline groundwater quality sampling of 34 wells in and adjacent to the proposed wellfields found that site average concentrations of uranium, thorium-230, and polonium-210 in groundwater were below EPA MCLs (65 FR 76708), while the site average radium-226 concentrations of 4.92 kilobecquerel per cubic meter (kBq/m^3) [133 pCi/L] and lead-210 of 529 Bq/m^3 [14.3 pCi/L] were above the EPA MCLs of 180 Bq/m^3 [5 pCi/L] for radium and 0.04 mSv [4 mrem] for beta/photon radioactivity [equivalent to 37 Bq/m^3 or 1 pCi/L lead-210, based on a drinking water dose calculation that assumes water consumption at the rate of 2 L/d for 365 days per year and Federal Guidance No. 11 dosimetry (EPA, 1988)]. Several sampling locations had individual measurements of uranium, combined radium-226 and radium-228, and lead-210 that exceeded the EPA MCLs {30 mg/m^3 [30 µg/L] uranium, 180 Bq/m^3 [5 pCi/L] combined radium-226 and radium-228, 0.04 mSv [4 mrem] or 37 Bq/m^3 [1 pCi/L] lead-210} (Uranium One, 2017d). The maximum measured groundwater concentrations included uranium at 267 mg/m^3 [267 µg/L], radium-226 at 55.1 kBq/m^3 [1,490 pCi/L], and lead-210 at 7.88 kBq/m^3 [213 pCi/L]. The licensee reported that the elevated groundwater concentration reflected pre-existing conditions in the production zone aquifer and that none of the monitoring wells underlying or overlying the productions zone had measured concentrations of the sampled radiological constituents that exceeded the EPA MCLs (Uranium One, 2017d). The NRC staff note that high concentrations of uranium and its decay products are commonly encountered in ore zone aquifers at proposed ISR sites during preoperational sampling. Additional information about groundwater resources is provided in Section 3.4.2.

Vegetation samples taken from six sampling locations distributed across the proposed site area showed average uranium, thorium-230, radium-226, polonium-210, and lead-210 concentrations of 4.4, 2.4, 8.5, 5.9, and 48 millibecquerel per gram (mBq/g) [0.12, 0.065, 0.23, 0.16, and 1.3 pCi/g], respectively (Uranium One, 2017d). These plant concentrations are less than the average measured surface soil concentrations for these radionuclides by approximately an order of magnitude or less. An exception is lead-210, for which measured plant concentrations were approximately equal to average surface soil concentration results. Lead-210 concentrations in the vegetation samples were significantly higher than the other radionuclides and may be due to the higher relative abundance of lead-210 in air particulates from radon decay products. No fish sampling was conducted based on the lack of available habitat (Uranium One, 2017d).

Public Health and Safety

Regarding the protection of public health and safety, the NRC has the statutory responsibility, pursuant to the Atomic Energy Act of 1954, as amended by the Uranium Mill Tailings Radiation Control Act (UMTRCA), to protect the public health and safety and the environment. The NRC's regulations at 10 CFR Part 20 specify annual dose limits to members of the public of 1 mSv [100 mrem] total effective dose equivalent (TEDE) with no more than 0.02 mSv [2 mrem] in any 1-hr period from any external sources. This public dose limit from NRC-licensed activities is a fraction of the background radiation dose, as discussed previously.

A review of the surrounding area indicated that there are several ISR facilities within 80 km [50 mi] of the proposed Ludeman Project area (Uranium One, 2017e):

- Smith Ranch—this operational ISR facility is located approximately 9 km [6 mi] northwest of the proposed Ludeman Project.
- Highland Ranch—this operational satellite ISR facility is located approximately 10 km [6 mi] north of the proposed Ludeman Project.
- Reynolds Ranch—this licensed but not operating satellite ISR facility is located approximately 17km [11mi] north of the proposed Ludeman Project.
- Moore Ranch—this licensed but not operational ISR facility is located approximately 68 km [42 mi] northwest of the proposed Ludeman Project.
- Reno Creek—this licensed but not operational ISR facility is located approximately 80 km [50 mi] north of the proposed Ludeman Project.

Several inactive and decommissioned conventional uranium mills are within the 80-km [50-mi] radius. However, because of their relative distances, none of these projects are considered to represent an appreciable source of radiation exposure in and around the proposed Ludeman Project. Therefore, the natural background represents the primary source of radiation exposure to individuals in the area surrounding the proposed Ludeman Project. The Dave Johnston Power Plant, located approximately 10 km [6 mi] east of Glenrock {approximately 13 km [8 mi] southeast of the proposed Ludeman Project}, produces electricity from coal. The plant is operated under a WDEQ permit and is a major source of emissions of particulate matter, particulate matter less than 10 micrometers [0.0004 in] in diameter, sulfur dioxide, nitrogen oxides, carbon monoxide, and hazardous air pollutants (WDEQ, 2008). Coal plant air emissions are known to contain small quantities of radioactive material that naturally occurs in coal; however, previous analyses have shown that these air emissions are a small percentage of the average background radiation dose (USGS, 1997). There are no other major sources of nonradioactive, chemical releases to the atmosphere or water-receiving bodies in the immediate area surrounding the proposed project area.

The public health in a region is commonly assessed by reviewing health studies conducted in the region over a period of time. Neither the licensee nor the NRC staff identified health studies about radiological and chemical exposures in the vicinity of the proposed project area.

Occupational Health and Safety

Regarding the protection of workers, the occupational health and safety concerns and protections that apply to the proposed Ludeman Project would be the same as those previously considered in the Willow Creek license renewal EA and supplemental EA (NRC, 2011c; NRC, 2013a) because the proposed activities would be similar (i.e., the construction, operation, aquifer restoration, and decommissioning of the facilities and production units).

Radiation Protection Standards at 10 CFR Part 20 set limits on the annual radiation dose to workers and incorporate the principal of maintaining doses “as low as is reasonably achievable” (ALARA), taking into consideration the purpose of the licensed activity and its benefits, technology for reducing doses, and the associated health and safety benefits. The annual occupational dose limit is the more limiting of two calculated dose equivalents: (i) 0.05 Sieverts

(Sv) [5 rem] TEDE and (ii) the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, of 0.5 Sv [50 rem]. The lens of the eye is limited to a dose equivalent of 0.15 Sv [15 rem], and the skin (of the whole body or any extremity) is limited to a shallow dose equivalent of 0.5 Sv [50 rem]. Radiation safety measures that comply with these 10 CFR Part 20 standards must be implemented at ISR facilities to protect workers and to ensure that radiation exposures and doses are below the occupational limits and are ALARA.

Industrial hazards and exposure to nonradioactive pollutants present potential occupational health and safety concerns, which for an ISR operation can include common industrial airborne pollutants associated with service equipment (e.g., vehicles), fugitive dust emissions from access roads and wellfield activities, and various chemicals used in the ISR process. Industrial safety aspects associated with the use of hazardous chemicals at the proposed Ludeman Project will be regulated by the State of Wyoming. The types of chemicals and impacts are discussed in EA Section 4.12.

3.12 Waste Management

This section describes the environment that could potentially be affected by the disposition of liquid and solid waste streams generated by the proposed project. The analysis of waste management impacts is located in EA Section 4.13.

Liquid wastes generated from the proposed Ludeman ISR Satellite Project would include well development and well test waters, stormwater, sanitary wastewater, and liquid byproduct material. As described in Chapter 2, the licensee would dispose of drilling fluids in mud pits adjacent to drilling pads (Uranium One, 2017e). Additionally, the NRC staff expects that the licensee would discharge well development water from constructed wellfields, in accordance with a WDEQ Wyoming Pollutant Discharge Elimination System (WYPDES) permit. The licensee proposes to manage stormwater in accordance with a WDEQ WYPDES permit and stormwater pollution prevention plan (Uranium One, 2017e). The licensee proposes to dispose of sanitary wastewater from restrooms and lunchrooms in a WDEQ-permitted septic system (Uranium One, 2017e).

Under the Uranium One's preferred liquid waste management option (EA Section 2.1.7), the licensee proposes to manage liquid byproduct material using a combination of evaporation and permeate ponds, and discharge of treated effluent generated from groundwater restoration activities to surface water, as described in Chapter 2. Uranium One plans to treat aquifer restoration water by reverse osmosis to meet surface water quality standards and store the treated restoration water in permeate ponds prior to surface water discharge (Uranium One, 2017e). The treatment approach would generate solid byproduct material that would be sent to a licensed disposal facility. These proposed activities would be subject to new or revised NRC license SUA–1341 conditions and WDEQ state permitting requirements.

Under Uranium One's proposed liquid waste management Options 1 and 2 (EA Section 2.1.7), the licensee proposes use of up to six WDEQ-permitted Class I DDWs to dispose of liquid byproduct material during operations and aquifer restoration (Uranium One, 2017e). Uranium One proposes to locate these Class I DDWs adjacent to planned production wellfields predominantly along planned trunk line routes (Uranium One, 2017e). The licensee expects to inject radionuclide-bearing liquid waste streams into subsurface geologic formations (bounded by the Lance and Parkman Formations) at depths ranging from 1,400 to 3,000 m [4,500 to 10,000 ft] below the ground surface (Uranium One, 2017e). Before the Class I deep

disposal wells can be operated, the licensee must obtain a permit from WDEQ that authorizes drilling, completion, and operation of the wells. Additionally, an aquifer exemption must be identified and requested by WDEQ and approved by EPA for the aquifer (or portion thereof) that is the discharge zone for the disposal well.

Solid wastes generated either directly or indirectly from the proposed Ludeman ISR Satellite Project would include solid byproduct material, nonhazardous solid waste, and hazardous waste.

Solid byproduct material (including radioactively contaminated soils or other media) that does not meet NRC unrestricted release criteria must be disposed at a licensed facility, as required by 10 CFR Part 40, Appendix A, Criterion 2. As described in Chapter 2, the proposed action would generate solid byproduct material that does not meet NRC criteria for unrestricted release. Prior to operating, the licensee commits to having an agreement in place for receiving byproduct material generated by the proposed Ludeman ISR Satellite Project (Uranium One, 2017e). Having a disposal agreement in place ensures the availability of sufficient disposal capacity for solid byproduct material. The licensee has identified the Pathfinder Mines Corporation, Shirley Basin facility in Carbon County, Wyoming, as the disposal location for solid byproduct material (Uranium One, 2017e). The Shirley Basin facility is a former uranium mill site located approximately 56 km [35 mi] south of Casper.

All proposed phases of the Ludeman ISR Satellite Project would directly or indirectly generate nonhazardous solid waste. The licensee has proposed to dispose of nonhazardous solid waste offsite in a WDEQ-permitted municipal landfill (Uranium One, 2017e). Uranium One intends to use the nearest municipal landfill, which is the Glenrock Area Solid Waste Disposal Facility {approximately 4.8 km [3 mi]} west of the proposed Ludeman ISR Satellite Project site. This landfill accepts construction and demolition nonhazardous solid waste for disposal and operates as a transfer station for other nonhazardous solid wastes, such as municipal solid waste (e.g., common household trash). If any nonhazardous solid waste is not accepted at Glenrock, the licensee proposes to ship the material to a large regional nonhazardous solid waste landfill located near Casper, Wyoming, in Natrona County (Uranium One, 2017e), approximately 47 km [29 mi] west of the proposed Ludeman ISR Satellite Project area. The volume of waste the Casper landfill receives annually is over 90,662 t [100,000 T], based on previously reported values (Wyoming Office of State Lands and Investments, 2007). The NRC staff converted that annual rate of waste received to a volume of 191,280 m^3 [250,000 yd^3] by applying a density factor of 0.36 t/m^3 [0.4 T/yd^3] (Wyoming Office of State Lands and Investments, 2007). In 2010, the permitted capacity of the Casper landfill was 317,000,000 m^3 [414,000,000 yd^3] of compacted solid waste, and the life expectancy was over 1,000 years (Uranium One, 2010).

The licensee would develop and implement waste management programs to meet the applicable WDEQ Solid and Hazardous Waste Division regulatory requirements. All wastes generated from these materials would be handled and disposed in accordance with applicable federal and state regulations.

4 ENVIRONMENTAL IMPACTS

4.1 Introduction

The Ludeman In Situ Recovery (ISR) Satellite Project is a proposed expansion of the Willow Creek (WC) ISR Project, for which Uranium One originally received a license in 1978 (named, at the time, the Irigaray site). The Christensen Ranch Satellite site was added to the license in 1988. The currently proposed Ludeman ISR Satellite Project is a distinctly separate area that was not analyzed by U.S. Nuclear Regulatory Commission (NRC) staff in previous Willow Creek license renewals. Unlike other NRC analyses of ISR expansion areas that are located close to an existing licensed ISR project, the distance between the licensed Willow Creek Project areas, combined with the lack of previous detailed analysis of the Ludeman ISR Satellite area, generates the need for NRC staff to conduct a site-specific impact analysis as part of this Environmental Assessment (EA). Based on the licensee's revised amendment application documents, the NRC staff anticipates that the proposed liquid waste management options described in EA Chapter 2 can be reasonably evaluated in this chapter for each resource area. For more information about the impact assessments for the Willow Creek ISR Project, see "Final Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SUA–1341 for Uranium One USA, Inc. Irigaray and Christensen Ranch Projects (Willow Creek Project) Wyoming" (NRC, 2011c) and "Supplemental Environmental Assessment, License Renewal Application Source Material License SUA–1341, Uranium One USA, Inc., Willow Creek *In Situ* Recovery Project Johnson and Campbell Counties, Wyoming" (NRC, 2013a).

This chapter analyzes the four lifecycle phases of ISR uranium extraction (i.e., construction, operations, aquifer restoration, and decommissioning) for the proposed Ludeman ISR Satellite Project (or, the proposed project) for the resource areas described in Chapter 3 of this EA and with consideration of the liquid waste management options discussed in EA Section 2.1.7. The resource areas described in this chapter include

- land use
- transportation
- geology and soils
- water resources
- ecology
- meteorology
- climatology and air quality
- noise
- historic and cultural resources
- scenic and visual resources
- socioeconomics and environmental justice
- public and occupational health
- waste management practices

The liquid waste management options proposed by the licensee would need to comply with all applicable regulatory requirements and address any license conditions that result from the NRC staff's safety evaluation. Therefore, some of the waste management options discussed in this EA may be more or less likely to be pursued by the licensee prior to construction of the proposed Ludeman ISR Satellite Project. However, to provide for a full analysis of the licensee's amendment application, the NRC staff has evaluated Uranium One's proposed action, including

the different liquid waste management options described in EA Section 2.1.7. The NRC staff also evaluated impacts from the No-Action Alternative.

The analysis in this chapter focuses on potential impacts for each resource area under Uranium One's preferred liquid waste management option (EA Section 2.1.7). Because impacts are similar among all three of Uranium One's liquid waste management options, a summary describing impacts under Options 1 and 2 and how those options may affect the impacts in each resource area is also provided in EA Table 4-1. In addition, NRC staff assumes that licensee commitments (including mitigation measures) discussed in this chapter would apply, as appropriate, to all of the licensee's proposed liquid waste management options included in the proposed action. As stated in Chapter 2, Uranium One has committed to a number of mitigation measures in its amendment application that will be made binding through a license condition.

The NRC established a standard of significance for assessing environmental impacts in the conduct of environmental reviews based on the Council of Environmental Quality (CEQ) regulations, as described in the NRC guidance in NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs" (NRC, 2003b) and summarized as follows:

SMALL: The environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource considered.

MODERATE: The environmental effects are sufficient to alter noticeably but not destabilize important attributes of the resource considered.

LARGE: The environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource considered.

In 40 CFR 1508.9, the CEQ defines an EA as a concise public document that briefly provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact (FONSI). As previously stated in EA Chapter 2, although impacts may exist, they may not be significant. An impact that is not significant does not equate to no impact in NUREG–1748 (NRC, 2003b).

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project*		
Land Use (Section 4.2)		
Preferred Option	**Option 1**	**Option 2**
Approximately 372 hectares (ha) [920 acres (ac)] of land would be disturbed. Greatest disturbances would be during construction. Approximately 533 ha [1,318 ac], or 7 percent of the project area, would not be accessible to livestock for grazing. Impacts during all phases would be SMALL.	Approximately 376 ha [930 ac] of land disturbed, which is an increase of approximately 4 ha [10 ac] or 0.02 percent of the project area. Largest land disturbance would occur among the liquid waste management options, but remains less than Generic Environmental Impact Statement (GEIS) impact analysis. An additional 2.8 ha [7 ac], or 0.04 percent, of the project area would not be accessible to livestock for grazing. Impacts during all phases would be SMALL.	Land area disturbed is less than the preferred option and Option 1 {approximately 344 ha [849 ac]}. More land would be available for livestock for grazing compared to the preferred option and Option 1. Impacts during all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Transportation (Section 4.3)		
Preferred Option	**Option 1**	**Option 2**
151 worker vehicles traveling to and from the site daily during construction (SMALL impact); 41 vehicles during operations (SMALL impact); aquifer restoration and decommissioning impacts would be less than construction and SMALL. Impacts from worker vehicles during the first year of construction phase on State Route 93 would be MODERATE; impacts during other phases would be SMALL. Environmental impacts of operational hazardous chemical and radiological materials shipments would be SMALL.	More shipments of construction supplies to install deep disposal wells. Magnitude of commuting workers, supply shipments, and waste shipments as well as the associated hazards and risks are not expected to change significantly. Wells are drilled by small crews using portable drilling rigs; therefore, the additional transportation activities are considered minor. Impacts for all phases would be considered comparable to the preferred option (e.g., SMALL except for MODERATE conclusion for traffic impacts to State Route 93 during the first year of construction)	Somewhat less traffic due to fewer workers, fewer construction materials and supplies needed, and less infrastructure material for disposal than for preferred option or Option 1. Impacts for all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Geology and Soils (Section 4.4)		
Preferred Option	**Option 1**	**Option 2**
The potential impact from earthquake hazards during all phases would be SMALL. Impact on geologic resources from subsidence and well usage during construction, operations, and aquifer restoration phases would be SMALL. The risk of contaminant release from an earthquake during all phases is SMALL. Impacts on site geology during all phases would be SMALL. Approximately 372 ha [920 ac] of soil, or less than 5 percent of the project area, would be disturbed. Impacts on soils during all phases would be SMALL.	The addition of up to six deep disposal wells (DDWs) would not change the expected earthquake hazards; thus, the potential impact from earthquake hazards during all phases would be SMALL. No significant change from preferred option; thus, impacts on geologic resources for all phases would be SMALL. The addition of up to 6 DDWs would disturb an additional 4 ha [10 ac] of soil from construction of the well pads and pipelines, or an increase of 1 percent relative to the preferred option; no additional disturbance during operations. Mitigation measures for the preferred liquid waste management option would remain; therefore, no significant increase in potential impacts on soils. Soil Impacts during all phases would be SMALL.	No significant change from preferred option or Option 1, thus geologic impacts during all phases would be SMALL. Approximately 344 ha [849 ac] of soil would be disturbed, which is approximately 8 percent less than the disturbance from the preferred option and approximately 9 percent less than the disturbance from Option 1. Impacts to soils would be less than the preferred option and Option 1. Impacts on soil during all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Water Resources-Surface Water (Section 4.5)		
Preferred Option	**Option 1**	**Option 2**
Stormwater runoff would be routed away from structures, roads, and ponds. Injection, production, and monitoring wells would be protected from flooding. Surface water discharges of treated groundwater restoration permeate are via a Wyoming Pollutant Discharge Elimination System (WYPDES) permit issued by the Wyoming Department of Environmental Quality (WDEQ). WYPDES permit requirements would limit impacts to surface water bodies, streams, and wetlands. Evaporation ponds permeate ponds would be designed to meet the safety and engineering design standards set forth under the Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, Appendix A, Criteria 4(a), 4A, and 5E, and WDEQ Rules and Regulations, Chapter 11, for lined wastewater storage ponds. Impacts to surface water and wetlands during all phases would be SMALL.	Land disturbance would increase by approximately 4 ha [10 ac] or 0.05 percent of the project area compared to the preferred option. The same permit requirements, mitigation measures, and design criteria to avoid and minimize the impacts to surface water and wetlands as for preferred option. WDEQ issues an Underground Injection Control (UIC) permit to drill, complete, and operate up to six Class I DDWs; wells would be subject to permitting requirements to protect surface waters. Impacts to surface water and wetlands from all phases would be SMALL.	Less land would be disturbed than from the preferred liquid waste management option and Option 1. All relevant permit requirements, mitigation measures, and design criteria to avoid and minimize the impacts to surface water and wetlands would be the same as Option 1. Surge ponds would meet the safety and engineering design standards set forth 10 CFR Part 40, Appendix A, Criteria 4(a), 4A, and 5E, and WDEQ Rules and Regulations, Chapter 11, for lined wastewater storage ponds. Operational stability, surveillance, inspection, and testing of the surge ponds would meet the recommendations of NRC Regulatory Guide 3.11.1 (NRC, 2008). Impacts to surface water and wetlands during all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Water Resources-Groundwater (Section 4.5)		
Preferred Option	**Option 1**	**Option 2**
Wellfields would be developed under a WDEQ-administered Class III UIC program that regulates the design and construction of injection, production, and monitoring wells. A WDEQ-approved Mechanical Integrity Test (MIT) program would be implemented for all wells prior to use. Evaporation ponds and permeate ponds would be double-lined and designed following NRC regulatory guides and WDEQ regulations. Surface water discharge of treated groundwater restoration permeate would occur via a WYPDES permit issued by the WDEQ. All private wells which are determined to be completed in the wellfield production zone within the monitoring well ring would be plugged and abandoned. A monitoring network would be designed and installed that is capable of detecting both horizontal and vertical excursions from the production zone. Impacts to groundwater resources during all phases would be SMALL.	All the same permit requirements, mitigation measures, and design criteria under the preferred option to develop wellfields, manage liquid waste, and avoid and minimize the impacts to groundwater resources. DDWs developed for some liquid waste management would target the Lance Formation through the Teckla-Parkman Formation at depths of approximately 1,372 to 3,048 m [4,500 to 10,000 ft]. Elevated concentrations of various constituents exceed Wyoming Class I, II, or III standards; thus, it is unlikely that these units would ever be underground sources of drinking water. WDEQ would issue a UIC permit to drill, complete, and operate up to six Class I DDWs; wells would be subject to permitting requirements to protect groundwaters. Impacts to groundwater resources during all phases would be SMALL.	All permit requirements, mitigation measures, and design criteria to avoid and minimize the impacts from the wellfields to groundwater resources are the same as the preferred option and Option 1. As described for Option 1, DDWs would target formations that are unlikely to be used for underground sources of drinking water. Requirements for UIC permit and surge ponds would be the same as Option 1. The surge ponds would be required to meet the safety and engineering design standards set forth in 10 CFR Part 40, Appendix A, Criteria 4(a), 4A, and 5E and WDEQ Rules and Regulations, Chapter 11, for lined wastewater storage ponds. Impacts to groundwater resources during all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Ecology (Section 4.6)		
Preferred Option	**Option 1**	**Option 2**
The total amount of vegetation and habitat disturbed during all phases would be approximately 372 ha [920 ac], or 5 percent, of the entire permit area. Greatest impacts would be during construction, but remains less than GEIS impact analysis and would be SMALL. Impacts to vegetation and wildlife from construction activities would be SMALL. Impacts during operations and aquifer restoration phases would be similar to or less than the construction phase and SMALL. Impacts during aquifer restoration phase would be similar to impacts during operation phase and SMALL. Site-specific decommissioning phase activities are similar to those activities evaluated in the GEIS and would be SMALL. There would be no effect on federally listed or candidate species or their critical habitat during any phase.	An additional 4 ha [10 ac] of vegetation and habitat would be disturbed, which is an increase of 1 percent compared to the preferred option. Impacts from construction remains less than GEIS impact analysis and would be SMALL. The DDWs and associated infrastructure would not contribute additional vegetation disturbance during the operations phase, and impacts would remain SMALL. Impacts during aquifer restoration would remain similar to those during the operations phase – SMALL. Impacts from decommissioning activities (including revegetation and removal of fencing that disturbs habitat), would be similar to those under the preferred option– SMALL. No effect on federally listed or candidate species or their critical habitat during any phase.	The amount of vegetation and habitat disturbances would be approximately 344 ha [849 ac], which is 8 percent less than the preferred option and 9 percent less than Option 1. No additional disturbances from evaporation ponds or surface water discharge. Impacts during all phases would be SMALL. No effect on federally listed or candidate species or their critical habitat during any phase.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Air Quality (Section 4.7)		
Preferred Option	**Option 1**	**Option 2**
Impacts during all phases would include nonradiological air emissions of nongreenhouse gasses. Peak year emissions, the highest amount of emissions and the greatest potential impacts, would occur in project year 5 and would be SMALL.	Increased fugitive dust and combustion emissions would be generated relative to the preferred option due to additional land clearing and well drilling. The increase in emissions remains lower than the peak year emissions, which occur in project year 5 Peak year emissions would be the same as for the preferred option and, therefore, would be SMALL.	Less fugitive dust and combustion emissions generated relative to the preferred option and Option 1 due to less land clearing. Peak year emissions would still occur in project year 5, and would be the same as the preferred option and would be SMALL.
Noise (Section 4.8)		
Preferred Option	**Option 1**	**Option 2**
Noise levels would be highest during construction, with a decrease during subsequent phases. Noise levels would return to background levels at distances more than 305 m [1,000 ft] from the noise-generating activities. Impacts during all phases would be SMALL.	Noise generated during the installation of DDWs and associated infrastructure would not increase the overall noise level compared to the preferred option. Noise levels would be highest during construction, with a decrease during subsequent phases. Impacts during all phases would be SMALL.	Overall noise-generating activities would be less than the preferred option and Option 1. Noise levels would be highest during construction, with a decrease during subsequent phases. Impacts during all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Historic and Cultural Resources (Section 4.9)		
Preferred Option	**Option 1**	**Option 2**
Construction activities have the potential to directly affect four archaeological sites, but two sites have been recommended not eligible to be listed on the National Register of Historic Places (NRHP), and two sites that are eligible for listing on the NRHP will be avoided; therefore, impacts would be SMALL and there would be no impact to the eligible sites. Mitigation measures (inadvertent discovery plan) would be enacted. No sites would be directly impacted by operations, aquifer restoration, and decommissioning. Impacts during all phases would be SMALL.	The footprint for construction, operation, and decommissioning is slightly larger than under the preferred option, but no archaeological sites are within proximity to the deep water disposal wells. Mitigation measures (inadvertent discovery plan) would remain in place similar to the preferred option and would apply to all ground disturbing activities. Impacts during all phases would be SMALL.	Impacts are the same as those evaluated under Option 1. Mitigation measures (inadvertent discovery plan) would remain in place similar to the preferred option and would apply to all ground disturbing activities. Impacts during all phases would be SMALL.
Visual and Scenic Resources (Section 4.10)		
Preferred Option	**Option 1**	**Option 2**
Impacts would be greatest from construction of the evaporation and permeate ponds, satellite building, and ancillary structures, but remain less than GEIS impact analysis. Impacts would not change during operations or aquifer restoration phases. Impacts during decommissioning would be less than during the construction and operations phases. Impacts during all phases would be SMALL.	An increase of 4 ha [10 ac] of land that would be visually disturbed for well pads and buried pipelines. Additional impacts would not be significant compared to the preferred option. Impacts during all phases would be SMALL.	Fewer impacts would occur compared to the preferred option and Option 2 due to less disturbed land. Impacts during all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Socioeconomics and Environmental Justice (Section 4.11)		
Preferred Option	**Option 1**	**Option 2**
Peak annual employment is 151 workers, which is less than GEIS impact analysis. Greatest impacts would be during construction phase but remain less than GEIS impact analysis. Impacts during all phases would be SMALL.	No additional workers would be needed for drilling up to six deep disposal wells and associated infrastructure, and no additional changes in population would occur beyond those anticipated for the preferred option. No significant differences from the preferred option would occur regarding income, housing needs, health care, schools, or other services. No changes in tax revenues would occur compared to the preferred option. Impacts during all phases would be SMALL.	No additional workers would be needed and no additional changes in population would occur compared to the preferred option and Option 1. No change in socioeconomic characteristics compared to preferred option and Option 1. Impacts during all phases would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Public and Occupational Health (Section 4.12)		
Preferred Option	**Option 1**	**Option 2**
Public and occupational health impacts during construction are comparable to those considered previously in the Willow Creek (WC) In Situ Recovery (ISR) Project licensing review. Impacts on workers and the general public during construction would be SMALL. Occupational health impacts during operations are comparable to those considered previously in the Willow Creek ISR Project licensing review. Radiological impacts to workers and the public during operations would be SMALL. Operational radiological accident risks would be less than what was previously evaluated for the Willow Creek ISR Project. Overall radiological impacts from accidents would be SMALL. Nonradiological impacts during normal operations and accidents would be SMALL. Impact on public and occupational health and safety during aquifer restoration and decommissioning phases are similar to those considered previously in the Willow Creek ISR Project licensing review and would be SMALL.	Development of DDWs would be contingent on WDEQ permitting, U.S. Environmental Protection Agency (EPA) aquifer exemption determinations, and NRC determination regarding compliance with waste disposal standards. Based on the need to comply with the DDW permits and requirements, public and occupational health impacts from the disposal of liquid byproduct material using up to six deep Class I deep disposal wells would be SMALL. Impacts during construction, operation, aquifer restoration, and decommissioning phases would be similar to the impacts evaluated under the preferred option and would be SMALL.	Impacts due to use of DDWs during construction, operation, aquifer restoration, and decommissioning phases would be the same as the impacts evaluated under the preferred Option 1 and would be SMALL. Other public and occupational impacts associated with the use of evaporation ponds in the preferred option and Option 1 would not occur; therefore, overall impacts would be less than Option 1 and would be SMALL.

Table 4-1. Comparison of Uranium One's Liquid Waste Management Options for the Ludeman ISR Satellite Project* (Continued)		
Waste Management (Section 4.13)		
Preferred Option	**Option 1**	**Option 2**
Impact on waste management from constructing the proposed project would be SMALL. Impacts on waste management during operations from the disposal of solid byproduct material would be SMALL. Impacts from waste management activities on nonhazardous and hazardous solid waste management resources during operations would be SMALL. Impacts on waste management from the use of evaporation ponds and surface water discharge during the aquifer restoration phase would be SMALL. Other waste streams produced during aquifer restoration, including solid byproduct material, nonhazardous solid waste, and hazardous waste would involve volumes and disposition similar to, or less than, the operation phase, and impacts would therefore be SMALL. Impacts to waste management resources during the decommissioning phase would be SMALL for all waste materials.	Development of DDWs would be contingent on WDEQ permitting, EPA aquifer exemption determinations, and NRC determination regarding compliance with waste disposal standards. DDWs would sufficiently accommodate the estimated maximum production of liquid byproduct material during all phases. Because only small volumes of additional waste would be generated during decommissioning by the use of DDWs, the additional solid byproduct material that would be generated from pipelines and well materials would not significantly affect the waste management conclusions determined previously for the preferred option. Impacts during all phases would be SMALL.	Development of DDWs would be contingent on WDEQ permitting, EPA aquifer exemption determinations, and NRC determination regarding compliance with waste disposal standards. The use of DDWs with surge ponds would sufficiently accommodate the estimated maximum production of liquid byproduct material during all phases. No evaporation ponds or surface water discharge would be used to manage liquid byproduct material; the minor waste management resource impacts attributed specifically to evaporation pond and surface water discharge facilities and related activities evaluated previously for Uranium One's preferred option would not occur; therefore, impacts are less than those for Option 1 for all phases and are SMALL.

*All of Uranium One's proposed liquid waste management options are part of the proposed action.

4.2 Land Use

The analysis in this section evaluates the land use impacts for the proposed action during each phase of the proposed ISR facility life cycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. The land use impacts associated with the No-Action Alternative are also evaluated in this section.

Under the proposed action, potential environmental impacts to land use at the Ludeman ISR Satellite Project site may occur during all phases of the facility lifecycle. As described in the NRC's Generic Environmental Impact Statement (GEIS) (NRC, 2009, Section 4.3.1), impacts could include (i) land disturbance associated with construction, operations, and decommissioning activities; (ii) grazing and access restrictions; (iii) altering ecological, cultural, and historical resources; and (iv) competing access for mineral rights (e.g., leasing of land for both uranium and oil and gas exploration and development). The NRC staff concluded in the GEIS that, depending on the phase of the facility life cycle, potential impacts on land use in the Wyoming East Uranium Milling Region could range from SMALL to LARGE (NRC, 2009). The impact conclusions that contributed to a greater than SMALL impact finding in the GEIS addressed potential alterations to ecological, historical, and cultural resources. The following discussion assesses land use impacts at the proposed Ludeman ISR Satellite Project site considering proposed land disturbances and associated access restrictions that could limit grazing activities, recreational activities, or other mineral extraction activities.

As described in EA Section 3.1, the proposed Ludeman ISR Satellite Project area covers approximately 7,632 hectares (ha) [18,861 acres (ac)]. The total potential land disturbance would be approximately 372 ha [920 ac] because of the construction of the satellite building, wellfields, ancillary buildings, booster stations, header houses, access roads, trunk lines, evaporation ponds, and permeate ponds (Uranium One, 2017e). Land within the proposed project area would be converted temporarily from its primary use as rangeland to use as an ISR facility, with facilities constructed and wellfields brought into production over time (i.e., a phased approach, EA Chapter 2). At the end of ISR operations, final site reclamation would occur during decommissioning, and all lands would be returned to their current land use.

Approximately 1.8 ha [4.6 ac] of land would be disturbed because of the construction of the satellite building and associated ancillary buildings and structures (e.g., offices, a parking area, a septic area, and laydown areas). The estimated footprint for the total disturbed area associated with the Ludeman satellite facility includes all fenced areas. An additional 37 ha [91 ac] of land (including fenced areas) would be disturbed related to wastewater treatment and disposal using evaporation ponds and groundwater permeate ponds (including surface water discharge points) (Uranium One, 2017e). Additional livestock access restrictions of approximately 494.5 ha [1,222 ac] of land because of the development (and fencing) of wellfields would exclude livestock from grazing. The total livestock restriction accounts for approximately 533 ha [1,318 ac], or 7 percent, of the total proposed project area. In addition, surface owners would be compensated for the temporary loss of grazing area. All land within the proposed project area is privately owned; therefore, as discussed in EA Section 3.1.2, hunting and any other recreational activities are limited inside the proposed project boundary (Uranium One, 2017e). All hunting would be restricted during the life of the proposed project (Uranium One, 2017e).

Some land use impacts are associated not only with the construction phase but all phases of the proposed project; these include access restrictions associated with access roads, livestock access restrictions, and restrictions on recreational activities (e.g., hunting). During construction, these activities would have a minimal impact on erosion (Uranium One, 2017e). Land disturbance caused by the construction of access roads would be minimized by using existing roads within the proposed project area. To ensure minimal land use is impacted if new roads are needed, the construction designs for the roads would consider how to best optimize parameters such as drainages, elevation contours, location, and land rights. Access roads would be controlled by fencing and signage, and any surface land disturbance would be reseeded. All constructed access roads would be reclaimed during decommissioning, or ownership would be transferred to the landowner. In addition, Uranium One has committed to using common corridors for the locations of access roads, pipelines, and utilities as practicable (Uranium One, 2017e). Wellfield construction would include well development, pipeline construction, header house construction, and lateral pipeline placement. Uranium One would construct up to six wellfields in a phased approach. The land disturbance associated with the wellfields would be approximately 309 ha [764 ac], with a total fenced area of 494.5 ha [1,222 ac]. Pipeline construction (e.g., trunk lines and feeder lines) would include surface disturbance activities, such as topsoil stripping, trenching, backfill, topsoil replacement, and reseeding, and would impact approximately 19 ha [47 ac] of land (Uranium One, 2017e).

Because the potential land use impacts from construction of the proposed Ludeman ISR Satellite Project would not exceed those impacts previously evaluated in the GEIS, and because the mitigation measures described would limit impacts on land use, the NRC staff concludes that the construction impacts on land use impacts (including constructing a satellite building, wellfields, pipeline and access road construction, and access restriction for grazing and hunting) from the proposed action under Uranium One's liquid waste management option would be SMALL.

Potential land use impacts during operations would be expected to be less than those for construction because the impacts from operations would include continued access restrictions for the wellfields and access roads and restriction of hunting. However, no additional land disturbance would occur from conducting operational activities; therefore, the NRC staff concludes that land use impacts during operations would be SMALL.

The proposed aquifer restoration activities at the proposed Ludeman ISR Satellite Project would use the same infrastructure as during the operations phase and would, therefore, be similar to operational impacts. As aquifer restoration proceeds and wellfields are closed, fewer wells and header houses would be used and onsite activities would diminish. No additional land disturbances or uses of additional land outside of the proposed permit area would occur during the aquifer restoration phase. Aquifer restoration activities make use of evaporation ponds, permeate ponds and/or associated surface water discharge points, which would have been constructed prior to this phase of the project. Therefore, the NRC staff concludes that land use impacts from aquifer restoration would be SMALL.

During the Ludeman ISR Satellite Project decommissioning phase, the area previously disturbed from the wellfields and access roads (those not taken over by the land owner) would progressively decrease. After ISR production activities are completed, the wellfields and all disturbed areas would be reclaimed and potentially approved for livestock grazing by the Wyoming Department of Environmental Quality (WDEQ)–Land Quality Division (LQD). If approved by WDEQ, the project-related fencing would be removed, forage production would return as permanent vegetation is re-established, and livestock grazing would be allowed in

accordance with the approved reclamation standards (Uranium One, 2017e). Land would be reseeded and soil replacement would occur primarily where the header houses and roads were removed (Uranium One, 2017e). Because wellfield land would be reclaimed, access roads released or ownership transferred, and vegetation would be re-established in reclaimed areas, the NRC staff concludes that the impacts on land use from decommissioning at the Ludeman ISR Satellite Project would be SMALL.

Under the No-Action Alternative, the Ludeman ISR Satellite Project would not be licensed, and there would be no associated construction, operation, aquifer restoration, or decommissioning; therefore, the land would remain available for uses such as grazing and oil and gas production. No wells would be drilled; no pipeline would be laid; and no new access roads would be constructed. Access restrictions would continue to be in place because state-owned plots of land will not be readily accessible, because they are surrounded by private land, where owner permission for access must be obtained.

4.3 Transportation

The impact analysis in this section evaluates the potential transportation impacts from the preferred liquid waste management option during each phase of the proposed Ludeman ISR Project lifecycle. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. The No-Action Alternative is also analyzed for comparison. As described in GEIS Section 4.3.2, potential transportation impacts at an ISR facility may occur during all phases of the facility lifecycle. Impacts would result from vehicles traveling to and from the site carrying workers, construction equipment and materials, operational processing supplies, ion-exchange resins, and waste materials (NRC, 2009).

During construction of the proposed Ludeman ISR Satellite Project, the licensee estimates that approximately 75 vehicles (passenger vehicles, light duty trucks, commercial service vehicles) would travel to the project area each day (Uranium One, 2013a). Uranium One estimated the maximum number of construction workers for the first year of construction would be 151 (Uranium One, 2017e), or approximately double the number of vehicles estimated to be traveling to the site. Although carpooling could explain the lower estimated number of vehicles visiting the site, because Uranium One has not committed to providing transportation services for workers or otherwise arranging carpooling, the NRC staff's traffic analysis considers the possibility of single-person vehicle occupancy for commuting workers. Because each commuting vehicle would travel in both directions, the NRC staff estimated the daily traffic doubling the licensee's employee count, resulting in 302 vehicles on the road each day. The licensee anticipates that the construction workforce would mostly travel from Converse and Natrona counties. The NRC staff expects that commuting workers would be dispersed throughout the area and would travel on various routes. Considering the daily traffic counts on the local roads (EA Section 3.2) and assuming that half of the proposed traffic would approach the project area on State Route 93 and the remaining half on State Route 95, the NRC staff estimate that traffic would increase 45 and 10 percent, respectively, and would be a noticeable change only on State Route 93. Based on the preceding analysis, the NRC staff concludes that the construction phase would have MODERATE impacts on traffic on State Route 93 during the first year of construction and SMALL impacts on transportation on all other traveled roads and on all roads during subsequent years of construction.

During operations, the proposed transportation activities at the Ludeman ISR Satellite Project would include employee commuting and truck shipments of ion exchange resins, processing

chemicals, hazardous materials, and solid byproduct material. Materials that would result from processing ion exchange resins from the Ludeman Satellite at the Willow Creek ISR Project (including yellowcake, processing chemicals, hazardous material, and byproduct material) would also be shipped to and from the Willow Creek ISR Project. The types of operations impacts evaluated in the following paragraphs are similar to those evaluated in the GEIS, including impacts to traffic and potential hazards associated with shipment of the produced materials.

The licensee's estimation of vehicle traffic during operations is the same as during construction. Additionally, the maximum number of employees estimated by the licensee during operations is 41 (Uranium One, 2017e). Therefore, the amount of traffic and potential for accidents during the operations phase and the resulting impacts would be the same or less than described for the construction phase after the first year and remain SMALL.

Regarding the impacts of radioactive material transportation, ion exchange resin shipments would be the most frequent radioactive materials shipments during operations at approximately two (round trip) shipments per day (Uranium One, 2017e). Ion exchange resins present a low hazard both during incident-free transportation [when shipped in accordance with applicable U.S. Department of Transportation (DOT) regulations] and in the event of an accident because the uranium is bound to the resin and is less concentrated than the yellowcake product that was previously evaluated in the GEIS and found to present a small risk (NRC, 2009). Additionally, the low expected number of daily shipments and the travel distance to the Willow Creek facility, approximately 221 kilometers (km) [137 miles (mi)] (Uranium One, 2017e), indicate that the likelihood of an accident involving an ion exchange resin shipment would be low. Solid byproduct material shipments would also occur at a much lower frequency relative to ion exchange shipments and, therefore, are less likely to contribute significantly to incident-free or accident impacts.

The NRC staff also considered the effects of radioactive materials shipments from processing Ludeman-sourced ion exchange resins at the Willow Creek ISR Project. Accidents involving proposed radioactive material shipments were previously analyzed in the most recent Willow Creek renewal EA and supplemental EA (NRC, 2011c, 2013a) and environmental report (ER) (Cogema Mining, Inc., 2008), the prior license renewal (NRC, 1998), and most substantively in the initial licensing environmental statement (NRC, 1978). Additionally, the GEIS (NRC, 2009) used similar methods to estimate the annual risk of health effects (latent cancer fatalities) from yellowcake shipments for a facility producing over twice the annual licensed production of Willow Creek, and the estimated risks were low. These analyses demonstrate that the risks from yellowcake and byproduct material shipments at the level proposed by the Ludeman ISR Satellite Project would be low; therefore, the public health impacts from these activities would be SMALL.

Transportation impacts associated with shipments of process chemicals, fuel, and hazardous waste involve the potential for in-transit accidents. The process chemicals, fuels, and small quantities of hazardous waste described in the licensee's proposal are commonly used in industrial applications, and they would be transported following applicable DOT hazardous materials shipping provisions. If an accident occurred, Uranium One's spill response would follow their emergency response procedures, although a spill of nonradiological materials would be reportable to the appropriate State agency, U.S. Environmental Protection Agency (EPA), and DOT (NRC, 2009). Spill material would be recovered or removed, and the affected areas reclaimed. Uranium One would maintain transportation safety by following applicable DOT hazardous materials transportation requirements (Uranium One, 2017e). The potential impacts

from transportation of the process chemical supplies for a full ISR facility that encompasses the chemicals needed for the proposed Ludeman project (which is a more limited satellite operation) were also previously evaluated in GEIS Section 4.3.2.2 (NRC, 2009) and found to be SMALL. Based on these considerations, the NRC staff concludes that the environmental impacts of operational hazardous chemical shipments of the proposed Ludeman ISR Satellite Project would be SMALL.

In summary, the proposed transportation activities during operations would not noticeably increase traffic on local and regional roads and would present low, incident-free, and accident hazards and risks. Therefore, the NRC staff concludes that the operational transportation impacts of the proposed Ludeman ISR Satellite Project would be SMALL.

During aquifer restoration at the proposed Ludeman Project, the rate of uranium extraction would gradually decrease, as would associated transportation activities. The number of vehicles traveling to the proposed project area would decrease during aquifer restoration compared to the operations phase because the number of commuting employees and shipments of process chemicals, resin transfers, and waste products would decrease relative to production (Uranium One, 2017e). Therefore, based on these factors, the NRC staff concludes that the transportation impacts of the proposed Ludeman ISR Satellite Project during aquifer restoration would be less than during the construction and operations phases, which are SMALL.

Transportation activities during decommissioning of the proposed Ludeman ISR Satellite Project would include transporting construction equipment, workers, and solid byproduct material and nonhazardous solid waste shipments to offsite disposal facilities.

Regarding the impacts of commuting workers on traffic during decommissioning of the proposed Uranium One ISR Satellite Project, the licensee did not provide a specific analysis of the impacts; therefore, NRC staff assumes that the number of commuting workers would be similar to the construction phase. Based on the preceding construction phase traffic analysis, NRC staff concludes that the decommissioning phase of the proposed Ludeman ISR Satellite Project could have MODERATE impacts on traffic on State Route 93 during the peak periods of activity and SMALL impacts on traffic on all other traveled roads during decommissioning.

Waste materials generated during decommissioning would be segregated by type and transported offsite to approved disposal facilities. Nonhazardous solid waste would be shipped to the Glenrock Area Solid Waste Disposal Facility or Casper landfill, and solid byproduct material would be shipped to the Pathfinder Mines Corporation, Shirley Basin facility. The total volume of materials that would need to be shipped for disposal during decommissioning was estimated by the NRC staff (by compiling the licensees estimates) to be approximately 6,100 m^3 [8,000 yd^3] (EA Section 4.13; Waste Management). Half of this volume would be byproduct material and half nonhazardous solid waste. Assuming a truck capacity of 15 m^3 [20 yd^3] per load, the NRC staff estimated approximately 400 shipments would occur during the year of active decommissioning. If these shipments were made 5 days per week, the NRC staff estimate that the number of daily shipments would be approximately two trucks per day or four (one-way) truck trips per day. NRC staff concludes that this level of shipping activity during decommissioning would not noticeably impact traffic on local and regional roads and would present low incident-free and accident hazards. Therefore, based on the preceding analysis, the transportation impacts from decommissioning the proposed Ludeman ISR Satellite Project would be SMALL.

Under the No-Action Alternative, the proposed Ludeman Satellite facility would not be licensed; therefore, there would be no transportation of materials to and from the site to support licensed activities. There would be no transportation of either radioactive or solid waste attributable to ISR activities, because the project area would neither be licensed nor constructed and operated. Traffic volumes associated with current land use activities, such as coalbed methane (CBM) extraction, oil and gas extraction, and cattle ranching would continue into the future. Therefore, the No-Action Alternative would have no additional impacts to existing transportation.

4.4 Geology and Soils

This section describes potential environmental impacts to geologic and soil resources (e.g., soil disturbance, erosion, sedimentation, contamination, subsidence) that could occur during all phases of the proposed Ludeman ISR Satellite Project under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. As discussed in GEIS Section 4.3.3, potential environmental impacts to geologic and soil resources could occur during all phases of the ISR facility lifecycle (NRC, 2009); however, impacts would be most likely during the construction phase. The potential impacts on site geology and soils from proposed ISR activities at the Ludeman ISR Satellite Project would result primarily from (i) earth-moving activities associated with constructing facilities, roads, wellfields, pipelines, utilities, and ponds, and (ii) wind-driven soil erosion. Potential environmental impacts on geology and soils from the construction, operation, aquifer restoration, and decommissioning phases of the project lifecycle are detailed in this section.

Geologic Impacts

During the construction, operations, and aquifer restoration phases of the proposed action, the geologic resources affected by the proposed Ludeman ISR Satellite Project would be the sediments and rocks of the ore-bearing Fort Union Formation because of the construction and use of injection, production, and monitoring wells.

The impacts discussed next are similar among construction, operations, and aquifer restoration, and apply to all three phases. Although removal of uranium from the various production zones during the operations and aquifer restoration phases would result in a permanent change to the composition of this uranium-bearing rock, the uranium mobilization and recovery processes during operations and the groundwater sweep and recirculation processes would not result in the removal of rock matrix, production of void space, or changes to the rock structure. Therefore, no significant matrix compression or subsidence would be expected to result in the collapse of overlying geologic units (Uranium One, 2017d) during these phases. In addition, Uranium One has committed to include information concerning newly permitted wells or renewed use of existing wells onsite and within a buffer around the proposed project boundary (Uranium One, 2013a) in its NRC annual report. The NRC staff concludes that the potential impact on geologic resources at the proposed Ludeman ISR Satellite Project area from subsidence and well usage during construction, operations, and aquifer restoration phases of the proposed action would be SMALL.

During the decommissioning phase, all monitoring, injection, and production wells would be plugged and abandoned, in accordance with WDEQ rules and regulations described in EA Section 4.5 (water resources). Based on the negligible impacts of the ISR process and groundwater sweep and recirculation processes on the host rock matrix and the low risk that

proposed project activities would induce earthquakes, the NRC staff concludes that the potential environmental impacts on site geology from construction, operations, aquifer restoration, and decommissioning at the Ludeman ISR Satellite Project for the proposed action are unlikely and would be SMALL.

Geologic impacts could occur at the proposed Ludeman ISR Satellite Project from a low-probability earthquake (Uranium One, 2017e), which potentially could damage a pipeline, process vessel, chemical storage tank, or permeate/evaporation pond and cause a contaminant release. Because of the low probability of an earthquake occurring in the area during the proposed project schedule and given that buildings and structures would be designed to 2,500-yr seismic probability standards in the International Building Code (Uranium One, 2017e), the risk of contaminant release at the Ludeman ISR Satellite Project from an earthquake under all of Uranium One's liquid waste management options is SMALL. There are no mapped faults in the immediate vicinity of the Ludeman site; therefore, it is unlikely that ISR activities associated with the proposed project would reactivate local faults (Uranium One, 2017e). Therefore, the NRC staff concludes that the potential impact from earthquake hazards during construction, operations, aquifer restoration, and decommissioning phases at the proposed Ludeman ISR Satellite Project would be SMALL.

Soil Impacts

The principal impacts on soils during the construction phase of the proposed action would result from earthmoving activities associated with constructing the satellite building, access roads, wellfields, drilling pads, header houses, pipelines, evaporation and permeate ponds, and related infrastructure. Earthmoving activities include clearing ground, removing topsoil, and preparing the land surface for the infrastructure construction. Potential impacts on soils from activities proposed at the Ludeman ISR Satellite Project would result primarily from wind-driven soil erosion and soil loss occurring as a result of construction-related activities (e.g., vegetation clearing, topsoil stripping) (Uranium One, 2017e). Other potential environmental impacts to soil from ISR activities include soil compaction, contamination (including increased salinity), and loss of soil productivity (Uranium One, 2017e). However, the quantity of soil disturbed and reclaimed at ISR sites is generally small (NRC, 2009), and WDEQ has established guidelines for topsoil and subsoil management at uranium ISR facilities (WDEQ, 2018b).

During construction, removal of vegetation and physical disturbance associated with vehicle and heavy-equipment traffic would increase the potential for wind and water erosion. The satellite facility would be underlain by soils with a potential for both water and wind erosion (Uranium One, 2017e). Uranium One has committed to dust suppression, which would reduce the overall impact of wind erosion on disturbed areas (Uranium One, 2017e). The proposed location of the satellite facility is fairly level (EA Section 3.4.1) and free of vegetation requiring cutting and hauling. Any subsoil removed from the satellite facility area would be transported to fill areas, such as pond embankments or used as fill to construct access roads (Uranium One, 2017e); this soil would not be stockpiled. Some topsoil stripping would be necessary to construct wellfield infrastructure (e.g., drilling pads, access roads, pipelines, and header houses), which may increase soil erosion hazards from both wind and water due to removal of vegetation and physical disturbance by heavy equipment (Uranium One, 2017e). To obtain a Permit to Mine, Uranium One would be required by WDEQ to implement WDEQ-approved techniques (WDEQ, 2006) to minimize soil erosion such as placement, sloping, and seeding of stockpiles during both the construction and operations phases of the proposed project (Uranium One, 2017e).

During well construction, potential soil contamination resulting from the spread of drilling fluid and drilling mud would be mitigated by directing drilling fluids and muds into mud pits (Uranium One, 2017e). After mud pit use is complete (usually within 30 days of excavation), the subsoil would be redeposited in the mud pit, and the topsoil would be replaced (Uranium One, 2017e). The licensee would also follow a similar topsoil salvage approach for pipeline ditch and utility trench construction (Uranium One, 2017e).

The topsoil that would be salvaged during the construction phase at the proposed Ludeman ISR Satellite Project would be managed in accordance with WDEQ guidelines and conditions of the Ludeman WDEQ Permit to Mine (Uranium One, 2017e) and temporarily stored in stockpiles to conserve, stabilize, and minimize loss of soil productivity. Salvage depth of soils at the Ludeman site would vary from nonexistent to 1.5 meters (m) [5 feet (ft)] (Uranium One, 2017e); however, topsoil stripping depth is expected to average 0.65 m [2 ft] (Uranium One, 2017e). Stockpiles would be located away from drainages and windy ridge tops and on leeward hill slopes, where practicable, to minimize wind and water erosion (Uranium One, 2017e). Topsoil stockpiles would be sloped no greater than 33 percent (Uranium One, 2017e). In accordance with WDEQ guidelines (WDEQ, 2018b), a perimeter berm/toe ditch would be installed around each topsoil stockpile. Uranium One may apply other soil protection measures, as appropriate, including diversion of surface runoff and use of water velocity dissipation structures, grading and contouring, silt fencing, installation of sediment logs or straw bale check dams to capture sediment, use of wing ditches, mulching, and reseeding (Uranium One, 2017e).

Potential soil contamination could also occur from spills and leaks of fuel and lubricants from heavy construction equipment and other vehicles that would be operated during construction of the proposed project. Potential soil contamination resulting from fuel and oil leaks would be promptly cleaned up and contaminated soil removed and disposed offsite in an approved disposal facility (Uranium One, 2017e).

Uranium One estimates that the total amount of soil disturbed during all phases of ISR activities would be approximately 372 ha [920 ac], or less than 4.9 percent of the project area (Uranium One, 2017e). The project life of wellfields would be phased; therefore, not all of the potential effects would occur at the same time. Based on (i) the limited extent of the construction area, (ii) the proposed topsoil stockpiling procedures, (iii) WDEQ guidelines and conditions associated with the WDEQ Permit to Mine that would be implemented to limit erosion (e.g., sloping, seeding), and (iv) the short duration of mud pit usage and pipeline construction activities, the NRC staff concludes that the potential environmental impact on soils from construction at the Ludeman ISR Satellite Project site would be SMALL.

During the operations and aquifer restoration phases, the NRC staff expects potential impacts to soils would be smaller than during the construction phase. Potential impacts to soils during the operations and aquifer restoration phases could be generated from wellfield leaks (pipeline, rupture, joint, or flange failure). However, as stated previously, soils contaminated with process fluids resulting from spills or leaks would be promptly cleaned up and contaminated soil removed (Uranium One, 2017e). Additionally, a smaller amount of soil would be disturbed during operations and aquifer restoration because of the reduced numbers of vehicles accessing the area, and because of the licensee's commitment to mitigation measures (i.e., use of pre-existing roads). Thus, the potential impacts on soil from the operations and aquifer restoration phases would be SMALL.

Decommissioning activities for the proposed action would include (i) removing buried piping, (ii) plugging and abandoning wells in accordance with accepted practices, and (iii) replacing and

revegetating topsoils and recontouring the satellite facility to match preconstruction topography where required (unless other agreements are made with the landowner for post-decommissioning land and facility use) (Uranium One, 2017e). The main impacts on soils during decommissioning would be from land-reclamation activities and the cleanup of contaminated soils, but impacts from disturbance and/or displacement of soils would be relatively small. Removal of impervious surfaces at the Ludeman ISR Satellite Project site (e.g., cement foundation pads and footings) would assist in returning the proposed project area to previous natural conditions (Uranium One, 2017e). Also, during decommissioning, compacted soils such as dirt access roads would be ripped to loosen prior to reseeding (Uranium One, 2017e). Based on the licensee's goal to decommission and reclaim the site to preconstruction conditions, the NRC staff concludes that the impact on soils from the decommissioning phase of the proposed Ludeman ISR Satellite Project would be SMALL.

While impacts to soils from the proposed action would be SMALL, the NRC staff recognizes that alternative methods for managing drilling fluids are available, which the licensee could choose to implement to further limit or mitigate potential impacts from mud pits. These methods include lining mud pits with an impermeable membrane, disposal of drilling mud offsite, and using portable tanks or tubs for containing drilling mud and other drilling fluids. The NRC staff also recommends that Uranium One construct berms around topsoil stockpiles to reduce/mitigate sediment runoff. These additional recommended mitigations could further reduce impacts to ensure that the potential impacts to site soil from all the licensee's liquid waste management options would remain SMALL.

Under the No-Action Alternative, a license would not be issued, and the proposed Ludeman ISR Satellite Project would not be constructed, operated, or decommissioned. Site geology and soils would be unaffected by the proposed action and the associated liquid waste management options, and no fluids would be injected into the subsurface. None of the proposed construction would occur, including a satellite building, access roads, well installations, and pipelines; no soils would be disturbed by earthmoving activities, and no spills from associated equipment would occur. Current land uses on and near the proposed project area, which include rangeland grazing, irrigation and agriculture, recreation (e.g., hunting) and residential uses, and energy resource extraction and transmission would continue, with no environmental impact from the proposed action.

4.5 Water Resources

This section evaluates the potential environmental impacts to water resources that could occur at the Ludeman ISR Satellite Project during all phases of the facility's lifecycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. Potential environmental impacts on surface water and wetlands and groundwater are detailed in this section. The impacts to water resources associated with the No-Action Alternative are also evaluated in this section.

Surface Water and Wetland Impacts

As described in GEIS Section 4.3.4.1, potential environmental impacts to surface waters and wetlands may occur during all phases of the ISR facility lifecycle (NRC, 2009). Impacts may result from (i) road construction and crossings; (ii) erosion runoff; (iii) spills or leaks of fuels, lubricants, and process-related fluids; (iv) stormwater discharges; (v) surface water discharge; and (vi) discharge of wellfield fluids as a result of pipeline or well head leaks. Potential

impacts to surface waters and wetlands may be greater in areas containing jurisdictional waters and wetlands.

As described in EA Section 3.4.1, the Ludeman ISR Satellite Project area and 3.2-km [2-mi] review buffer occur within eight subwatersheds of the Middle North Platte-Casper watershed. All of the subwatersheds discharge directly into the North Platte River, which lies approximately 1.6 km [1 mi] south of the proposed Ludeman Project boundary (Uranium One, 2017e). The drainage channels of the eight subwatersheds are ephemeral and transmit measureable flow only in response to snow melt during the spring and early summer or after large rain storms (Uranium One, 2017e). As further described in EA Section 3.4.1, 195 water bodies and 233 individual wetlands have been identified within the Ludeman Project area (Uranium One, 2017e). Surface water bodies are either in depressions or behind dikes in ephemeral drainages (stock ponds), or within playas. Of the wetlands and surface water bodies, the licensee classified 11.7 ha [29 ac], consisting of 43 wetlands and 4 surface water bodies, as jurisdictional (Uranium One, 2017d) with final determinations to be made by the U.S. Army Corps of Engineers (USACE).

During construction of the proposed Ludeman ISR Satellite Project, earthmoving and excavation activities have the potential to adversely impact surface water quality. To minimize impacts to surface water in ephemeral drainages and wetlands, Uranium One would implement best management practice (BMP) measures, in accordance with a WDEQ Large Construction Wyoming Pollutant Discharge Elimination System (WYPDES) permit (Uranium One, 2017e). The WYPDES permit would limit the amount of pollutants discharged to surface water bodies, such as streams and wetlands. As part of the WYPDES permit, Uranium One would be required to develop a Storm Water Pollution Prevention Plan (SWPPP) to control stormwater runoff during construction activities. The SWPPP would describe BMPs (e.g., silt fencing, sediment logs, straw bale check dams, diversion ditches, and culverts) that would be implemented by Uranium One to control and minimize erosion and sediment transport from disturbed areas to surface water.

Wetlands would not be impacted by the construction of the proposed ISR satellite building (Uranium One, 2017e). However, approximately 2.67 ha [6.6 ac] of wetlands fall within the boundaries of identified orebodies at the Ludeman Project site (Uranium One, 2017e). Of those, approximately 0.73 ha [1.8 ac] are potentially jurisdictional (Uranium One, 2017e). USACE permits under Section 404 of the Clean Water Act are required for placing fill material, excavating, or using earthmoving equipment to clear land in jurisdictional wetlands. The USACE permitting process ensures proper techniques and mitigation measures are implemented to ensure protection of habitat and water quality in jurisdictional wetlands. Uranium One has committed to seek authorization from USACE and comply with Section 404 permitting requirements before conducting work in jurisdictional wetlands in the proposed project area (Uranium One, 2017e).

To minimize impacts to surface water and wetlands during construction, Uranium One has committed to using existing roads within the proposed project area to the extent possible and limiting the width of new access roads constructed within the proposed project area (Uranium One, 2017e). In addition, Uranium One has committed to the following mitigation measures to reduce impacts from access road construction on ephemeral drainages: (i) crossing ephemeral drainages at a nearly right angle to minimize soil erosion; (ii) using properly sized engineered culverts, diversion ditches, drainage dips, low-water crossings, and subsurface drains to divert and control runoff; and (iii) using BMPs in accordance with a WDEQ Permit to Mine to protect stream embankments from erosion (Uranium One, 2017e). In addition

to access roads, pipelines connecting the injection and production wells to the satellite plant may also cross ephemeral drainages. Pipelines crossing ephemeral channels would be installed below grade, backfilled after installation, and would not block surface water flow (Uranium One, 2017d).

Surface facilities (including the proposed satellite plant and its ancillary facilities, chemical storage, and evaporation ponds) would be located on high ground outside of the 100-yr floodplain (Uranium One, 2017e). The SWPPP would describe flood protection measures that Uranium One would design and implement to route stormwater runoff away from structures, roads, and ponds. Injection, production, and monitoring wells would be protected from flooding by installation of cement seals around the well casings (Uranium One, 2017e).

Based on review of surface water features near proposed wellfields, the NRC staff concludes that with the exception of a large surface impoundment in Wellfield 5 (identified as WB-43), Federal Emergency Management Agency (FEMA) 100-yr flood hazard zones are located sufficiently distant from the proposed wellfields and are unlikely to be a significant source of flooding (NRC, 2018b). The NRC staff's review of recent satellite images of WB-43 in Wellfield 5 indicated that this surface water feature was variable, but it was inundated in different seasons from 2009 to 2015. The NRC staff concludes that any wellfield infrastructure located in the footprint of WB-43 in Wellfield 5 would be subject to damage from periods of standing water and flooding, resulting in potential surface water contamination. If NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman ISR Satellite Project, NRC will include a license condition requiring that Uranium One will not install any wells or wellfield infrastructure in Wellfield 5 within the boundary of the surface water impoundment located in Section 28 of T34N R73W, as shown in Figure 2.7A-1 of Addendum 2.7-A of the Revised Technical Report (Uranium One, 2017d).

Because of (i) the limited areal extent of surface disturbance; (ii) the limited extent of surface water and wetlands; (iii) implementation of WDEQ guidelines and conditions associated with a WDEQ Permit to Mine, such as use of riprap aprons to protect embankments from erosion, stormwater runoff, and sedimentation; (iv) compliance with USACE Section 404 permitting requirements for wetlands; (v) compliance with WYPDES permit requirements for discharge to surface waters; and (vi) a new license condition that would require Uranium One not to install any wells or wellfield infrastructure in Wellfield 5 within the boundary of the surface water impoundment, the NRC staff concludes that impacts to surface water and wetlands from construction at the Ludeman ISR Satellite Project would be SMALL.

During operations and aquifer restoration activities, surface water could be impacted by release of process fluids or chemicals from leaks, spills, or equipment ruptures in the proposed satellite plant and wellfields. To minimize the potential for leaks and spills, Uranium One would adhere to NRC and WDEQ design criteria for ISR facilities (Uranium One, 2017e). These criteria include: (i) designing and constructing adequate spill containment and leak detection systems; (ii) monitoring process parameters, such as pressure and flow in pipelines and injection and production wells to identify leaks before they occur; (iii) routinely inspecting process equipment, pipelines, waste management systems, and effluent control systems; and (iv) training employees in spill detection, containment, and cleanup procedures. Process buildings and chemical storage areas would be constructed with sumps and secondary containment berms or curbing, and a regular program of preventative maintenance would be implemented (Uranium One, 2017e). Wellfield facilities would be equipped with leak detection equipment, and alarms and routine inspections of wellfield facilities and well heads would be conducted (Uranium One, 2017e).

Concentrated brines would be disposed using lined evaporation ponds, and treated groundwater restoration permeate would be separately stored in lined permeate ponds. Subject to NRC license conditions and WDEQ permits, water stored in the permeate ponds may be disposed by surface water discharge. The evaporation and permeate ponds would be designed to meet the safety and engineering design standards set forth in 10 CFR Part 40, Appendix A, Criteria 4(a), 4A, and 5E, and WDEQ Rules and Regulations, Chapter 11, for lined wastewater storage ponds (Uranium One, 2017d). Operational stability, surveillance, inspection, and testing of the ponds would be required to meet the recommendations of NRC (2008). Uranium One has proposed potential surface water discharge of treated groundwater restoration permeate via a WYPDES permit issued by the WDEQ. Once a permit application is submitted, the WDEQ would evaluate the proposed discharge considering the applicable Wyoming surface water quality and permitting requirements and make a determination on whether or not to grant a permit. The WYPDES permit, if granted, would limit flow rates and would specify any necessary permit conditions, including effluent limits, to ensure water quality standards are maintained. In addition, the treated permeate would need to meet NRC dose limits, waste disposal standards, and effluent limits in 10 CFR Part 20, Subparts D and K and Appendix B, and the provisions of 10 CFR Part 40, Appendix A. The NRC staff reviewed the permeate water quality estimates provided by Uranium One in the ER (Uranium One, 2017e) and concluded that the estimated permeate water quality may exceed the values in Table 2 of Appendix B to 10 CFR Part 20. In addition, the licensee did not provide the location and features of the surface water body that will receive the liquid effluent. Without this information, the NRC staff could not evaluate whether the liquid effluent reaches any nearby surface water body and where public doses would be likely to occur. If NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition prohibiting surface water discharge of permeate pond water.

As described in EA Section 3.4.3, the Wyoming State Engineer's Office (WSEO) determined that Wellfields 5 and 6 are not considered hydrologically connected, and water from these wellfields would not be subject to the Modified North Platte River Decree. Based on (i) adherence to NRC and WDEQ design and inspection criteria for ISR facilities and wastewater storage ponds; (ii) compliance with WYPDES permit requirements and NRC release and disposal standards for surface discharge of treated effluents; and (iii) compliance with the terms of the Modified North Platte River Decree, the NRC staff concludes that the impacts to surface water and wetlands from operations and aquifer restoration at the Ludeman ISR Satellite Project would be SMALL.

During decommissioning, stormwater runoff and sediment transport would increase compared to the operations and aquifer restoration phases due to disturbances associated with equipment and structure removal and soil reclamation activities. Surface water impacts would be minimized through implementation of sediment control BMPs (such as silt fencing, sediment logs, straw bale check dams, diversion ditches, and culverts) described in a SWPPP. The potential impacts to surface water during decommissioning would be less than those during construction because reclamation and decommissioning of the wellfields would be ongoing throughout the life of the project, thereby reducing the overall area of disturbance. Therefore, the NRC staff concludes that the impacts to surface water and wetlands from decommissioning at the Ludeman ISR Satellite Project would be SMALL.

Groundwater Impacts

As described in GEIS Section 4.3.4.2, potential environmental impacts to groundwater could occur during all phases of an ISR facility life cycle, although impacts are more likely to occur

during operations and aquifer restoration (NRC, 2009). At ISR sites, ore-bearing aquifers are typically separated from adjacent aquifers at varying depths by confining layers, known as aquitards. If the confining layers do not effectively isolate the ore-bearing aquifer from the hydrogeological system, the aquifers above and below the uranium-bearing aquifer can be adversely affected during ISR operations. As further described in GEIS Section 4.3.4.2, ISR facility impacts on groundwater resources can result from surface spills, leaks from buried piping, consumptive water use (i.e., water removed from available supplies without return to a water resource system), horizontal and vertical excursions of lixiviant from production aquifers, degradation of water quality from changes in production zone aquifer chemistry, and waste management practices involving evaporation ponds and/or deep well injection (NRC, 2009).

As described in EA Section 3.4.2, surficial and near-surface aquifers, production zone aquifers, and overlying and underlying monitoring aquifers at the proposed Ludeman ISR Satellite Project are generally sand units of the Lebo Member of the Paleocene Fort Union Formation (Uranium One, 2017e). Groundwater for domestic use and livestock watering within and surrounding the proposed Ludeman Project area (e.g., the Negley Subdivision and JS well) is sourced from shallow aquifers (e.g., the 100, 110, and 120 Sands) at depths ranging from 1.5 to 110 m [5 to 360 ft]. The depth and thickness of production zone and monitoring aquifers at the proposed Ludeman Project are shown in EA Table 3-3. The production zone aquifers are, from shallowest to deepest, the 90, 80, and 70 Sands. Historical and recent aquifer pumping tests provide average hydrologic property data, gradient magnitudes, and flow directions in the production zone aquifers, and generally illustrate hydrostratigraphic confinement (isolation) between the 70, 80, and 90 Sand production zones and the overlying 100 or 110 Sands and the underlying 60 Sand in the areas tested due to the local competence of confining layers (Uranium One, 2017e). However, both the revised ER and TR indicate that the 80 and 90 Sands have similar hydraulic heads near Wellfield 1 (Uranium One, 2017d,e). Based on review of previous investigations conducted at the Wellfield 1 ore bodies (Teton, 1980), the NRC (1983) staff concluded that the 80 Sand exhibited a greater degree of confinement than the somewhat leaky 90 Sand aquifer. NRC (1983) noted that the aquifer test data collected at that time also suggested that there are no natural or manmade pathways (e.g., faults, fractures, abandoned boreholes) through the confining units for significant amounts of fluid to migrate between aquifers. This conclusion was also supported by an independent research and development mining test (Teton, 1980), during which no vertical excursions were observed for 13 months (NRC, 1983). As described in EA Section 2.1.3, the licensee is required by NRC to perform additional pumping tests—one in each mining unit—to verify ore zone confinement as part of its wellfield hydrogeologic data packages. These tests would be designed, in part, with NRC approval, to supply data for a detailed evaluation of ore zone anisotropy and hydraulic properties of the shale confining units, which have not been measured to date.

During construction, consumptive groundwater use would be limited to dust suppression, cement mixing, and drilling support. As described in the GEIS, the volume of water used for these activities is small relative to available pumpable water and would have a SMALL impact to groundwater supplies within the Wyoming East Uranium Milling Region (NRC, 2009). Uranium One has not defined a water source for these activities. As described previously, domestic and livestock wells within and surrounding the proposed Ludeman Project area are completed in shallow aquifers (e.g., the 100, 110, and 120 Sands). Therefore, the NRC staff considers these aquifers to be the most likely source of water for construction activities.

As described in EA Section 2.1.4, Uranium One plans to use standard mud rotary drilling techniques to construct production, injection, and monitoring wells. Drilling muds introduced downhole are designed to seal boreholes to set casing, thereby preventing vertical

contamination across subsurface units. To reduce potential contamination of surficial and near-surface aquifers, drilling muds produced during well construction would be directed and disposed of in mud pits constructed adjacent to drill sites (Uranium One, 2017e). Uranium One has committed to appropriate onsite geological supervision during all drilling activities (Uranium One, 2017e). A WDEQ-administered Class III Underground Injection Control (UIC) program regulates the design and construction of injection, production, and monitoring wells. Uranium One has committed to construct injection, production, and monitoring wells using methods approved by WDEQ and in compliance with WDEQ Chapter 11, Section 6 Engineering and Design Report (Uranium One, 2017e). Uranium One has also committed to implement an approved Mechanical Integrity Test (MIT) program for all wells prior to use in accordance with WDEQ procedures to ensure casing integrity (Uranium One, 2017e).

After wells are installed, some water may be pumped from aquifers for well development or hydrologic testing, such as pumping tests. As proposed by the licensee, under the preferred liquid waste management option and Option 1, this water may be discharged to the surface in accordance with construction and industrial/mining WYPDES stormwater permits that Uranium One must obtain from WDEQ. These permits protect surficial and near-surface groundwater aquifers by limiting the discharge volume and prescribing concentration limits to discharged water.

Spills of fuels and lubricants from construction equipment and vehicles could also impact surficial and near-surface groundwater quality during facility construction and wellfield installation. Uranium One has committed to the following to protect groundwater quality: (i) developing and implementing an NRC-required spill response and cleanup plan to contain and remediate affected soil or surface water and (ii) training employees in spill detection, containment, and cleanup procedures (Uranium One, 2017e).

Based on (i) the limited amount of water consumed for routine construction activities; (ii) the use of mud pits to control the spread of drilling fluids to surficial and near-surface aquifers; (iii) the licensee's commitment to WDEQ UIC requirements for Class III well design, construction, and testing; (iv) the licensee's adherence to WYPDES permit requirements for discharged water during well development and hydrologic testing; and (iv) the licensee's mitigations associated with WYPDES permit requirements to protect water quality in the event of leaks and spills of fuels and lubricants, the NRC staff concludes that the impacts to groundwater from construction of the Ludeman ISR Satellite Project would be SMALL.

During operations and aquifer restoration, groundwater quality in near-surface aquifers at the proposed project area has the potential to be impacted by accidental spills or leaks from chemical storage areas, process solution vessels, or evaporation and permeate ponds, as wells as by spills and leaks of lixiviant from failure of pipelines or valves or a break in the casing of a well. As described previously, NRC-required leak detection, spill response, and cleanup programs would greatly reduce the potential impact on near-surface groundwater from any surface releases during the operations and aquifer restoration phases. Within the wellfields, Uranium One has committed to continuously monitoring wellfield flows to detect any variations in flow or pressure that could indicate a leak in pipelines or wells (Uranium One, 2017e). In addition, Uranium One has proposed the following mitigation measures to detect and control potential adverse impacts of spills and leaks: (i) installing automated equipment capable of detecting leaks and shutting down pump systems; (ii) equipping facilities and manholes with leak detectors having audible and visible alarms; (iii) performing periodic (every 5 years) MIT of wells to detect potential leakage; (iv) constructing buried wellfield pipelines with corrosion-resistant, high-density polyethylene (HDPE); (v) constructing piping within the satellite

plant with corrosion-resistant HDPE, polyvinyl chloride (PVC), or stainless steel; (vi) hydrostatically testing piping prior to use; (vii) using piping rated for pressures greater than the maximum operating pressure; and (viii) providing thrust blocking at pipe bends and valves (Uranium One, 2017e).

Concentrated brines would be disposed using lined evaporation ponds and treated groundwater restoration permeate stored in separate permeate ponds would be disposed by surface water discharge, subject to NRC license conditions and WDEQ permits (EA Section 2.1.7). Evaporation and permeate ponds would be double-lined and designed following guidelines described in NRC Regulatory Guide 3.11 for embankment systems (NRC, 2008) and WDEQ Water Quality Rules and Regulations, Chapter 11, for disposal ponds (Uranium One, 2017e). Adherence to these guidelines would ensure that the evaporation and permeate ponds meet NRC requirements for groundwater protection at 10 CFR Part 40, Appendix A, Criterion 5 and groundwater protection standards established under WDEQ water quality rules and regulations. Furthermore, Uranium One has committed to the following mitigation measures to minimize the impacts of leaks from the evaporation and permeate ponds: (i) selecting optimum pond location based on topography, access, proximity to the satellite plant, and distance from surface drainage features; (ii) using two layers of low-permeability liners; and (iii) equipping the pond with a leak detection system between the liner layers consisting of a perforated pipe system with collection sumps that will be checked regularly (Uranium One, 2017e).

The NRC staff evaluation of the groundwater hydrology at the Ludeman site indicates that the first aquifer under the proposed evaporation and permeate ponds is located in the 110 Sand. Uranium One reported that the 100 Sand aquifer acts as a source of groundwater for the Negley Subdivision private wells north of the evaporation pond. Therefore, potential leaks from the evaporation and permeate ponds may seep into the 110 Sand aquifer and lead to contaminant migration toward the Negley Subdivision wells. If NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition requiring the licensee to install one groundwater monitoring well upgradient and three monitoring wells downgradient of both the evaporation pond and the permeate pond in the 110 Sand aquifer. These wells will be required to be monitored in the same manner as required for the excursion monitoring wells in License Conditions 10.4 and 11.2 of the Willow Creek Source Material License (SUA–1341), with the exception that the licensee will test the wells quarterly and the licensee will not be required to implement correction actions, but instead will inform the NRC of the actions it will take to determine if the excursion is associated with leaks from the evaporation pond.

As described previously, Uranium One has proposed potential surface discharge of treated groundwater restoration permeate via a WYPDES permit issued by the WDEQ. Once a permit application is submitted, the WDEQ would evaluate the proposed discharge, considering the applicable Wyoming surface water quality and permitting requirements, and make a determination on whether or not to grant a permit. The WYPDES permit, if approved, would limit flow rates and would specify any necessary permit conditions, including effluent limits, to ensure groundwater quality standards are maintained. In addition, the treated permeate would need to meet NRC dose limits, waste disposal standards, and effluent limits in 10 CFR Part 20, Subparts D and K and Appendix B, and the provisions of 10 CFR Part 40, Appendix A. The NRC staff reviewed the permeate water quality estimates provided by Uranium One in the ER (Uranium One, 2017e) and concluded that the estimated permeate water quality may exceed the values in Table 2 of Appendix B to 10 CFR Part 20. In addition, the licensee did not provide the location and features of the surface water body that will receive the liquid effluent. Without this information, the NRC staff could not evaluate whether the liquid effluent reaches any nearby

surface water body and where public doses would be likely to occur. Therefore, if NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition prohibiting surface water discharge of permeate pond water.

Based on (i) implementation of required spill response and cleanup procedures; (ii) Uranium One's commitments to mitigation measures to detect, control, and minimize potential adverse impacts of spills and leaks in processing facilities, pipeline infrastructure, evaporation ponds, and wellfields; (iii) adherence to NRC guidelines and WDEQ rules governing design and construction of embankment systems and disposal ponds; (iv) a new license condition requiring the licensee to install groundwater monitoring wells upgradient and downgradient of both the evaporation and permeate ponds in the 110 Sand aquifer; and (v) adherence to WYPDES permit conditions for surface water discharge of treated groundwater restoration permeate (under Uranium One's preferred liquid waste management option and Option 1), the NRC staff concludes that impacts to shallow (near-surface) groundwater during operations and aquifer restoration from the proposed project would be SMALL.

During operation and aquifer restoration, the potential impact to groundwater in the production and surrounding aquifers is related to consumptive groundwater use and groundwater quality. No stock or domestic water wells would be located in the currently proposed ISR operation areas and would not be completed in the ore-bearing aquifer where production would occur (Uranium One, 2017e). If future development within the proposed project area includes an area(s) where a stock well is located in an ISR production aquifer, Uranium One has committed to the following mitigation measures: (i) replacing the wells with new wells completed in either shallower or deeper sands that are not impacted by ISR operations or (ii) providing another source of stock water (Uranium One, 2017e). In addition, if NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition requiring the licensee to plug and abandon all private wells within the production zone aquifer of a Ludeman Project wellfield within 152 m [500 ft] of the perimeter excursion monitoring well ring before injection of lixiviant in that wellfield production zone aquifer.

As described previously, local domestic and livestock groundwater within and surrounding the proposed Ludeman Project area (e.g., the Negley Subdivision and JS well) is sourced from shallow aquifers (e.g., the 100, 110, and 120 Sands) at depths ranging from 1.5 to 110 m [5 to 360 ft]. If NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition requiring Uranium One to identify the location and report publicly available information (e.g., well depth, screen depth, and estimated pumping rate) of any new wells or new use of existing wells within 2 km [1.2 mi] of any Ludeman Project wellfield monitoring well rings. Furthermore, the licensee would be required to evaluate the impact of ISR operations on groundwater wells and submit the evaluation as part of annual reporting to the NRC. To assess the impacts from ISR operations and aquifer restoration on local groundwater, background water levels would be measured in domestic and livestock wells surrounding the project area before ISR operations and every three months during operations (Uranium One, 2017e). If significant effects to either domestic or stock wells near the proposed project area were observed (e.g., the water levels drop to a point that impairs the usefulness of the wells), Uranium One has committed to implementing measures that would mitigate potential impacts, including: (i) lowering the pump level in the wells, if possible; (ii) deepening the wells, if possible; or (iii) replacing the wells with new wells completed in aquifers that are not affected by ISR operations and aquifer restoration (Uranium One, 2017e).

During ISR operations, Uranium One proposes a maximum production rate of approximately 34,000 Lpm [9,000 gpm] (Uranium One, 2017e). The production bleed would average up to 1 percent of the lixiviant flow from the wellfields. Production bleed is the net withdrawal maintained to ensure that groundwater flows toward the production wells (inward gradient) to minimize excursions of lixiviant and its hazardous constituents out of the wellfield (NRC, 2009). During concurrent production and aquifer restoration, the average total bleed would rise to as much as 1.2 percent of the lixiviant flow from the wellfields (Uranium One, 2017e). Thus, during concurrent production and restoration, water consumption would be slightly higher than during production alone.

Uranium One evaluated the potential impact of operations on groundwater quantity in surrounding wells using an analytical model to estimate cumulative groundwater drawdown in the production zone aquifers (i.e., the 70, 80, and 90 Sands) (Uranium One, 2017e). Model inputs included aquifer characteristics based on site-specific studies, proposed wellfield areas, proposed operational schedule, and proposed pumping rates. Rates of 113.5 Lpm [30 gpm] during production and 397 Lpm [105 gpm] during aquifer restoration were used as estimates of consumptive groundwater use by each wellfield and were expected to produce reasonable estimates of drawdown (Uranium One, 2017e). The NRC staff concluded that these consumptive groundwater use rates are reasonable based on proposed production and aquifer restoration bleed rates. Drawdown contours produced by the model were typically circular to somewhat elliptical in shape, depending on the distribution of pumping centers in the given aquifer (Uranium One, 2017e). At times of maximum drawdown, simulated 7.6 m [25 ft] contours of the 70, 80, and 90 Sands had radii that ranged between 1.9 to 3.8 km [1.2 to 2.4 mi] from their approximate pumping centers in wellfields at the Ludeman Project site (Uranium One, 2017e). Simulated 1.5 m [5 ft] drawdown contours of the 70, 80, and 90 Sands had radii that ranged between 5.5 to 7.7 km [3.4 to 4.8 mi] from the pumping centers (Uranium One, 2017e). Because there is minimal use of groundwater in the production zone aquifers near the proposed wellfield areas, the NRC staff does not expect that these simulated drawdowns would have an impact on groundwater quantity in groundwater wells outside the Ludeman Project area.

As described in EA Section 3.4.3, the WSEO determined that Wellfields 5 and 6 are not considered hydrologically connected to surface water flows of the North Platte River, and water from these wellfields would not be subject to the Modified North Platte River Decree. Therefore, no water depletions resulting from the Proposed Action would affect these species, which may occur in the downstream riverine habitats of the North Platte River system.

During operations, groundwater quality in the overlying and underlying aquifers and adjacent aquifers could be degraded if horizontal or vertical lixiviant excursions occur beyond production zones. To prevent horizontal excursions, inward hydraulic gradients need to be maintained in the production aquifer during ISR operations (NRC, 2009). These inward hydraulic gradients are created by the net groundwater withdrawals (production bleeds) maintained during pumping during ISR operations. As described previously, Uranium One plans to maintain an average 1 percent production bleed rate (Uranium One, 2017e). The inward hydraulic gradients would ensure that groundwater flow in the production zone aquifers is toward operating wellfields and that horizontal excursion would not occur.

NRC regulations require that the licensee of an ISR facility take preventive measures to reduce the likelihood and consequences of potential excursions. An applicant must design and install a monitoring network capable of detecting both horizontal and vertical excursions from the production zone. Uranium One has committed to construct a monitoring well network around each wellfield to mitigate the potential for excursions (Uranium One, 2017e). The monitoring

well network would include perimeter wells and wells completed in the overlying and underlying aquifer. Production zone monitoring well spacing would be based on the aquifer characteristics determined from hydrologic modeling and aquifer testing, while the overlying and underlying monitoring wells would be installed on the approximate basis of one well per 1.6 ha [4 ac] of wellfield (Uranium One, 2017e). Uranium One has committed to sampling monitoring wells on a biweekly basis and analyzing samples for excursion parameters that would be selected specifically to detect and provide "early warning" of lixiviant excursions (Uranium One, 2017e). Water levels in monitoring wells would also be measured to provide an early warning of a potential excursion. For example, a water level increase in monitoring wells would indicate that the inward hydraulic gradient created by the production bleed is not being maintained during wellfield ISR operations. If excursions are detected in the monitoring well ring, corrective actions to either stop or reverse fluid movement (i.e., excursions) are required. Uranium One would need to modify wellfield operations, as necessary, to correct the excursion. Corrective actions may include increasing sampling frequency to weekly, increasing the pumping rates of production wells in the area of the excursion to increase the net bleed, and pumping individual wells to enhance recovery of solutions.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, and improperly abandoned exploration drill holes. Uranium One would use its MIT program to mitigate the impacts of potential vertical excursions resulting from borehole failure of injection, production, and monitoring wells. As mentioned previously, after well installation, Uranium One would conduct periodic MITs on each well to check for leaks and cracks in the well casing, as required by WDEQ regulations. To reduce the potential of an excursion due to an improperly abandoned exploration drill hole, Uranium One has committed to plugging old drill holes in proximity to wellfields if pump testing and hydrologic results indicate that leakage through the old drill hole is a potential problem (Uranium One, 2017e). These holes would be re-entered to total depth and sealed with plug gel or other methods, in accordance with WDEQ rules and regulations.

The Negley Subdivision is located adjacent to the northwest portion of the proposed Ludeman Project boundary and includes 21 private wells completed in the 100, 110, and 120 Sands overlying the production zone aquifers. The shortest pathway for a production fluid release to reach the Negley wells would be from a failed casing in a production well near the northern margin of Wellfield 1 into any of the 100, 110, or 120 Sands {a distance of approximately 296 m [970 ft]; EA Figure 2-1}. If NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition requiring the licensee to install guard-monitoring wells in Wellfield 1, as described in Addendum 4-B of the revised Ludeman Project ER (Uranium One, 2017e), to protect shallow water supply aquifers of the Negley Subdivision from potential releases of lixiviants during ISR operations. The proposed monitoring well network for Wellfield 1 would include one well every 1.6 ha [4 ac] within the projected footprint of Wellfield 1 in the 100 Sand (which lies directly over the production zone sands) and a row of wells spaced between 137 and 152 m [450 and 500 ft] apart along the north margin of the wellfield to monitor the 110 Sand (Uranium One, 2017e). The 120 Sand is not expected to be water-bearing in the vicinity of Wellfield 1. However, if it is determined that saturated conditions are present in the 120 Sand, Uranium One would also install a row of wells spaced between 137 and 152 m [450 and 500 ft] apart along the north margin of the wellfield to monitor the 120 Sand (Uranium One, 2017e).

Based on (i) Uranium One's commitment to implement measures to mitigate potential impacts to local domestic and livestock groundwater; (ii) maintenance on inward hydraulic gradients (production and restoration bleeds) to minimize excursions of lixiviant out of the proposed

wellfield areas; (iii) analytical modeling results indicating that drawdown during ISR operations would not impact groundwater in wells outside the proposed project area; (iv) Uranium One's commitment to construct a monitoring well network around each wellfield to detect for potential excursions; (v) Uranium One's commitment to implement an MIT program to mitigate potential impacts from borehole failures of production, injection, and monitoring wells; (vi) Uranium One's commitment to plug old drill holes in proximity to the proposed wellfields; (vii) a new license condition requiring Uranium One to plug and abandon all private wells within 152 m [500 ft] of the wellfield perimeter excursion monitoring well rings; and (viii) a new license condition requiring Uranium One to install guard-monitoring wells in Wellfield 1 to protect shallow water supply aquifers of the Negley Subdivision, the NRC staff concludes that the potential impacts to groundwater during operations and aquifer restoration in the production zone and surrounding aquifers at the proposed Ludeman ISR Satellite Project would be SMALL.

During decommissioning, Uranium One would continue to implement a spill-prevention cleanup program to reduce the potential impacts of spills of fuels and lubricants. Uranium One would continue to implement mitigation measures under its SWPPP to control erosion and stormwater runoff that could impact surficial and near-surface aquifers (Uranium One, 2017e). Uranium One's WYPDES permit requirements (which limit discharge volumes and prescribe concentration limits to discharged water) would ensure that stormwater runoff would not contaminate near-surface groundwater. After ISR operations are completed, improperly abandoned production, injection, and monitoring wells could affect water quality in aquifers above and below the production aquifer by providing hydrologic connections between aquifers. As part of the restoration and reclamation activities, all monitoring, injection, and production wells would be plugged and abandoned, in accordance with WDEQ requirements (Uranium One, 2017e). In addition, Uranium One would submit decommissioning plans, including detailed plans for plugging and abandoning wells, to the NRC for review and approval.

If this process is properly implemented and the abandoned wells are properly isolated from the flow domain, the environmental impacts to groundwater in the production zone and surrounding aquifers would be minimal. Based on the foregoing analysis, the NRC staff concludes that the potential impacts to groundwater during decommissioning of the Ludeman ISR Satellite Project would be SMALL.

Under the No-Action Alternative, a license authorizing operation of an ISR facility would not be issued. There would be no construction of facility buildings, wellfields, evaporation and surge ponds, or access roads. No pipelines would be laid. Therefore, land surface disturbances associated with these activities would not occur, and additional sediment loading to surface water bodies would be avoided. Spills of fuels and lubricants from equipment and vehicles would not occur. Consumptive use of groundwater would not occur from the proposed project activities. Liquid byproduct material would not be generated; therefore, there would be no potential impact to surface water or groundwater quality. The current land uses affecting surface waters and groundwater would persist. Consequently, the No-Action Alternative would result in no impacts to surface water and groundwater.

4.6 Ecology

This section describes potential environmental impacts to ecological resources that could occur at the Ludeman ISR Satellite Project during all phases of the facility's life cycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. As discussed in GEIS Section 4.4.5,

potential environmental impacts to ecological resources, including both flora and fauna, could occur during all phases of the ISR facility lifecycle (NRC, 2009). Potential effects on ecology from the proposed Ludeman ISR Satellite Project would be due to habitat-related disturbances, such as habitat alteration, fragmentation, or loss. Potential impacts to individual animals and wildlife habitat could occur during well drilling, topsoil stripping, trenching, excavating, backfilling, compacting, and grading. Potential impacts to wildlife from clearing and grading, increased noise, traffic, or other disturbances associated with the development of the Ludeman ISR Satellite Project wellfields include: (i) direct and indirect mortalities; (ii) displacement of individual animals; (iii) loss of forage; (iv) erosion; (v) changes in wildlife movement; and (vi) changes in predator/prey populations. Indirect effects due to vegetation alteration affecting wildlife habitat typically persist longer than direct effects to individual animals due to the length of time (months to decades, depending on the type of plant community) required for vegetation to re-establish and become habitable.

Vegetation

The potential impacts on vegetation (including protected species) from ISR activities at the proposed Ludeman ISR Satellite Project would result primarily from the clearing of land associated with well-drilling activities and from the construction and decommissioning of wellfields and associated infrastructure, such as the satellite plant, storage ponds, pipelines, access roads, and overhead power lines. These potential impacts to vegetation include: (i) an increased potential for non-native species invasion establishment; (ii) shifts in species composition; (iii) changes in vegetative density; and (iv) expansion from invasive and noxious species found within the Ludeman Project area. Potential effects as a result of vegetation effects include increased soil erosion, changes in visual aesthetics, reduction of wildlife habitat, and reduction in livestock forage.

The upland grassland, big sagebrush shrubland, and upland grassland rough breaks complex would be the most affected vegetation communities at the Ludeman ISR Satellite Project. Grassland communities compose approximately 66 percent of the permit area. The NRC staff found that the overall amount of vegetation expected to be disturbed during all phases of the Ludeman ISR Satellite Project is less than the maximum amount of potential impacts to terrestrial vegetation evaluated in the NRC's GEIS (NRC, 2009). Uranium One estimates that for the Ludeman ISR Satellite Project, the total amount of soil and vegetation disturbed during all phases of ISR activities would be approximately 372 ha [920 ac], or 4.9 percent, of the entire permit area (Uranium One, 2017e). This estimate includes contributions from the satellite building, wellfields, evaporation ponds, and permeate ponds that are proposed to support surface discharge of treated aquifer restoration effluent. The project life of wellfields would be phased; therefore, not all of the potential effects would occur at the same time. Permit areas of ISR facilities evaluated in the GEIS have ranged from 1,034 ha to 6,480 ha [2,552 ac to 16,000 ac] of land (NRC, 2009). Typically, the land disturbance within these permit areas have been from 49 ha to 490 ha [120 ac to 1,200 ac], or 1 to 20 percent of the entire permit areas. The licensee anticipates that for the proposed Ludeman project, wetlands will not be impacted by the construction of the satellite plant or associated support facilities. However, approximately 2.7 ha [6.6 ac] of wetlands or water bodies are located within the footprint of ore bodies, and wetlands or surface water channels may be impacted by the construction of wellfields (EA Section 4.5). The licensee acknowledges that permits issued by the USACE are required for planned activities that would affect jurisdictional wetlands (Uranium One, 2017d).

Vegetation at the proposed site could also be affected by construction, use, and removal of roads. Uranium One would access the Ludeman satellite plant from an existing improved,

unpaved all-weather road, which would serve as the primary access that will not require surface disturbance (Uranium One, 2017e). Converse County Road 26 (Leuenberger Lane) is also an existing road within the Ludeman Project site that would not require surface disturbance. The licensee has also proposed to restrict vehicular traffic to roads within the project area (e.g., to minimize driving off-road) to reduce damage to vegetation (Uranium One, 2017e). Road reclamation will include breaking up compacted soil on the road surface (also called “ripping”) and shallow subsoil prior to seeding reclaimed road areas with a WDEQ-approved seed mixture, which would ensure vegetation growth (Uranium One, 2017e).

To restore habitat and vegetation after construction of temporary well pads, mud pits, access roads, pipelines, road ditches, cut and fill slopes, satellite plant, and associated evaporation and permeate ponds, Uranium One has committed to restore and reseed disturbed areas at the end of construction, which would typically occur within the same construction season (Uranium One, 2017e). As stated in EA Section 3.5, Converse County noted that noxious weed species are present at the Ludeman ISR Satellite Project. Cheatgrass, in particular, is a growing threat for Wyoming sagebrush habitats because of its ability to change fire and vegetation patterns [Wyoming Game and Fish Department (WGFD), 2017]. Revegetation of disturbed areas and soil stockpiles will reduce the potential for invasive and non-native weeds to become established in the project area. Uranium One has committed to conduct weed control, as needed, during all phases of the project and to consult with the Converse County Weed and Pest District for effective weed control techniques (Uranium One, 2017e). Suitable topsoil collected during construction activities will be salvaged and seeded as soon as practicable using WDEQ-approved seed mixtures until the soil is replaced during decommissioning (Uranium One, 2017e; WDEQ, 2006). Uranium One estimates that constructing the wellfields, satellite plant, and associated infrastructure for the proposed Ludeman ISR Satellite Project would take approximately 5.5 years (Uranium One, 2017e). If active revegetation measures are used with WDEQ-approved seed mixtures, the NRC staff expects that rapid colonization by annual and perennial herbaceous species in the disturbed staging areas and rights-of-way would restore most vegetative cover within the first growing season (NRC, 2009). As stated in EA Section 3.5, the Ute ladies’-tresses and Western prairie fringed orchid have not been found at the Ludeman ISR Satellite Project, and, therefore, would not be affected by construction impacts. The revegetation and weed control methods, size of the project area, and type and amount of vegetation to be disturbed during construction at the Ludeman ISR Satellite Project are consistent with the evaluations previously conducted in the GEIS; therefore, the NRC staff concludes that construction impacts on vegetation, including threatened and endangered plant species, from the proposed Ludeman ISR Satellite Project would be SMALL.

Because the project life of wellfields would be phased, only minor effects to vegetative communities would occur during the operations phase due to clearing activities for staggered wellfield expansion. The potential for these effects to occur during operations is less than that during construction, due to smaller areas of land being disturbed. Material spills from wellheads, pipelines, and failure of backup pond liners or embankment systems could occur during the operations phase, which could kill vegetation exposed to the spilled material. The ponds would be designed in accordance with NRC and WDEQ regulations; specifically, they would be either self-contained or would have a means of secondary containment, thus limiting the amount of material that could potentially affect vegetation. The licensee would continue to control the spread of weeds, limit vehicles to specific roads to reduce damage to vegetation, and reseed newly disturbed areas as soon as practicable. Because a small amount of land would be disturbed during the proposed operations phase and because of the lower number of vehicles accessing the proposed project area, and because of the licensee’s commitment to mitigation

measures, the potential impacts on vegetation, including threatened and endangered plant species, from the proposed Ludeman ISR Satellite Project would be SMALL.

Construction and drilling equipment are not used during the aquifer restoration phase; therefore, the NRC staff expects potential impacts to ecological resources from the Ludeman ISR Satellite Project during aquifer restoration would remain similar to those described previously for the operations phase and less than during the construction phase. During the aquifer restoration phase, the liquid byproduct material generated would be stored in evaporation ponds and permeate ponds. Additionally, the licensee proposes (subject to NRC license conditions and WDEQ permits) to discharge treated groundwater stored in the permeate ponds onto the land surface where it would flow into an ephemeral drainage. Potential impacts to vegetation may occur as a result of surface water discharge that could range from increased vegetation growth due to the increase of available water to the build-up of salts in the soil (NRC, 2009). Prior to discharging treated groundwater to the ground surface, an application will be submitted to the WDEQ (Uranium One, 2017d). A WDEQ permit would limit flow rates and effluent concentrations based on the classification of the receiving stream (Uranium One, 2017e). Because aquifer restoration activities would produce similar effects on vegetation compared to operations, and because the licensee would continue to implement similar mitigation measures and would be under specific limits imposed by WDEQ, the potential impacts, including impacts to threatened and endangered plant species, would not increase beyond those of the operations phase. Consistent with the determination in the GEIS, the NRC staff concludes that impacts during aquifer restoration on ecology (including vegetation) and to threatened and endangered plant species from the proposed Ludeman ISR Satellite Project would be SMALL.

The licensee estimates that decommissioning activities at the Ludeman ISR Satellite Project would take approximately 7 years (Uranium One, 2017e). Uranium One commits to revegetation measures described for the operations phase and to following WDEQ guidelines (WDEQ, 2014) for evaluating the success of final revegetation using an extended reference area concept (Uranium One, 2017e). Once permanent revegetation efforts are complete, it would likely require 2 to 4 years for grasses to be re-established, but it could take 10 or more years for mature shrub communities to be re-established (BLM, 2013a; BLM, 2015b). As required for decommissioning, the licensee would submit an updated reclamation plan for review and approval by NRC and appropriate state agencies. Consistent with the determination in the GEIS, the NRC staff concludes that impacts during decommissioning on ecology (including vegetation) and to threatened and endangered plant species from the proposed Ludeman ISR Satellite Project would be SMALL.

Re-establishment of native shrub species could be hindered by yearlong grazing pressure. Large ungulates (i.e., wild and domestic animals with hooves) are attracted to more succulent, younger plants, and they often concentrate in newly seeded locations during the critical early-growth stage. The NRC staff recommends that the licensee apply mitigations such as fencing off areas with young vegetation, which would reduce these types of disturbances, where possible. In addition, the NRC staff recommends that the licensee avoid disturbing all wetlands. The NRC staff further recommends that the licensee consider using seed mixes for revegetation that benefit pollinators, birds, and other wildlife. These additional recommended mitigations could further reduce effects on ecological resources to ensure that the potential impacts to vegetation from the proposed Ludeman ISR Satellite project remain SMALL.

Under the No-Action Alternative, the proposed wellfields and facilities associated with the Ludeman ISR Satellite Project would not be constructed, operated, restored, or decommissioned. Therefore, none of the impacts to vegetation discussed for the proposed

action, including all proposed liquid waste management options, would occur. Existing activities such as grazing in the area and associated impacts would likely continue.

Wildlife

Impacts to individual animals and wildlife habitat could occur during well drilling, topsoil stripping, trenching, excavating, backfilling, compacting, grading, and building construction. Direct effects such as injuries or mortality to individual animals and removal of wildlife habitat could occur during these land disturbing activities. Indirect effects such as changes in vegetative communities (including weed colonization), displacement of individual animals, changes in predator/prey populations, loss of forage, and soil erosion could result from clearing and grading, increased noise, traffic, or other disturbances associated with activities proposed for the Ludeman ISR Satellite Project. Indirect effects due to vegetation alteration affecting wildlife habitat typically persist longer than direct effects to individual animals due to the length of time (months to decades, depending on the type of plant community) required for vegetation to re-establish and become habitable. Degradation of water quality, construction activities that cause erosion, and exposure to accidental spills could result in the mortality of individual species.

As previously discussed, the Ludeman ISR Satellite Project falls into the range of land area and planned disturbances that the NRC staff previously evaluated in the GEIS (NRC, 2009). The GEIS evaluated potential impacts to wildlife from ISR facilities in the region where the Ludeman ISR Satellite Project is located and found that potential impacts on terrestrial wildlife from construction could range from SMALL to MODERATE, depending on site-specific conditions. Potential impacts to vegetation, and thus indirect effects to wildlife due to habitat loss, from construction of the proposed Ludeman ISR Satellite Project, were described previously in this section. Direct effects to terrestrial wildlife could include deaths from collisions with traffic and equipment. Direct mortalities could be higher for smaller mammal species (e.g., voles, ground squirrels, mice) than for other wildlife because of the likelihood that they would retreat into burrows if disturbed and thus potentially be killed by vehicles, topsoil scraping, or staging activities. Individual animals, such as raptors and migratory birds, could desert their nests or experience reproductive failure as a result of increased presence of humans and noise from traffic and construction activities resulting in temporary reductions of bird populations in the project area. Fugitive dust could be generated from vehicle travel on unpaved roads and bare land (EA Section 4.7 and Appendix B for fugitive dust analysis). Fugitive dust could increase localized air and visual disturbances to wildlife and settle on plants, making them unpalatable to wildlife. Hunting and hunting access would not likely be affected because, as discussed in EA Section 3.1.2, hunting and any other recreational activities are limited inside the proposed project boundary (Uranium One, 2017e).

To limit potential impacts to wildlife movement because of fencing that is planned to be installed around approximately 494.5 ha [1,222 ac] of wellfields, the licensee has committed to constructing wellfield fences in accordance with WDEQ Guideline 10 (Wildlife type III fence) (Uranium One, 2017e; WDEQ, 1994b). To reduce noise, fugitive dust, and the potential for direct collisions with vehicles and wildlife, Uranium One commits to enforcing speed limits year round (Uranium One, 2017e) and applying water or chemical dust suppressant to control fugitive dust emissions from unpaved roads (EA Section 4.7). The licensee has committed to conducting additional mitigation measures that would limit effects on water quality, and thus ecological resources, such as limiting activities that cross stream beds (EA Section 4.5), applying dust suppressant to control fugitive dust emissions from unpaved roads (EA Section 4.7), implementing spill response plans (EA Section 4.5), and limiting

activities that lead to soil erosion (EA Section 4.5). The licensee has committed to implementing mitigation measures such as reduced speed limits during all phases of the project to reduce the risk of vehicular collisions and potential collisions with animals. The licensee has committed to limiting potential construction impacts on vegetation, and thus animal habitat and forage, by revegetating disturbed areas and soil stockpiles and by controlling weeds and invasive plant species. The project life of wellfields would be phased; therefore, not all of the potential effects would occur at the same time.

Based on the 2008 baseline wildlife surveys for the proposed Ludeman ISR Project, two ferruginous hawk ground nests and two great horned owl/red-tailed hawk tree nests are located within or adjacent to planned wellfields (Uranium One, 2017e). To obtain a Permit to Mine, Uranium One would be required by WDEQ to provide updated wildlife surveys (WDEQ, 2016a). Wildlife surveys are conducted at different times of the year and, if not completed prior to the issuance of the permit, WDEQ would include the completion of the surveys as a permit condition. To reduce unnecessary or undue disturbance to raptors and sage grouse, Uranium One has committed to use existing overhead power lines where possible, and to constructing all new power lines using designs that meet or exceed current Avian Power Line Interaction Committee (APLIC, 2006) recommendations (Uranium One, 2017e). Uranium One also has committed to conduct annual raptor surveys within the project area and a 1.6-km [1-mi] buffer in late May or early April each year to identify any new nests and assess the status of known nests and to consult with the U.S. Fish and Wildlife Service (FWS) prior to any nest disturbance (Uranium One, 2011b; Uranium One, 2017e). Removal of any active migratory bird nest or removal of any structure that contains an active nest (e.g., a tree, fence post, or power line pole) is prohibited by law (FWS, 2015). In addition, nest manipulation is not allowed without a permit (FWS, 2015). Also, all native migratory birds, their feathers and body parts, nests, eggs, and nestling birds are protected by the Federal Migratory Bird Treaty Act (MBTA), making it unlawful to, hunt, shoot, wound, kill, trap, capture, or sell birds listed under this convention. All the bird species observed during baseline wildlife surveys for the proposed project area are protected under the MBTA (Uranium One, 2017e; 70 FR 12710). Eagles are additionally protected by the Bald and Golden Eagle Protection Act (BGEPA) (FWS, 2015). The licensee would be responsible for complying with these acts during all phases of the proposed Ludeman ISR Satellite Project, limiting potential effects on birds from the proposed project.

The licensee estimates that constructing the Ludeman satellite facility, initial wellfields, and storage pond systems for the proposed Ludeman ISR Satellite Project would require up to 5.5 years to complete (Uranium One, 2017e). The NRC staff anticipates that the Ludeman ISR Satellite Project area would not be uninhabitable when construction ends, and some animals may return to their previously occupied habitats (NRC, 2009). The NRC staff concludes that, given the mitigations that the licensee commits to employ during construction at the Ludeman ISR Satellite Project and the mitigations required by WDEQ, potential impacts to ecological resources from construction activities would be SMALL.

As discussed in EA Section 3.5, the FWS has indicated that the Ludeman ISR Satellite Project, which is located within the Platte River System, may affect downstream populations of one threatened bird species (piping plover), two endangered bird species (whooping crane and least tern), and one endangered fish species (pallid sturgeon) (FWS, 2017b). As stated in Section 3.4.1 (surface water), water to be used in well drilling operations would be obtained from sources within the Ludeman Project area that are not hydrologically connected to the North Platte River. Therefore, the NRC staff determines that no water depletions resulting from the Ludeman ISR Satellite Project would affect these threatened and endangered species that may occur in the downstream riverine habitats of the North Platte River system. Uranium One

has committed to conduct annual wildlife surveys, which would identify whether whooping crane, least tern, and piping plover were present within the project area. In addition, the project area does not contain sufficient river habitat to support the pallid sturgeon (EA Section 3.5). No federally listed threatened or endangered species or critical habitats are known to occur within the Ludeman ISR Satellite Project; therefore, the NRC staff concludes there would be no effect on federally listed or candidate species or their critical habitat during construction and that impacts on protected species from activities would be SMALL.

To further minimize effects to wildlife from construction activities, NRC staff recommends that the licensee construct all fences, not only those around wellfields, in accordance with WGFD (2004) and WDEQ (1994b) construction technique guidelines. BLM's interim guidance for migratory birds (BLM, 2012b) recommends that pre-disturbance clearances are conducted within 7 days prior to the disturbance to detect any newly arriving nesting birds. Conducting pre-disturbance clearances and adhering to FWS-recommended buffer distances and timing stipulations (FWS, 2017b) for project activities would ensure that birds are not disturbed by the proposed Ludeman Project. Based on the 2008 baseline wildlife surveys, 11 active raptor nests were located closer to proposed facilities than the FWS-recommended spatial buffers for those particular species (Uranium One, 2017e; FWS, 2017c). If active nests with eggs or young are located within the Ludeman ISR Satellite Project area, the licensee should establish spatial and timing buffers around those nests, and construction activities should be delayed until all young have fledged, and the licensee should consult with the FWS.

The potential impacts to mammals, raptors, upland game birds, waterfowl, shorebirds, raptors, amphibians, and reptiles during operations would be similar to or less than those described earlier for the construction phase because earthmoving activities and the amount of traffic would be less than compared to the construction phase. As stated for impacts from construction, the licensee has committed to mitigation measures that would also limit potential effects on wildlife during the operations phase. These mitigations include implementing speed limits, driving on existing roads, following spill response plans, minimizing vehicular access to roads within the project area, reseeding disturbed areas, limiting noise and traffic, conducting annual raptor surveys, taking measures to limit erosion and sedimentation, designing the storage ponds to contain releases as much as possible if leaks occur, and following mandated spill response activities. During operations at the Ludeman ISR Satellite Project, proposed evaporation and permeate ponds and surface water discharges present an additional opportunity for wildlife, primarily migratory birds, to have direct contact with wastewater solutions. Mammals (including bats), amphibians, and birds, are attracted to storage ponds and mud pits by mistaking them for fresh bodies of water (FWS, 2009). The potential for wildlife to access the surface impoundments would be minimized by the installation of fencing around the wellfields and the storage ponds. The licensee expects that mud pits would be backfilled within 30 days of initial excavation (Uranium One, 2017e).

Some of the chemical constituent concentrations in proposed wastewater solutions that would be either discharged or stored in the evaporation and permeate ponds and contained in mud pits may exceed levels known to cause impacts to wildlife. The NRC staff have previously analyzed potential impacts on wildlife from ISR facilities in the Wyoming East Uranium Milling region and determined that some of the chemical constituent concentrations in proposed wastewater solutions that would be stored in storage ponds may exceed levels known to cause impacts to wildlife (NRC, 2016b). For the Ludeman ISR Satellite Project, the NRC staff compared Uranium One's expected range of post mining liquid waste water quality concentrations that would be stored in the evaporation pond (Uranium One, 2017d) with EPA's chronic (long-term), exposure-based water quality criteria (guidance) established for the

protection of aquatic life in fresh water and found the estimated concentration ranges of alkalinity, cadmium, chloride, lead, mercury, and selenium expected in proposed waste water solutions to exceed the EPA chronic and acute exposure-based water quality aquatic life criteria (EPA, 2014). The NRC staff also reviewed the permeate water quality estimates provided by Uranium One in the revised ER (Uranium One, 2017e) and concluded that the estimated permeate water quality discharged or stored in the evaporation pond may exceed the EPA's values for pH, alkalinity, and selenium. As discussed in EA Sections 4.5 and 4.12, if NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman ISR Satellite Project, NRC will include a license condition prohibiting surface water discharge of permeate pond water. However, for the purpose of protecting wildlife from impacts related to surface water discharge areas, if permitted, the WDEQ Permit to Mine will establish discharge limits and monitoring requirements and action levels for metal concentrations in soils, vegetation, surface water, and groundwater from ISR operations that are protective of the environment. Uranium One will collect water quality samples monthly from the surface water discharge location to ensure compliance with the WYPDES permit (Uranium One, 2017c). The WDEQ would review monitoring data and impose corrective actions if action levels are exceeded. If WDEQ finds that the liquid waste management activities could impact wildlife directly or indirectly through soil and vegetation, it will impose additional conditions on the licensee to mitigate impacts and protect the environment. The NRC staff concludes that impacts to individual animals would be possible even with the practices proposed by the licensee and the WDEQ regulatory controls that would be imposed by permit conditions, which include monitoring, setting action levels, and requiring corrective actions if those controls do not limit all direct exposures of wildlife to wastewater solutions. However, because the licensee has committed to employing mitigations, such as perimeter fencing and an avian-deterrent system around ponds should bird deaths be observed, the NRC staff concludes that the direct exposure of wildlife to wastewater solutions will be limited and that, under current regulatory controls, environmental concentrations of wastewater constituents are unlikely to reach levels that would lead to destabilization of wildlife populations.

The licensee has committed to conducting annual raptor surveys and employing mitigations, such as taking measures to limit erosion and sedimentation, designing the evaporation pond to contain releases as much as possible if leaks occur, collecting water quality samples monthly from the surface water discharge location, following mandated spill response activities, and limiting the potential for animals to be exposed to waste water solutions. Therefore, NRC staff determines that potential impacts to wildlife during the operations phase would be consistent with the GEIS and would be SMALL. No federally listed threatened or endangered species or critical habitats are known to occur within the Ludeman ISR Satellite Project, and the licensee would continue to implement similar mitigation measures employed during construction; therefore, the NRC staff concludes that there would be no effect on federally listed or candidate species or their critical habitat during operations.

The licensee could further limit the potential for birds and other wildlife to access impoundments. The NRC recommends that the licensee limit liquid waste exposure to wildlife during operations by installing an avian-deterrent system to evaporation and permeate ponds before injuries or deaths are noted to startle or make the birds feel uncomfortable and otherwise prevent the birds from using the ponds. While drilling wells, the licensee could use temporary fencing around all open mud pits to prevent wildlife from potentially being trapped or exposed to mud pit constituents. To further minimize impacts to birds and other wildlife, the NRC staff recommends that if mud pits are not backfilled within 30 days, the licensee should employ operational practices (e.g., netting or screening) to deter birds and other wildlife from the mud

pits. These additional recommended mitigation measures would ensure that potential impacts to wildlife during the operations phase would remain SMALL.

GEIS Section 4.3.5.3 (NRC, 2009) describes potential impacts to ecological resources during the aquifer restoration phase that are similar to potential impacts described previously that could occur during operations. These impacts could include habitat disruption, spills and leaks, and animal mortalities. Because existing (in-place) infrastructure will be used during aquifer restoration, little additional ground disturbance would occur, and, therefore, potential impacts would be SMALL (NRC, 2009). Uranium One has committed to limiting potential impacts on ecological resources by applying mitigation measures, including but not limited to, the following: (i) limiting vegetation disturbances, (ii) following spill control and erosion plans, (iii) seeding disturbed areas and topsoil stockpiles (EA Section 4.4), (iv) suppressing fugitive dust on unpaved roads, (v) enforcing speed limits, (vi) fencing wellfield areas, and (vii) conducting annual raptor surveys. Aquifer restoration activities and associated impacts from permeate storage ponds and surface water discharge would be similar to the operations phase if a WYPDES permit were issued by WDEQ. There would be no expected impacts to protected species during aquifer restoration beyond those that occurred during the construction and operations phases, because the existing infrastructure would be in place. Based on NRC's previous conclusion for the GEIS, the foregoing analysis that impacts to ecological resources from aquifer restoration would be similar to impacts to ecological resources on operations, the licensee's mitigation commitments, and that no threatened or endangered species or critical habitat would be affected, the NRC staff determines that impacts to ecological resources during the aquifer restoration phase would be SMALL.

GEIS Section 4.3.5.4 describes potential impacts to ecological resources during the decommissioning phase that are similar to potential impacts during construction (NRC, 2009). Decommissioning activities would be temporary and would reduce with time as decommissioning and reclamation proceed. The removal of piping would impact vegetation that has re-established itself. Wildlife could come in conflict with heavy equipment and could be temporarily displaced until reclamation is completed. Land that is used for irrigation would be included in decommissioning surveys to ensure that potentially impacted (contaminated) areas would be appropriately characterized and remediated, as necessary, in accordance with NRC regulations. Because the proposed site-specific decommissioning phase activities are similar to those activities evaluated in the GEIS, and based on Uranium One's routine monitoring program and the inclusion of surface water discharge areas in decommissioning surveys, the NRC staff concludes that impacts on ecological resources during the decommissioning phase would be SMALL.

Under the No-Action Alternative, the Ludeman ISR Satellite Project would not be licensed, and the land would continue to be available for other uses and wildlife. Under the No-Action Alternative, there would be no ISR activities associated with the proposed Ludeman ISR Satellite Project; therefore, there would be no land disturbance from the proposed action that could impact wildlife populations. The proposed project area would continue to support vegetation communities and wildlife habitat typical of the region, as characterized in EA Section 3.5. Land would continue to be used for livestock grazing. Grazing of existing vegetation, particularly the grassland communities, would continue. Under the No-Action Alternative, if current grazing practices continue, only a few individual species could be affected as a result of land management decisions (e.g., overgrazing or conflicts between cattle and other species); however, other wildlife species would be likely to relocate to suitable nearby habitats.

4.7 Air Quality

This section addresses nonradiological air emissions of nongreenhouse gases that may occur as a result of developing the proposed Ludeman ISR Satellite facility under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. The air quality impacts associated with the No-Action Alternative are also evaluated in this section. The NRC staff's analysis in this section considers the impacts on air quality from the peak year of activity at the proposed project for all project phases (construction, operation, aquifer restoration, and decommissioning). The peak year accounts for the times when some or all of these ISR phases occur simultaneously and represents the highest amount of emissions the project would generate in one year. Radiological emissions are addressed in EA Section 4.12, and greenhouse gases, as well as climate change, are addressed in EA Section 5.7 and Appendix B.

As described in the NRC's GEIS (NRC, 2009), potential air quality impacts may occur during all ISR phases from the various activities that generate air emissions. Potential effects on nonradiological air quality from the proposed Ludeman ISR Satellite Project mirror those described in the GEIS and primarily involve fugitive dust emissions from vehicles traveling on unpaved roads as well as combustion engine emissions from mobile sources. The GEIS analysis concluded that, in general, air-quality impacts from ISR emission sources were SMALL (GEIS Section 4.3.6). The emission levels and associated air dispersion modeling specified in GEIS Table 2.7-2 provides the basis for this conclusion. Because the Ludeman facility is located approximately 150 km [93 mi] from Willow Creek and the concentration of airborne effluents decrease with distance, consideration of the Willow Creek facility airborne emissions is limited to the cumulative effects analyses in EA Chapter 5.

Annual emission estimates for both the proposed Ludeman ISR Satellite Project and the GEIS are summarized in EA Appendix B, Table B–2. The Ludeman emission estimates in Appendix B Table B–2 incorporate the following three mitigation measures that the licensee has committed to implement during the Ludeman ISR Satellite Project for all project phases:

- Using dust suppression to reduce fugitive dust emissions from travel on unpaved roads
- Reclaiming disturbed land as soon as practicable to reduce fugitive dust emissions from wind erosion, and
- Using newer drill rigs and construction equipment with engines that meet certain emission standards mandated by the Federal Government and produces fewer emissions relative to older engines.

The effectiveness of these mitigation measures is described in EA Appendix B Section B.1.4. The licensee has also committed to use an acid scrubber/demister, which would eliminate acid fumes from unloading and handling hydrochloric acid. The NRC staff identified other mitigation measures that could further reduce air emissions generated by the proposed action under all liquid waste management options (EA Table 6-1). For the proposed Ludeman ISR Satellite Project, particulate matter PM_{10} is the pollutant with the highest emission level. Uranium One estimates that 133.0 metric tons [146.6 short tons] of this pollutant would be emitted, which is greater than the estimated 10.0 metric tons [11.0 short tons] that the NRC staff analyzed for ISR facilities in the GEIS (EA Appendix B, Table B–2). Based on the difference between these estimated particulate matter PM_{10} emission levels, the NRC staff concludes that the site-specific

analysis in this EA for the Ludeman ISR Satellite Project is not bound by NRC's analysis conducted in the GEIS for effects on air quality from particulate matter emission levels.

One key factor in assessing potential impacts from the proposed Ludeman ISR Satellite Project is the proximity of residences to the emission sources. Locations of residences relative to the locations of the Ludeman ISR Satellite Project emission sources are provided in EA Figure 2-1. A cluster of fugitive dust emission sources including access roads, two wellfields, evaporation and permeate ponds, and the satellite plant are located in the northwest corner of the Ludeman ISR Satellite Project. Over 98 percent of the expected particulate matter PM_{10} emissions that would be generated from the proposed Ludeman ISR Satellite Project come from fugitive sources like this cluster (EA Appendix B, Table B–5). One residence is located within the proposed Ludeman ISR Satellite Project boundary, approximately 800 m [2,640 ft] east of Wellfield 2 and 1,600 m [5,280 ft] east of the proposed satellite plant (Uranium One, 2017e). The predominant wind direction would transport emissions from this cluster of fugitive dust emission sources towards the residence located within the Ludeman ISR Satellite Project boundary (Uranium One, 2016b). However, the onsite residence would not be the closest residence to the proposed Ludeman ISR project emission sources. The Negley residential subdivision that has about a dozen residences is located across State Highway 93 northwest of the Ludeman ISR Satellite Project. The nearest residence to the proposed project within the Negley Subdivision is located approximately 300 m [984 ft] from the cluster of fugitive dust emission sources (Uranium One, 2011b). Winds at the Ludeman ISR Satellite Project are also common from the east-southeast (EA Section B2). Winds from the east-southeast would transport emissions generated from the cluster of emission sources towards the Negley Subdivision across the northwest corner of the Ludeman ISR Satellite Project boundary.

The NRC staff's analysis in this EA does not include site-specific air dispersion modeling for the Ludeman ISR Satellite Project. However, the NRC staff's analysis of the Reno Creek ISR Project (NRC, 2016b) included site-specific modeling. The NRC staff considered the site-specific conditions at the proposed Ludeman ISR Satellite Project and determined that the air dispersion modeling conducted for the Reno Creek ISR Project is appropriate to use to characterize the air quality impacts from the proposed Ludeman ISR Project. The NRC staff's basis for drawing this conclusion is described in EA Appendix B Section B–2. The modeling conducted for the Reno Creek Supplemental Environmental Impact Statement (SEIS) compared the expected pollutant airborne concentrations from the peak year emissions of that project to the EPA's National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) regulatory thresholds. As described in Reno Creek SEIS Section 4.7.1 (NRC, 2016b), the purpose of this comparison was to characterize the magnitude of the potential air emission impacts from the proposed project rather than conducting or documenting a formal regulatory determination for air permitting purposes. To respond to the NRC staff's requests for information, the licensee considered the air dispersion modeling conducted for Reno Creek in the context of the proposed Ludeman project. The results of the Reno Creek site-specific air dispersion modeling showed that at a distance of 200 m [656 ft] from the emission source, particulate matter PM_{10} concentrations were below NAAQS and PSD thresholds (Uranium One, 2016b; Uranium One, 2017b). The same held true for the particulate matter $PM_{2.5}$ emissions (Uranium One, 2016c; Uranium One, 2017b).

Therefore, based on the consideration that peak year particulate matter concentrations are expected to be below NAAQS and PSD thresholds at a distance of 200 m [656 ft] from the emission sources and that the nearest residence is about 300 m [984 ft] from the proposed Ludeman ISR Satellite Project emission sources, the NRC staff concludes that the potential environmental impact from the peak year particulate matter emissions on air quality would be

SMALL. Based on the consideration that the proposed Ludeman ISR Satellite Project particulate matter emission levels for each ISR phase are lower than the peak year emission levels (EA Appendix B, Table B–4), the NRC staff concludes that the potential environmental impact on air quality from particulate matter emissions at the proposed project during each ISR phase option would be SMALL.

For the pollutants other than particulate matter, peak year emission levels at the Ludeman ISR Satellite Project are estimated to be either lower than or similar to the emission levels used for the GEIS analysis, as well as the Reno Creek ISR Project analysis (EA Appendix B Table B–2). The NRC staff concluded in the GEIS and the Reno Creek SEIS that impacts on air quality from these other pollutants would be SMALL. Therefore, because emission levels at the Ludeman ISR Satellite Project are estimated to be similar to or lower than emission levels analyzed for the GEIS and Reno Creek SEIS, the NRC staff concludes that the potential environmental impact of peak year emission levels from the pollutants other than particulate matter at the Ludeman ISR Satellite Project would also be SMALL. Based on the consideration that the proposed Ludeman ISR Satellite Project emission levels for pollutants other than particulate matter for each ISR phase are lower than the peak year emission levels (EA Appendix B, Table B–4), the NRC staff concludes, in summary, that the potential environmental impact on air quality from emissions of pollutants other than particulate matter at the proposed project during each ISR phase would be SMALL.

In summary, the NRC staff concluded that the particulate matter emission levels for the Ludeman ISR Satellite Project are not bound by the NRC's GEIS analysis; however, based on the analysis described previously, the NRC staff concludes that the potential environmental impact on air quality from the peak year particulate matter emissions from the proposed Ludeman ISR Satellite Project would be SMALL. For the pollutants other than particulate matter, the proposed Ludeman ISR Satellite Project peak year emission levels are either lower than or similar to the emission levels estimated in the analyses that the NRC staff conducted for the GEIS and Reno Creek ISR Project (determined to be SMALL) and are, therefore, SMALL. Thus, the NRC staff concludes that the overall impacts on air quality from the Ludeman ISR Satellite Project would be SMALL.

Under the No-Action Alternative, the proposed wellfields and facilities associated with the Ludeman Project would not be constructed, operated, restored, or decommissioned. None of the potential air quality impacts associated with the proposed action, such as particulate matter emissions, would occur. Existing activities in the area and associated impacts would likely continue.

4.8 Noise

This section describes potential noise impacts from the Ludeman ISR Satellite Project during all phases of the facility's life cycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. The potential impacts from the No-Action Alternative are also evaluated in this section.

As discussed in GEIS Section 4.3.7, potential impacts from noise at an ISR facility may occur during all phases of the facility lifecycle and could include (i) noise generated from the use of heavy equipment (e.g., bulldozers, graders, drill rigs, compressors); (ii) increases in potential noise compared to the rural or undeveloped setting of the proposed project; and (iii) increases in

noise from traffic associated with all phases of the proposed project (NRC, 2009). During all phases of the proposed project, the NRC determined that noise-generating activities and associated traffic would be expected to have a SMALL to MODERATE noise impact for residences, communities, or sensitive areas (NRC, 2009). Therefore, the GEIS concluded that overall noise impacts would be SMALL to MODERATE.

State Highways 93 and 95 provide access to the proposed project area and are line sources of noise. Vehicular traffic sound at a distance of 15 m [50 ft] from the receptor has been estimated at 54 to 62 dBA for passenger cars and 58 to 70 dBA for heavy trucks (FHWA, 2011). Because noise from line sources, such as roads, is reduced by approximately 3 dBA per doubling of distance (FHWA, 2011), the maximum truck sound level of 70 dBA on the shoulder of either State Highway 93 or 95 (or Interstate Highway 25 to the south of the proposed project area) would diminish to the level of a Category "A" activity (57 dBA) approximately 480 m [1,575 ft] from the source. Noise dampening characteristics of topographic interference and vegetation are not part of these calculations (NRC, 2009). It is expected that sound levels beyond a distance of 480 m [1,575 ft] from State Highway 93 and 95 will be approximately 40 dBA. This calculation produces a conservative estimate of a baseline for ambient noise that is slightly higher than the GEIS statement that existing ambient noise levels in the region range from 22 to 38 dBA (NRC, 2009). GEIS Figure 3.2-17 provides examples of sound levels for common activities (NRC, 2009).

The primary land use within the Ludeman ISR Satellite Project is rangeland, with noise sources dominated by the existing ambient noise from State Highways 95, 93, or County Road 26 and surrounding oil and gas operations. The nearest noise receptors are residents located within the Negley Subdivision, located approximately 300 m [984 ft] north of Wellfield 1. In addition, the proposed satellite building is approximately 0.8 km [0.5 mi] from the residential Negley Subdivision and approximately 1.6 km [1 mi] from the Leuenberger Ranch house. For all phases of the proposed project, the NRC staff expects that wildlife would avoid areas where noise-generating activities occur.

Primary noise sources associated with construction at the Ludeman ISR Satellite Project would be (i) drilling, specifically the use of heavy equipment to scrape and level the ground surface for drilling; (ii) installing evaporation ponds, permeate ponds, and/or surface water discharge points; and (iii) traffic noise. Noise levels would be highest during construction, with a decrease during subsequent phases. Noise levels are expected to be higher during daylight hours {conservatively anticipated to be 85 dBA at a distance of 15 m [50 ft]} when construction is more likely to occur, and noise would be more noticeable in proximity to the operating equipment. Noise levels would return to background levels at distances more than 305 m [1,000 ft] from the noise-generating activities. Although residences are located slightly less than 305 m [1,000 ft] from noise-generating activities associated with the Ludeman ISR Satellite Project, the licensee has committed to installing appropriate engineering controls that include protective enclosures for equipment to further reduce noise levels (Uranium One, 2017e). The licensee has also committed to implementing speed limits to mitigate traffic noise, as well as restricting road construction activities to the daytime (Uranium One, 2017e). Due to the rural location of the proposed project, the low population density of the surrounding area, and proposed mitigation measures (e.g., engineering controls and speed limits), potential impacts from noise during construction at the Ludeman ISR Satellite Project would be SMALL.

During operations, the primary noise source would be wellfield equipment (e.g., pumps and compressors). Wellfield equipment would be contained within structures (e.g., header houses), thus limiting the propagation of noise. Because construction equipment, such as bull dozers,

would not be used during the operations phase, the nearest residents, approximately 300 m [984 ft] away, would not be able to hear noise associated with wellfield operations. Traffic noise from commuting workers and truck shipments to and from the satellite plant would be localized and limited to access roads and highways in the vicinity of the proposed project (Uranium One, 2017e). In addition, noise levels produced by unshielded machinery at the proposed project site have the potential to be about 85 dBA at 15 m [50 ft]. However, operational experience at ISR facilities indicates that this sound level is conservative and that the average sound pressure levels during construction (loudest project phase) will be less than 85 dBA. The licensee may use appropriate engineered controls (i.e., the protective enclosure for the equipment) to reduce the noise levels, thereby making the levels closer to those associated with line source traffic (Uranium One, 2017e). The potential impact from noise associated with the Ludeman ISR Satellite Project during the operations phase would be less than during the construction phase because fewer pieces of heavy machinery would be in use. Therefore, the NRC staff concludes that impacts from noise during operations at the Ludeman ISR Satellite Project would be SMALL.

Noise generated at the Ludeman ISR Satellite Project during the aquifer restoration phase would either be similar to or less than noise generated during the operations phase because of reduced traffic. Traffic noise would be limited to supply deliveries and staff traveling to the site, resulting in overall fewer vehicular trips than during previous phases (Uranium One, 2017e). Because the amount of equipment used and the volume of traffic would be less than during the construction phase (the phase with highest potential for noise impacts), the NRC staff concludes that impacts from noise during aquifer restoration at the Ludeman ISR Satellite Project would be SMALL.

The noise generated during decommissioning would be similar to or less than the noise generated during the construction phase. Sources of noise during decommissioning would include earthmoving, excavation, and building demolition. However, fewer demolition shipments to and from the Ludeman ISR Satellite Project site would occur as decommissioning progressed, resulting in less noise from traffic. Therefore, the NRC staff concludes that the impact from noise during decommissioning at the Ludeman ISR Satellite Project would be SMALL.

Under the No-Action Alternative, the Ludeman ISR Satellite Project would not be licensed, and there would be no associated construction, operation, aquifer restoration, or decommissioning. Therefore, there would be no associated change in the current sound levels within the proposed project area or to surrounding noise receptors. The rural setting of the proposed project area and the continuation of ongoing natural resources exploration activities would result in sound levels remaining at ambient levels.

4.9 Historic and Cultural Resources

This section describes potential environmental impacts to historic, cultural, and paleontological resources at the proposed Ludeman ISR Satellite Project during each phase of the facility lifecycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. The impacts to historic, cultural, and paleontological resources associated with the No-Action Alternative are also evaluated in this section. Predominantly, these impacts could result from the loss of or damage to historic, cultural, and archaeological resources, as well as temporary restrictions on access to these resources.

As part of the pre-licensing activities, licensees are required by NRC to conduct the appropriate historic and cultural resource surveys. The eligibility evaluations of historic properties for listing in the National Register of Historic Places (NRHP) or as a traditional cultural property (TCP) under criteria in Title 36 of the *Code of Federal Regulations* (36 CFR) 60.4(a)–(d) are conducted as part of a site-specific environmental review because most TCPs are identified through consultation. To determine whether significant historic and cultural resources are to be avoided or mitigated, consultations involving the NRC, the licensee, Wyoming State Historic Preservation Office (WY SHPO), and Native American Tribes occur as part of the site-specific review. If discovery of previously undocumented historic or cultural resources are identified during construction activities, NRC requires licensees to stop work and notify the appropriate federal, Tribal, and state agencies, with regard to appropriate mitigation measures.

Construction activities, including wellfields, facilities, liquid waste management systems, and access roads, have the potential to directly affect archaeological sites identified within the Ludeman project area. Of the archaeological sites identified during the Class III inventory, four are located in proximity to areas where construction would occur (EA Section 3.8). One of these resources is a livestock watering station, including a windmill and tank, site 48CO3027, located within the monitor well ring of Wellfield 4. A prehistoric stone ring feature, site 48CO3009, is located within the monitor well ring of Wellfield 3. Both of these sites have been recommended not eligible to the NRHP. The remaining two sites, 48CO3036 and 48CO3037, are prehistoric rock features and lithic scatters that were identified within the direct area of potential effect. Site 48CO3036 was initially recommended not eligible, and the Class III Cultural Resource Report recommended further investigations at 48CO3037. The NRC conducted tribal consultation, specifically with the Northern Cheyenne Tribe (as described in EA Section 3.8.2) on the nature of stone feature sites in the area and on sites 48CO3036 and 48CO3037, in particular. The Northern Cheyenne Tribe stated that both sites 48CO3036 and 48CO3037 are of significance to the Tribe and recommend that both sites be determined eligible for the NRHP under Criteria A and D due to the sites' association with past events and their potential to yield information significant to prehistory. As a result of these comments, the NRC determined that the sites are eligible and submitted revised site forms and determinations of eligibility to the WY SHPO. The WY SHPO concurred with the NRC's determinations of eligibility for sites 48CO3036 and 48CO3037 (WY SHPO, 2018a). Therefore, the NRC will require by license condition that Uranium One commit to avoid sites 48CO3036 and 48CO3037 during all phases of the project. The WY SHPO concurred with the NRC's determination of no effect (WY SHPO, 2018b). Because of the avoidance measures previously described in this section and in Section 3.8.2, the NRC staff concludes that there would be no impact from construction on the NRHP eligible sites, and impacts to historic and cultural resources would be SMALL.

The footprint for operations would be the same as that considered for the construction phase. There would be no impacts on NRHP-eligible sites from the operation of the facility, nor from the aquifer restoration or decommissioning phases. Uranium One has committed to an inadvertent discovery plan to address the potential identification of previously unrecorded historic and cultural resources during any phase of the project. The inadvertent discovery plan includes a stoppage of work and notification of appropriate authority parties (federal, Tribal, and state agencies) (Uranium One, 2017e). Therefore, the NRC staff concludes that there would be no impacts to the NRHP eligible sites, and impacts to historic and cultural resources at the Ludeman ISR Satellite Project for operations, aquifer restoration, and decommissioning would be SMALL.

Although no paleontological resources were identified, should there be an inadvertent discovery of a paleontological resource, NRC-approved procedures would be followed to address any

disturbance in excess of a few feet. Therefore, the NRC staff concludes that the impact from all phases on paleontological resources would be SMALL.

Under the No-Action Alternative, the Ludeman site would not be licensed, and there would be no associated construction, operation, aquifer restoration, or decommissioning; therefore, there would be no archaeological sites, isolated cultural resources, TCPs, or paleontological resources affected by the proposed action. Cultural impacts from current land activities, such as CBM extraction, oil and gas extraction, and cattle ranching, would continue.

4.10 Visual and Scenic Resources

This section describes potential visual and scenic resource impacts from the Ludeman ISR Satellite Project that may occur during all phases of the facility's lifecycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. The visual and scenic resource impacts associated with the No-Action Alternative are also evaluated in this section.

As described in GEIS Section 4.3.9, most visual and scenic impacts from an ISR facility would be associated with drilling and other land-disturbing activities, such as access road and facility construction (NRC, 2009). Additional construction impacts would include dust that is generated during clearing for access roads, wellfields, laydown areas, ponds, monitoring wells, and piping. Fewer impacts to visual and scenic resources would be anticipated for the operations, aquifer restoration, and decommissioning phases. The use of mitigation measures (e.g., dust suppression and neutral-colored wellheads) would further reduce overall visual and scenic impacts from ISR projects. Overall, the GEIS concluded that impacts to visual and scenic resources during all phases of an ISR project would be SMALL (NRC, 2009).

The proposed Ludeman ISR Satellite Project is in an area where livestock grazing, oil and gas extraction, and a small residential community (the Negley Subdivision) are present. The visual and scenic resources potentially impacted from the project would be from the use of equipment such as drill rigs; dust and other emissions from such equipment; installation of header houses and a satellite building; construction and use of wellfield access roads; and land clearing and grading activities. Disturbance associated with access roads, pipelines, and power lines would create linear contrasts with the natural lines, and the wells would contrast with natural landforms.

Construction of the evaporation and permeate ponds, satellite building, and ancillary structures would be the most visually noticeable because of their size. The evaporation ponds would encompass the largest footprint at approximately 28 ha [69 ac]. The permeate ponds, satellite plant, and parking and laydown areas would total approximately 7 ha [18 ac]. Once constructed, the total Ludeman ISR Satellite Project fenced area would encompass a space of approximately 533 ha [1,318 ac]. The satellite plant and ponds would be prominent in both the fore- and middle-ground and would be silhouetted in the background. The licensee has committed to mitigation measures that would limit the visual impacts of the proposed project. Specifically, header houses associated with the Ludeman ISR Satellite Project would be painted to blend in to the natural landscape, and power lines and pipelines would be buried where appropriate (Uranium One, 2107e). The licensee commits to recontouring surface disturbances to blend in with the natural terrain, to revegetate areas, to use erosion control BMPs consistent with guidelines and requirements of a WDEQ Permit to Mine, and would use dust suppressant (water or chemical suppressant), as warranted, to minimize fugitive dust (Uranium One, 2107e).

In addition, during construction, the licensee would remove construction debris and reclaim land as soon as possible (Uranium One, 2107e). These mitigation measures to limit visual contrasts would minimize visual resource impacts from the proposed project activities and keep the visual impacts consistent with the predominant scenic and visual quality of the proposed project area. Therefore, the NRC staff concludes that the impacts on visual and scenic resources from construction activities at the proposed Ludeman ISR Satellite Project would be SMALL.

The facilities constructed for the Ludeman ISR Satellite Project would not change visually during operations or aquifer restoration phases and, therefore, would not add to the impacts experienced during construction. Uranium One would continue to mitigate visual and scenic impacts during operations and aquifer restoration by recontouring surface disturbances to blend in with the natural terrain and would use dust suppressant to minimize fugitive dust. Therefore, impacts on visual and scenic resources from operations and aquifer restoration would remain SMALL.

During decommissioning at the proposed Ludeman Project, the amount of visual disturbances would decrease as wellfields are decommissioned and facilities are removed. After ISR production activities are completed, the wellfields and all disturbed areas would be reclaimed. The ownership of some roads may be transferred to land owners and may not be reclaimed. Therefore, based on these factors, the NRC staff concludes that the impacts on visual and scenic resources from the proposed Ludeman ISR Satellite Project during decommissioning would be less than during the construction and operations phases, and would thus be SMALL.

In summary, the permit areas of past facilities evaluated in the GEIS have ranges from 1,034 ha to 6,480 ha [2,552 to 16,000 ac] of land (GEIS Section 2.10.1). Typically, the land disturbance within these permit areas have been from 49 ha to 490 ha [120 ac to 1,200 ac], or 1 to 20 percent of the permit areas. Visual and scenic impacts from all phases of the proposed Ludeman ISR Satellite Project would fall within those impacts analyzed in the NRC's GEIS (NRC, 2009). In addition, Uranium One has committed to reducing visual and scenic impacts by using neutral color paint, utilizing dust suppressants, and maintaining visual impacts consistent with the predominant scenic and visual quality of the proposed project area. Therefore, the NRC staff concludes that the impacts from the proposed Ludeman ISR Satellite Project during all phases would be SMALL.

For the No-Action Alternative, the proposed Ludeman Satellite ISR Project would not be licensed, and there would be no associated construction, operation, aquifer restoration, or decommissioning; therefore, there would be no change to the existing visual and scenic resources. The existing pipelines, wellfields, and utility lines within the proposed project boundary from oil and gas would remain. No additional structures (header houses) associated with the proposed project would be introduced from the proposed action to affect the existing viewscapes, and the existing scenic quality would remain unchanged. Therefore, under the No-Action Alternative, there would be no impact to visual and scenic resources.

4.11 Socioeconomics and Environmental Justice

This section describes the potential environmental impacts to socioeconomic conditions (e.g., demographics, employment rate, housing, income, and education) that could occur during all phases of the facility's lifecycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. This section also provides an assessment of potential disproportionate impacts on

minority and low-income populations from the Ludeman ISR Satellite Project. The No-Action Alternative is also evaluated.

For all phases of the Ludeman ISR Satellite Project (construction, operations, aquifer restoration, and decommissioning), the peak annual employment is estimated to reach 151 workers (Uranium One, 2017d,e), which is less than the 200 annual peak number of workers analyzed in the NRC's GEIS (NRC, 2009). The first year of the project, when the Ludeman ISR Satellite Project is being constructed, is the year that the licensee anticipates would be the peak employment year. Uranium One anticipates that approximately 38 indirect jobs and 40 induced jobs would be created during the peak year of the Ludeman ISR Satellite Project. Assuming that all direct, indirect, and induced jobs are filled by persons currently living outside of Wyoming, and based on average household size in Wyoming of 2.42 in 2012 (Uranium One, 2017e), a total increase of 554 persons would be added to the populations of Converse and Natrona Counties.

The communities of Douglas, Glenrock, and Casper alone have more than 2,500 housing units available to provide the peak number of direct and indirect workers and their families with housing without significant effects to the baseline housing supply or demand. Assuming that the directly and indirectly employed families represent a similar average of school-aged children compared to that of Wyoming (20 percent), the NRC staff expects no more than 79 additional children to be enrolled in one of the 55 public schools within the area surrounding the proposed project as a result of families relocating to the area. Directly employed workers (up to 151 workers) will command salaries that provide income levels equal to or higher than the average local and statewide income levels, which is not expected to have a significant effect on employment in comparison to the combined labor force in Converse and Natrona Counties. For these reasons, the NRC staff concludes that the potential impact across all aspects of socioeconomics would be SMALL.

Under the No-Action Alternative, the Ludeman ISR Satellite Project will not be constructed or operated. Socioeconomic conditions in the populations of Converse and Natrona Counties would not change under the No-Action Alternative. Potential benefits from the proposed project, such as job creation and contribution to local, regional, and State revenues, will not occur under the No-Action Alternative.

Environmental Justice

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the construction and operation of a federal action. NRC environmental justice guidance discusses the procedures to evaluate potential disproportionately high and adverse impacts associated with physical, environmental, socioeconomic, health, and cultural resources to minority and low-income populations (69 FR 52040). The NRC requires that an environmental justice analysis be included in its EISs, and, as appropriate, supplements to an EIS; however, if a particular action will have no clear potential for offsite impacts to minority and low-income communities, NRC guidance states that there is no need to consider whether the action will have disproportionately high and adverse impacts on certain populations (69 FR 52040; NRC, 2003b).

The NRC staff assessed minority and low-income populations within a 6.4-km [4-mi] radius of the proposed Ludeman ISR Satellite Project considering each of Uranium One's proposed liquid waste management options. Because no minority or low-income populations, following

NRC guidance (NRC, 2003b), have been identified within 6 km [4 mi] of the Ludeman ISR Satellite Project area, no further environmental justice analysis was conducted. Consistent with NRC's Policy Statement (69 FR 52040) and guidance (NRC, 2003b), the NRC staff's environmental justice analysis for the proposed Ludeman ISR Satellite Project revealed that there would not be disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of the proposed Ludeman ISR Satellite Project. Therefore, environmental justice impacts during each phase would be SMALL.

Under the No-Action Alternative, the proposed Ludeman ISR Satellite Project would not be constructed and operated. Socioeconomic conditions in Converse and Natrona Counties would remain unchanged. Additionally, there would be no associated high and adverse effects to minority and low-income populations.

4.12 Public and Occupational Health

The analysis in this section evaluates the radiological and nonradiological public and occupational health and safety impacts for normal and accident conditions in each phase of the ISR facility lifecycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7), and has provided a comparison of the impacts for each option in EA Table 4-1. The potential impacts associated with the No-Action Alternative area were also evaluated.

During construction of the proposed Ludeman ISR Satellite Project, workers could be exposed to low levels of background radiation by direct exposure, inhalation, or ingestion of radionuclides during well construction, soil-disturbing activities, and fugitive dust from vehicular traffic. Because the proposed activities (e.g., wellfield construction) and the environmental conditions (including measured background radiation and radionuclide concentrations in soils and water at the Ludeman Unit wellfields, as described in Section 3.12), are comparable to those considered previously in the Willow Creek ISR Project licensing review, the NRC staff concludes that the construction phase of the proposed Ludeman ISR Satellite Project would also have a SMALL impact on workers and the general public.

Potential occupational health impacts during operations would be similar to the impacts analyzed in the previous licensing review for the Willow Creek ISR Project (NRC, 2011c; NRC, 2013a) and the NRC's GEIS (NRC, 2009). From an occupational health perspective, the proposed Ludeman ISR Satellite Project activities and associated Willow Creek ISR processing operations would be comparable to the activities and operations evaluated in these prior impact analyses. To limit radiological exposure to workers, the NRC requires that each licensee maintains a radiological protection program that complies with 10 CFR Part 20 requirements and satisfies applicable license conditions. The licensee expects that existing procedures for the Willow Creek ISR Project radiation safety program would apply to the proposed Ludeman ISR Satellite Project (Uranium One, 2017d; Cogema Mining Inc., 2008). Past operations at the Willow Creek ISR Project have demonstrated a capability to comply with NRC regulations. Measured historical annual worker doses at the Willow Creek ISR Project have been well below 10 percent of the limits in 10 CFR 20.1201(a) (Cogema Mining Inc., 2008).

To evaluate the radiological impacts to the public and the environment from normal operations, the licensee estimated the radiological emissions from all concurrent activities associated with the proposed Ludeman ISR Satellite Project (Uranium One, 2017d). Sources of radon that the licensee identified and modeled included wellfield development during the construction phase

and satellite facility (including resin transfer) and wellfield operations during the operational and aquifer restoration phases (Uranium One, 2017d). The licensee ran the computer code MILDOS to model the radiological dose impacts on human receptors and calculate soil concentrations of radon decay products in the vicinity of the site from release of radon gas from proposed activities. These calculations involved site-specific data, including radon release estimates, meteorological and population data, and other parameters. Similar calculations were previously conducted for operations at the Willow Creek facility where the licensee proposes processing the loaded ion exchange resins from the Ludeman ISR Satellite Project (Cogema Mining Inc., 2008). Because the proposed Ludeman ISR Satellite Project is approximately 150 km [93 mi] away from the Willow Creek ISR Project and the airborne concentration of radionuclides would decrease significantly with distance, the radiological doses for the two facilities were evaluated by NRC staff as separate impacts.

The NRC staff's review of the licensee's radiological impact modeling of the Ludeman ISR Satellite Project independently verified that appropriate receptor locations and exposure pathways were modeled and reasonable input parameters were used. The NRC staff also found that the licensee's source terms adequately reflected planned operations. The source terms included emissions from wellfield development, satellite facility and wellfield operations (including liquid byproduct material management involving evaporation ponds), and aquifer restoration (Uranium One, 2017d). The NRC staff also verified that the licensee used the most recent site-specific meteorological measurements taken for the Ludeman ISR Satellite Project (Uranium One, 2017d). The licensee calculated the annual total effective dose equivalents (TEDEs) at seven residential receptor locations surrounding the Ludeman ISR Satellite Project.

Results of the licensee's modeling (Uranium One, 2017d) indicated that the maximum TEDE of 0.0159 mSv/yr [1.59 mrem/yr] is located at the residence within the project boundary but beyond the controlled areas where ISR operations would be occurring. This residence is the closest receptor location downwind of modeled radon release locations and is approximately 1.6 km [1.0 mi] to the east of proposed Wellfield 2 and 2.4 km [1.5 mi] east of the proposed satellite plant. Because Wellfield 2 will not be included as part of this licensing action, the NRC staff expects that the maximum TEDE during the operational period would be less than the aforementioned 0.0159 mSv/yr [1.59 mrem/yr]. For comparison, the calculated dose is 1.59 percent of the NRC 10 CFR Part 20 public dose limit of 1 mSv/yr [100 mrem/yr]. Additionally, the maximum calculated TEDE to the nearest residence at the Willow Creek site was 0.011 mSv/yr [1.1 mrem/yr] (Cogema Mining Inc., 2008). The maximum calculated TEDE at a residence beyond the proposed Ludeman ISR Satellite Project boundary was 0.0127 mSv/yr [1.27 mrem/yr] at a location just beyond the northwest boundary (near an existing residential subdivision). This is 1.27 percent of the 10 CFR Part 20 public dose limit of 1 mSv/yr [100 mrem/yr]. Thus, the modeling results show that all the calculated doses are below the 10 CFR Part 20 public dose limit. These calculated doses are also within the range of dose modeling results reported for ISR facilities in the GEIS {0.317 mSv [31.7 mrem] per year for the Crow Butte facility to 0.004 mSv [0.4 mrem] per year for the Irigaray facility} (NRC, 2009).

Based on the preceding analyses, the potential radiation doses to occupationally exposed workers and members of the public during normal operations of the proposed Ludeman ISR Satellite Project would be SMALL. The licensee's existing radiation protection program (Cogema Mining Inc., 2008; NRC, 2016a) would maintain worker exposures below the NRC limits in 10 CFR Part 20 for protecting workers from radiation hazards. Additionally, calculated radiation doses from the releases of radioactive materials to the environment are small fractions of the limits in 10 CFR Part 20 that have been established for the protection of public health and safety.

Operational radiological accident risks at the proposed wellfields or satellite facility may involve wellfield or processing equipment failures leading to pregnant lixiviant or loaded ion exchange resin spills, or additional release of radon gas. Because the satellite facility is only involved in the ion exchange portion of ISR processing, which involves less concentrated uranium rich solutions and no dried yellowcake, these accident risks would be less than what was previously evaluated for the Willow Creek ISR Project (NRC, 2011c; NRC, 2013a,b) and would produce SMALL impacts to public and occupational health. Typical protection measures, such as radiation and occupational monitoring, respiratory protection, standard operating procedures for spill response and cleanup, and worker training in radiological health and emergency response are required as a part of the licensee's NRC-approved radiation protection program (Cogema Mining Inc., 2008; NRC, 2016a). These procedures and plans would further reduce the radiological consequences to workers from accidents. Therefore, the NRC staff concludes that the overall radiological impacts from accidents at the proposed Ludeman ISR Satellite Project would be SMALL.

As described in EA Chapter 2, process-related chemicals that support remote ion exchange operations would be stored in bulk at the proposed Ludeman satellite facility. These chemicals would potentially include carbon dioxide, sodium carbonate/bicarbonate, oxygen, sodium sulfide, and hydrogen peroxide (Uranium One, 2017d). Additionally, hazardous chemicals would be utilized to process ion exchange resins from the proposed Ludeman ISR Satellite Project at the Willow Creek ISR Project central processing plant (CPP) during operations and aquifer restoration. The GEIS evaluated the potential impacts of chemical storage at ISR facilities and concluded that the impacts would be SMALL, as long as a licensee followed chemical safety regulations and established safety procedures and training (NRC, 2009). The licensee would be required to comply with the applicable chemical safety regulations and has committed to construct and maintain chemical storage areas according to best practices, which includes following applicable industry standards and methods provided by the National Fire Protection Association and the Compressed Gas Association (Uranium One, 2017d). The licensee's standard operating procedures related to the handling, storage, and safety of bulk chemicals at the Willow Creek ISR Project CPP were also previously evaluated by NRC staff during the last license renewal (NRC, 2013b) and were found to be adequate. Therefore, the NRC staff concludes that the nonradiological impacts during normal operations and accidents at the proposed Ludeman ISR Satellite Project and existing Willow Creek ISR Project CPP from processing solutions generated by the Ludeman ISR Satellite Project would be SMALL.

The proposed aquifer restoration activities at the proposed Ludeman ISR Satellite Project are similar to activities that would take place during operations (e.g., operation of wellfields and the satellite processing facility, wastewater treatment and disposal from solution processing at the Ludeman ISR Satellite Project (ion exchange) and yellowcake production at the existing Willow Creek ISR Project CPP. Therefore, the potential impact on public and occupational health and safety would be expected to be similar to the operational impacts. The radiation doses associated with restoration are included in the previous operations assessment and associated MILDOS dose calculations.

One practice unique to aquifer restoration under the licensee's preferred liquid waste management option would be Uranium One's proposed WDEQ-permitted discharge of treated aquifer restoration water to surface water. The treated effluent would need to meet the NRC dose limits, waste disposal standards, and effluent limits in 10 CFR Part 20, Subparts D and K and Appendix B and the provisions of 10 CFR Part 40, Appendix A. The NRC staff reviewed the permeate water quality estimates provided by Uranium One in the revised ER (Uranium One, 2017e) and concluded that the estimated permeate water quality may exceed the values in

Table 2 of Appendix B to 10 CFR Part 20. In addition, the licensee did not provide the location and features of the surface water body that will receive the liquid effluent. Without this information, the NRC staff could not evaluate whether the treated restoration water reaches any nearby surface water body and where public doses would be likely to occur. Therefore, if NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition prohibiting surface water discharge of permeate pond water until the licensee provides for NRC review and approval information to demonstrate that the dose limits for individual members of the public in 10 CFR 20.1301 are met. A WYPDES permit for the proposed surface water discharge, if granted by the WDEQ, would specify any necessary permit conditions including effluent limits to ensure water quality standards are maintained. Once a permit application is submitted, the WDEQ would evaluate the proposed discharge considering the applicable Wyoming surface water quality and permitting requirements and make a determination on whether or not to grant a permit. In summary, aquifer restoration activities and associated impacts would be similar to the operations phase with the exception of surface water discharge where the public health and safety would be protected by state WYPDES permitting and continued NRC regulatory oversight. Therefore, for the proposed Ludeman ISR Satellite Project, aquifer restoration would be expected to have a SMALL impact on public and occupational health (primarily from the release of radon gas).

The potential public and occupational impacts from decommissioning the proposed Ludeman ISR Satellite Project would involve similar activities and impacts as previously evaluated for decommissioning wellfields and facilities in the Willow Creek ISR Project (NRC, 2011c). Assuming NRC review and approval of the licensee's decommissioning plan, the licensee's compliance with any applicable license conditions and regular NRC inspection and enforcement activities, the anticipated impact from decommissioning the proposed Ludeman ISR Satellite Project would be short term and SMALL.

In summary, considering the impacts determined in the preceding analyses, the NRC staff concludes that the public and occupational health impacts of the proposed Ludeman ISR Satellite Project would be SMALL for all phases.

Under the No-Action Alternative, the proposed wellfields and facilities associated with the Ludeman ISR Satellite Project would not be constructed, operated, restored, or decommissioned. Therefore, no associated impacts to public and occupational health would occur. Existing licensed activities in the area and associated impacts would likely continue.

4.13 Waste Management

The analysis in this section evaluates the impacts to waste management resources from each phase of the ISR facility lifecycle under Uranium One's preferred liquid waste management option. The NRC staff considered each of Uranium One's proposed liquid waste management options (EA Section 2.1.7) and has provided a comparison of the impacts for each option in EA Table 4-1. The impacts to waste management resources associated with the No-Action Alternative are also evaluated in this section.

As described in the NRC's GEIS (NRC, 2009), environmental impacts on waste management could occur during all phases of the ISR lifecycle. Impacts would be those associated with the proposed addition of the Ludeman ISR Satellite production unit to the Willow Creek ISR Project and the additional generation of construction, processing, aquifer restoration, and

decommissioning radiological and nonradiological liquid and solid wastes that would require management and disposal.

During the construction phase of the Ludeman ISR Satellite Project, the primary waste produced would be nonhazardous solid waste. Examples of nonhazardous construction waste include building materials and piping. As discussed in Section 3.13, Uranium One has proposed to dispose of nonhazardous solid waste at the Glenrock Area Solid Waste Disposal Facility that is located approximately 13 km [8 mi] west of the proposed Ludeman ISR Satellite Project. The Glenrock facility accepts construction and demolition waste for onsite disposal and transfers municipal solid waste to the landfill in Casper, Wyoming. As described in EA Section 3.13, the NRC staff expects that Uranium One would discharge drilling fluids into mud pits adjacent to drilling pads and obtain a WDEQ WYPDES permit to manage well-development water. The permit would require reporting of flow, pH, radium (Ra-226), uranium, total dissolved solids (TDS), and total suspended solids (TSS) to the WDEQ. Uranium One has indicated that sanitary waste would be addressed using portable toilets. Because well-development water would be managed onsite using permitted practices and capacity would be available to dispose of the small annual volume nonhazardous solid waste, the NRC staff concludes that the impact on waste management from constructing the proposed Ludeman ISR Satellite Project would be SMALL.

During operations of the proposed Ludeman ISR Satellite Project, the liquid byproduct material generated from processing the wellfield solutions would include waste brine streams (from reverse osmosis treatment of the production bleed), production bleed, spent eluate, liquid from process drains, fluids generated from work over operations on injection and recovery wells, resin transfer wash water, filter backwash water, plant wash down water, and decontamination water (e.g., employee showers). The licensee proposes to manage liquid byproduct material during the operations phase using evaporation ponds.

Before Uranium One could begin disposing wastewater into an evaporation pond system, the NRC staff would review the design and construction of the ponds and monitoring system against the criteria in 10 CFR Part 40, Appendix A (NRC, 2003b; NRC, 2008), taking into consideration EPA criteria in 40 CFR Part 61, Subpart W. Uranium One would be required to demonstrate that the evaporation ponds could be designed, operated, and decommissioned to prevent migration of wastewater to subsurface soil, surface water, or groundwater. Uranium One would also be required to demonstrate that monitoring requirements would be established to detect migration of contaminants to groundwater. If NRC approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, the NRC staff would establish license conditions applicable to the safe construction and operation of evaporation pond systems (EA Sections 4.5 and 4.12).

Evaporation ponds would have a total surface area of approximately 22.0 ha [54.3 ac] and a total storage capacity of 246,270 m^3 [65 million gal] when freeboard space is taken into account (Uranium One, 2017d). Uranium One provided a detailed analysis of monthly liquid byproduct material flow rates and pond capacity for the duration of the project that confirmed the pond capacity was sufficient to accommodate all planned liquid byproduct production when evaporation was accounted for. The NRC staff checked Uranium One's estimated total lifecycle facility production of liquid byproduct material that would be stored in the proposed evaporation ponds over a period of 8 years {approximately 1,321,635 m^3 [348.91 million gal]} (Uranium One, 2016b) and compared it with the volume of water that would be removed by evaporation during that period {1,231,019 m^3 [324.99 million gal]}. The NRC staff found the remaining volume of liquid byproduct material was within the storage capacity of the proposed ponds. Therefore, the

NRC staff concludes that Uranium One's proposed evaporation ponds provide sufficient capacity to manage liquid byproduct material as designed; thus, impacts of the proposed Ludeman ISR Satellite Project on waste management from the operation of evaporation ponds would be SMALL.

Solid byproduct material generated during operations could include spent resin, empty chemical containers and packaging, pipes and fittings, tank sediments, evaporation pond sediments, and contaminated soil from leaks and spills. As discussed in EA Section 3.13, Uranium One has identified the Pathfinder Mines Corporation, Shirley Basin facility in Carbon County, Wyoming, as the disposal location for all solid byproduct material generated at the proposed Ludeman ISR Satellite Project and would have a disposal agreement in place prior to operation. Other potential disposal facilities include the Denison Mines Corporation; White Mesa Uranium Mill, Blanding, Utah; and Energy Solutions LLC, Clive Disposal Site, Clive, Utah, should additional disposal capacity be needed. Based on the availability of licensed disposal facilities for all solid byproduct material, and the disposal agreement that would be in place prior to operation, the NRC staff concludes that the impacts of the Proposed Ludeman ISR Satellite Project on waste management during operations from the disposal of solid byproduct material would be SMALL.

Nonhazardous solid waste generated during operations of the proposed Ludeman ISR Satellite Project could include facility trash, septic solids, and other uncontaminated solid materials (e.g., piping, valves, instrumentation, and equipment) and any other items that are not contaminated or which may be successfully decontaminated. Because the proposed annual generation of 1,100 m^3 [1,500 yd^3] nonhazardous solid waste would be a small percentage of the available landfill capacity (EA Section 3.13), the NRC staff concludes that the impact on nonhazardous solid waste management would be SMALL. Additionally, as described in EA Section 3.13, Uranium One's management of the small quantity of hazardous waste produced by the proposed Ludeman ISR Satellite Project in accordance with state and federal laws would mitigate potential impacts and, therefore, the impacts on hazardous waste management would be SMALL.

Based on the preceding analysis of the type and quantity of byproduct material and waste expected to be generated and the available capacity for disposal, the NRC staff concludes that the waste management activities during the ISR operations phase of the proposed Ludeman ISR Satellite Project would have a SMALL impact on waste management resources.

During aquifer restoration of the proposed Ludeman ISR Satellite Project, Uranium One would use the same waste management systems as for ISR operations, with the exception of additional reverse osmosis treatment and the use of surface water discharge and associated permeate (storage) ponds to manage treated wastewater (the resulting concentrated brines from reverse osmosis treatment would go to the same evaporation ponds used during operations).

To surface discharge treated aquifer restoration wastewater, the effluent would need to meet the NRC dose limits, waste disposal standards, and effluent limits in 10 CFR Part 20, Subparts D and K and Appendix B, and the provisions of 10 CFR Part 40, Appendix A. The NRC staff reviewed the permeate water quality estimates provided by Uranium One in the ER (Uranium One, 2017e) and concluded that the estimated permeate water quality may exceed the values in Table 2 of Appendix B to 10 CFR Part 20. In addition, the licensee did not provide the location and features of the surface water body that will receive the liquid effluent. Without this information, the NRC staff could not evaluate whether the liquid effluent reaches any nearby surface water body and where public doses would be likely to occur. Therefore, if NRC

approves the license amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will include a license condition requiring the licensee to install one groundwater monitoring well upgradient and three monitoring wells downgradient of both the evaporation pond and the permeate pond in the 110 Sand aquifer. These wells will be required to be monitored in the same manner as required for the excursion monitoring wells in License Conditions 10.4 and 11.2 of the Willow Creek Source Material License (SUA–1341), with the exception that the licensee will test the wells quarterly, and the licensee will not be required to implement correction actions, but instead will inform the NRC of the actions it will take to determine if the excursion is associated with leaks from the evaporation pond. NRC will also include a license condition prohibiting surface water discharge of permeate pond water until the licensee provides for NRC review and approval information to demonstrate that the dose limits for individual members of the public in 10 CFR 20.1301 are met. The regulations at 10 CFR 20.2007 require compliance with other applicable federal, state, and local regulations. This includes the WDEQ WYPDES permitting requirements for surface water discharge (WDEQ, 2015a). The NRC staff assumes that surface water discharge of treated ISR aquifer restoration water is permissible under the EPA and WDEQ standards, provided the discharge water is not comingled with process wastewater and a discharge permit is obtained. Once a permit application is submitted, the WDEQ would evaluate the proposed discharge considering the applicable Wyoming surface water quality and permitting requirements and make a determination on whether or not to grant a permit. A WYPDES permit, if granted by the WDEQ, would specify any necessary permit conditions, including effluent limits, to ensure water quality standards are maintained. Uranium One proposes to pretreat the liquid byproduct material for surface discharge using ion exchange columns and reverse osmosis to decrease uranium and other constituent levels in wastewater. If, after the applicable reviews, the proposed surface water discharge is not approved by either WDEQ or NRC, the aquifer restoration permeate would be suitable for disposal in the proposed evaporation pond. Therefore the impacts to waste management resources would be minor.

As described in EA Section 2.1.7, surface discharge of treated aquifer restoration wastewater would involve storage of the treated effluent in a permeate pond with four cells. Uranium One provided a detailed analysis of monthly aquifer restoration treated water flow rates and pond capacity for the duration of the project that confirmed the pond capacity was sufficient to accommodate storage of all planned aquifer restoration groundwater sweep. Based on Uranium One's estimated water balance estimates (Uranium One, 2016b), the NRC staff concludes that the proposed permeate ponds and surface discharge capacity would be sufficient to accommodate the estimated combined peak demand for disposal of reverse osmosis permeate from treatment of the aquifer restoration phase liquid byproduct material flow. Additionally, the preceding impact analysis of the proposed Ludeman ISR Satellite Project operations involving evaporation and permeate ponds considered wastewater flow from both operation and aquifer restoration; therefore, the impacts of using evaporation and permeate ponds during aquifer restoration would be the same as during the operations phase. Based on the preceding analysis, the impacts on waste management from the proposed Ludeman ISR Satellite Project use of evaporation and permeate ponds and surface water discharge during the aquifer restoration phase would be SMALL. Other waste streams produced during aquifer restoration, including solid byproduct material, nonhazardous solid waste, and hazardous waste would involve volumes and disposition similar to, or less than, the operation phase, and impacts would therefore be SMALL.

Based on the type and quantity of waste expected to be generated and the available capacity for disposal, the NRC staff concludes that the aquifer restoration phase of the proposed Ludeman ISR Satellite Project would have a SMALL impact on waste management resources.

The anticipated decommissioning activities occurring at the proposed Ludeman ISR Satellite Project would be comparable to those described in GEIS Section 2.6 for decommissioning wellfields (NRC, 2009).

Uranium One estimated the volume of solid byproduct material that would be generated from decommissioning the proposed Ludeman ISR Satellite Project (over a planned 1-year decommissioning period) as up to 3,058 m^3 [4,000 yd^3] (Uranium One, 2017e). Prior to operations, Uranium One has committed to have a disposal agreement in place with the Pathfinder facility or a licensed site to accept solid byproduct material to ensure adequate capacity is available for byproduct material disposal (EA Section 3.13). Uranium One currently has a disposal agreement associated with the Willow Creek license that is the subject of the proposed license amendment. Based on the disposal agreement that confirms availability of disposal capacity, the NRC staff concludes that the waste management impacts of the proposed Ludeman ISR Satellite Project from the generation of byproduct material during decommissioning would be SMALL.

The volume of nonhazardous solid waste from decommissioning the proposed Ludeman ISR Satellite Project was estimated by Uranium One to be 1,500 m^3 [2,000 yd^3] (Uranium One, 2017e). Because of the available landfill disposal capacity (EA Section 3.13) and the proposed project duration (EA Chapter 2), the NRC staff concludes that there would be sufficient landfill capacity at the time of decommissioning. Based on this capacity analysis, the NRC staff concludes that the potential impacts to nonhazardous solid waste management resources from the proposed Ludeman ISR Satellite Project would be SMALL.

The hazardous waste streams from decommissioning the proposed Ludeman ISR Satellite Project would be similar to the waste streams generated during the ISR construction phase and could include used oil, batteries, and cleaning solvents. Uranium One has a hazardous material program in place to comply with applicable EPA and WDEQ requirements for its handling, storage, and disposal at approved facilities. Because the volume of hazardous waste generated by the proposed action during decommissioning would be small and the waste would be handled, stored, and disposed in accordance with applicable regulations, the NRC staff concludes that decommissioning hazardous waste impacts to waste management resources from the proposed Ludeman ISR Satellite Project would be SMALL.

In summary, the NRC staff concludes that the impacts to waste management resources during the decommissioning phase of the proposed Ludeman ISR Satellite Project would be SMALL for all waste materials, based on the type and quantity of waste expected to be generated and the available capacity for disposal.

Under the No-Action Alternative, the proposed Ludeman ISR Satellite Project would not be licensed and the associated construction, operations, aquifer restoration, or decommissioning actions that would produce environmental impacts would not occur. No radioactive or nonradioactive liquid or solid waste would be generated, because the facility would not be licensed. No buildings would be constructed, no wellfields would be developed, no wastewater would be produced that would be stored in evaporation or permeate ponds, surface discharged, or injected into the subsurface. No decommissioning activities would be conducted that could result in the generation of nonhazardous solid waste and solid byproduct material. No arrangements would need to be made for waste management. Existing activities in the area that produce various wastes would likely continue.

5 CUMULATIVE IMPACTS

5.1 Introduction

The Council on Environmental Quality's (CEQ's) National Environmental Policy Act (NEPA) defines cumulative effects as "the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (RFFAs) regardless of what agency (federal or non-federal) or person undertakes such other actions" [Title 40 of the *Code of Federal Regulations* (40 CFR) 1508.7]. Cumulative effects or impacts[1] can result from individually minor but collectively significant actions taking place over a period of time. A proposed project could contribute to cumulative effects when its environmental impacts overlap with those of other past, present, or RFFAs.

The analysis of the cumulative impacts of the proposed Ludeman project was based on publicly available information on existing and proposed projects, information in the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (GEIS) (NRC, 2009), information in the Willow Creek (WC) license renewal environmental assessment (EA) and supplemental EA (NRC, 2011c, NRC, 2013a), information provided in the licensee's revised amendment application (Uranium One, 2017d,e), general knowledge of the conditions in Wyoming and in the nearby communities, and RFFAs that could occur.

5.1.1 Methodology

In assessing potential cumulative impacts, the U.S. Nuclear Regulatory Commission (NRC) staff developed a methodology that follows CEQ guidance (NRC, 2009; CEQ, 1997).

1. Identify the potential cumulative impact issues associated with the proposed action based on the affected environment, the direct and indirect impacts of the proposed action, the cumulative impacts identified in past In Situ Recovery (ISR) licensing reviews, and the cumulative impact issues identified in the GEIS. For this EA, these cumulative impact issues are discussed in EA Sections 5.1.2.1 through 5.1.2.7.

2. Identify the geographic scope for the analysis for each resource area. This scope will vary from one resource area to another, depending on the geographic extent over which the potential impacts may occur; therefore, where appropriate, each individual resource area discussed in Sections 5.2 through 5.13 will note the geographic area covered in the analysis. For the cumulative impact issues in the region of the Ludeman project, the general study area includes an 80-kilometer (km) [50-mile (mi)] radius around the proposed Ludeman ISR Satellite Project area.

3. Identify the timeframe for assessing cumulative impacts. For this EA, the selected timeframe begins in June 2013 with the NRC's acceptance of the amendment application for an NRC license amendment to construct and operate the proposed Ludeman ISR Satellite Project. Assuming construction activities commence in 2018, the NRC staff determines that the cumulative impacts analysis timeframe ends at the end of

[1]For the purpose of this analysis, "cumulative impacts" is deemed to be synonymous with "cumulative effects."

2030, the date estimated for license termination after completion of the decommissioning period for the project (Uranium One, 2017e).

NRC licenses for ISR facilities are typically granted for a 10-year period. The proposed Ludeman ISR Satellite Project has an estimated 9-year production lifespan, with a total timeframe of 13 years, including construction and decommissioning (Uranium One, 2017e). If the NRC grants a license amendment, the licensee would have to apply for license renewal before the initial license period expires to continue operations beyond the initial license period.

4. Identify other ongoing and prospective projects and activities in the area surrounding the project site that could affect the same resource areas as the proposed action. These projects and activities, called other past, present, and RFFAs, are described in EA Section 5.1.2.

5. Assess the potential cumulative impacts on each resource area from the proposed action. The cumulative impacts are the incremental impacts from the proposed action added to the potential effects from other past, present, and RFFAs. This analysis is informed by the cumulative impact issues identified in Step 1 and considers the potential environmental impacts identified in Chapter 4 and the impacts of other past, present, and RFFAs identified in Step 4 that would occur within the resource-specific geographic scope and timeframe described in Steps 2 and 3.

6. The cumulative impacts are described using the same significance levels (SMALL, MODERATE, and LARGE) (NRC, 2003b) that were used in assessing the direct and indirect impacts of the proposed action in Chapter 4.

The NRC staff recognizes that many aspects of the activities associated with the proposed Ludeman ISR Satellite Project would have SMALL potential impacts on the affected resources. It is possible, however, that a potential impact may be SMALL by itself, but could result in a MODERATE or LARGE cumulative impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a potential SMALL individual impact could be important if it contributes to or accelerates the overall resource decline. The NRC staff determined the appropriate level of analysis that was merited for each resource area potentially affected by the proposed action. The level of analysis was determined by considering the impact significance level to the specific resource, as well as the likelihood that the quality, quantity, and stability of the given resource could be affected.

5.1.2 Other Past, Present, and Reasonably Foreseeable Future Actions

The proposed Ludeman ISR Satellite Project is located in the Wyoming East Uranium Milling Region, as defined by the GEIS (NRC, 2009). This region encompasses large portions of northeastern Wyoming within and beyond Converse County, including southern portions of the Powder River Basin (PRB), portions of the Thunder Basin National Grasslands, the City of Casper, and portions of the Medicine Bow-Route National Forest. The PRB covers approximately 26,000 km^2 [10,000 mi^2] of land and holds the largest deposits of coal in the United States, as well as significant reserves of uranium and other natural resources (i.e., oil and gas). As such, there has been, and continues to be, substantial resource extraction activities within the PRB portion of the Wyoming East Uranium Milling Region.

Federal agencies have completed several environmental impact statements (EISs) and EAs related to activities within the study area. In conducting the cumulative effects analysis, the NRC staff relied on information in GEIS Section 5.3.2 (NRC, 2009) and other publicly available information for projects within the Wyoming East Uranium Milling Region to identify other past, present, and RFFAs within an 80-km [50-mi] radius around the proposed Ludeman ISR Satellite Project, (hereafter, the study area) such as the environmental impacts of resource management actions on federal lands administered by the U.S. Bureau of Land Management (BLM) or U.S. Forest Service (USFS). In addition, the Ludeman ISR Project would be a license amendment to an existing license for the Willow Creek Project. As part of the review for the Willow Creek license renewal, a cumulative impact analysis was conducted, which included the consideration of the construction and development of the Ludeman ISR Satellite Project (NRC, 2011c, NRC, 2013a). Where appropriate, information from the Willow Creek Project has been incorporated by reference for this cumulative impact analysis. The other past, present, and RFFAs in the vicinity of the proposed Ludeman ISR Satellite Project are discussed in the next sections.

5.1.2.1 Uranium Recovery Sites

Within the study area of approximately 80 km [50 mi] surrounding the proposed Ludeman ISR Project, there are nine other uranium-recovery projects that are proposed, existing, or currently undergoing decommissioning (EA Figure 5-1). Licensed and proposed ISR sites within an 80-km [50-mi] radius of the proposed Ludeman ISR Satellite Project are listed in Table 5-1. One ISR facility is operating (Smith Ranch-Highland), and two ISR facilities are licensed but not operating (Moore Ranch and Reno Creek) (NRC, 2010; NRC, 2016b). Additionally, there are two licensed but not operating ISR satellite projects (Reynolds Ranch and Ruth) (NRC, 2006, NRC, 2017b). The Christensen Ranch and Irigaray sites (Willow Creek Project) are located in Johnson County and in the Pumpkin Buttes Uranium District between approximately 96.6 km [60 mi] and 112.7 km [70 mi] northwest of the Ludeman site; therefore, those sites are not listed in Table 5-1.

Four previously operating conventional uranium recovery projects (Bear Creek, Spook, Highland, and Pathfinder Shirley Basin) have been or are in the process of being decommissioned (NRC, 2017c; NRC, 2017a). While much of the Pathfinder Shirley Basin uranium recovery project has been decommissioned, the licensee maintains a tailings impoundment that continues to accept byproduct material from other ISR projects (NRC, 2015a). The Spook facility is a previously decommissioned Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I site (DOE, 2017) that is under general NRC license to U.S. Department of Energy (DOE) for long-term surveillance and maintenance.

As noted in the GEIS Section 5.1 (NRC, 2009) uncertainties exist related to the cumulative effects of mineral production (which includes uranium recovery) due to varying extraction technologies, design of long-term monitoring programs, and the effectiveness of predictive models. However, the likelihood of mining projects, milling projects, or both being collocated has the potential to impact the surrounding environment. The various activities associated with uranium production would likely impact multiple resource areas (for example: land use, ecology, and groundwater).

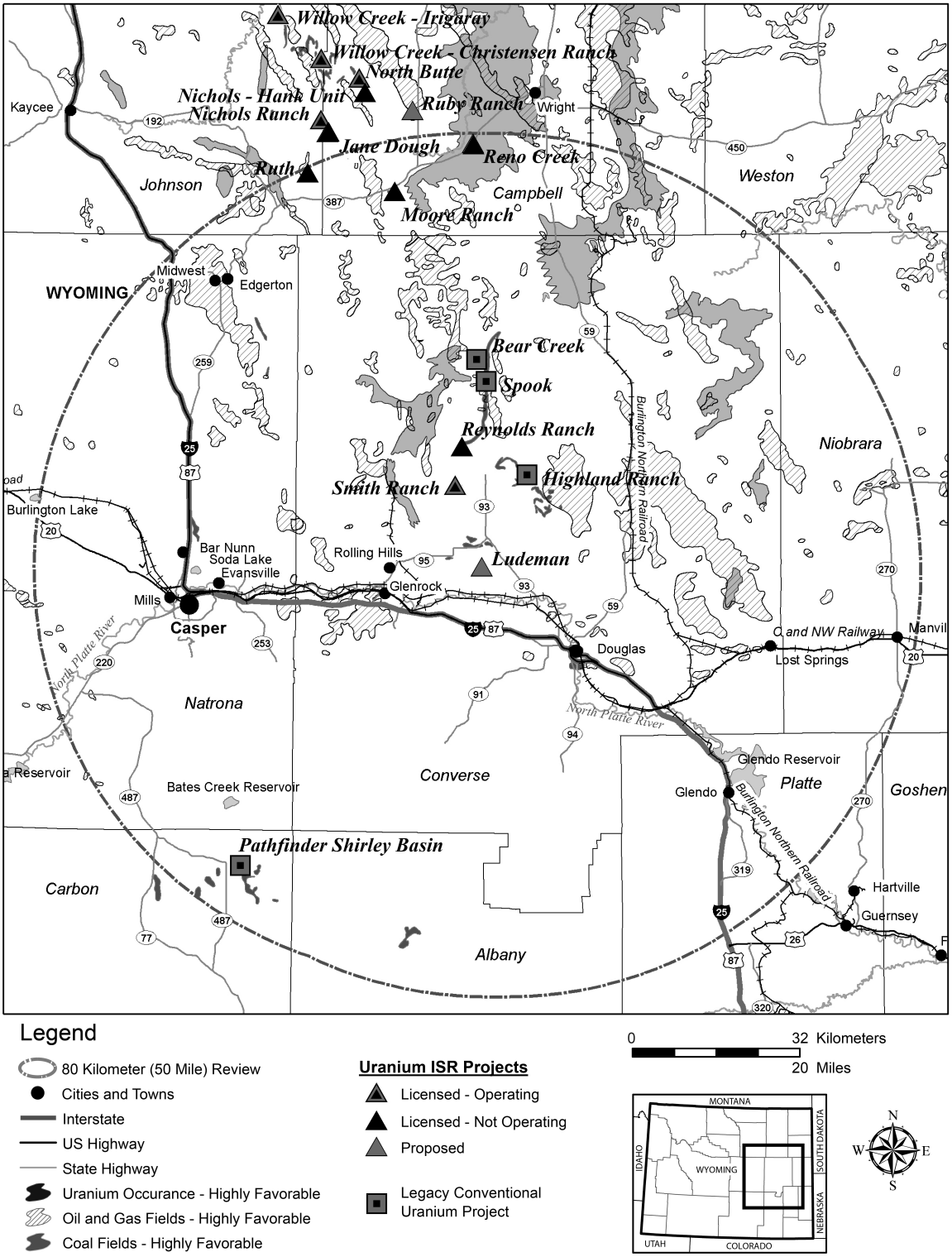

Figure 5-1. Potential and Existing Uranium Milling and Mining Sites Within 80 km [50 mi] of the Proposed Ludeman ISR Satellite Project

Table 5-1. Licensed and Proposed ISR Projects Within 80 km [50 mi] of the Ludeman ISR Satellite Project						
Project	**Company/ Owner**	**Uranium District**	**County**	**Status**	**Approx. Distance km [mi]**	**Direction**
Moore Ranch	Uranium One	Pumpkin Buttes	Campbell	Licensed–Not Operating	68.4 [42.5]	NW
Smith Ranch – Highland Ranch	Cameco Resources	Southern Powder River Basin	Converse	Licensed–Operating	8.7 [5.4]	NW
Ruth	Power Resources, Inc.	Pumpkin Buttes	Johnson	Licensed–Not Operating	81.4 [50.6]	NW
Reynolds Ranch	Cameco Resources, Inc.	Southern Powder River Basin	Converse	Licensed–Not Operating	16.6 [10.3]	N
Reno Creek	AUC	Pumpkin Buttes	Campbell	Licensed–Not Operating	75.3 [46.8]	N
Sources: NRC, 2017b						

5.1.2.2 Coal Mining

Coal mining within the 80-km [50-mi] study area predominantly occurs in areas within the southern PRB region and is less prevalent in the areas to the south that are in closer proximity to the proposed Ludeman ISR Satellite Project (BLM, 2008; BLM 2007). The PRB region contains some of the largest low-sulfur coal deposits in the world (BLM, 2008). In the 1970s and 1980s, the PRB emerged as a major coal-producing region that contains over 90 percent federally owned land (BLM, 2011). No underground coal mines are located within 80-km [50-mi] of the proposed Ludeman ISR Satellite Project.

As of 2015, there were 12 operating surface coal mines in the Wyoming PRB area (WMA, 2016). Coal produced from these surface mines is over 96 percent of the coal produced in Wyoming each year (BLM, 2005a, BLM 2011, BLM 2013a). Four of these mines, the Antelope, North Antelope Rochelle, School Creek, and Black Thunder mines, are operating surface mines located near the border of Converse and Campbell counties within 80 km [50 mi] of the proposed project (WDEQ, 2018e; WMA, 2016). Another coal mine, Dave Johnston, located further south in Converse County approximately 22.5 km [14 mi] from the proposed Ludeman Project, has been reclaimed (Uranium One, 2013a; WMA, 2016). The Dave Johnston coal mine has not produced coal since the year 2000 (Uranium One, 2015a), but the Dave Johnston power plant located east of Glenrock continues to operate with coal that was produced in the PRB (Uranium One, 2017e). Additionally, the licensee reported that no coal mines exist within 3.2 km [2 mi] of the proposed Ludeman ISR Satellite Project (Uranium One, 2017e). The environmental impacts of these coal mines have been evaluated by the BLM (BLM, 2010). Surface mining of coal can cause adverse impacts to land use, geology and soils, water resources, ecology, air quality, noise, historic and cultural resources, visual and scenic resources, socioeconomics, and waste management. The long-term historical trend in coal production is characterized by annual increases, despite several annual production declines that were due to periodic unfavorable market conditions (WMA, 2015a). Although difficult to accurately predict, existing coal mining operations are expected to continue throughout the life of the Ludeman ISR Satellite Project.

5.1.2.3 Oil and Gas Production

Conventional oil and gas production within the 80-km [50-mi] study area predominantly occurs in areas within the southern PRB region and is less prevalent in the areas to the south that are in closer proximity to the proposed Ludeman ISR Satellite Project (BLM, 2008; BLM 2007). The application of improved technology and the emergence of unconventional oil fields led to an oil production increase of 19 percent from 2013 through the first three quarters of 2014 in the Wyoming PRB (WSGS, 2015). Directional and horizontal drilling, as well as hydraulic fracturing in unconventional plays resulted in a nationwide surge in production between 2012 and 2014 (EIA, 2015). Wyoming produced 72.5 million barrels of oil in 2016, compared to the 54.7 million barrels of oil produced in 2011 when the proposed Ludeman ISR Satellite Project application was submitted (WSGS, 2017b). The 2016 U.S. oil production outpaced demand and may be adversely affected by current low oil prices; however, the boom in the Wyoming PRB is expected to continue in the next few years due to large oil and gas developments on federal lands (WSGS, 2017a).

U.S. natural gas production increased 35 percent between 2005 and 2013 and is expected to continue to increase through 2040, beyond the life of the Ludeman ISR Satellite Project, when it is expected to account for nearly 40 percent of U.S. energy production (EIA, 2015; EIA, 2017). Between 2011 and 2016, Wyoming's natural gas annual production fluctuated between 2.4 and 1.8 billion cubic feet (WSGS, 2015; WSGS 2017a). As stated in EA Section 3.1.3, there are three producing oil wells within the proposed project boundary, and within 3.2 km [2 mi] of the proposed project boundary, there are an additional four producing oil and gas wells and one disposal (or injector) well that has been shut down (Uranium One, 2016a; Uranium One, 2017d).

Regional oil and gas exploration, production, disposal, and pipeline construction could potentially generate cumulative impacts. Construction of wells (production and disposal) necessitates the building of temporary access roads to construct 1.2-hectare (ha) [3-acre (ac)] drill pads for each drill site (BLM, 2009). At that time, there would be a temporary increase in fugitive dust emissions and erosion due to the use of heavy machinery. During oil well production, the region would have an increase in traffic on county-maintained paved roads from oil trucks moving product to a refinery.

5.1.2.4 Coalbed Methane Development

Coalbed methane (CBM) production within the 80-km [50-mi] study area predominantly occurs north of the proposed Ludeman ISR Project and is less prevalent in the southern portion of the Wyoming PRB where the proposed project is located (BLM, 2008, 2007). Since 2008, this form of mining has been common in the PRB, but has been in decline and is expected to decline through 2040 (WMA, 2015a; EIA, 2017). Currently CBM activities account for 18 percent of Wyoming's natural gas production. The decline is due to (i) the drop in natural gas prices worldwide, (ii) the depletion of reservoirs, and (iii) competition from unconventional gas resources. Most of the remaining reserves in the PRB are currently not economically viable for development. The Wyoming Oil and Gas Conservation Commission (WOGCC) is in the process of reviewing options for the "orphaned" CBM wells that were abandoned but still remain in the PRB region (WOGCC, 2015). The overall life of each well is approximately 7 to 10 years, after which pipes are abandoned in place and well sites are reclaimed (NRC, 2009). There are no permitted or completed CBM wells within 3.2 km [2 mi] of the proposed Ludeman ISR Satellite Project (Uranium One, 2017e).

5.1.2.5 Energy Projects

Coal Generating Plants

The Dave Johnston coal-fired power plant is the only coal-fired power plant within the study area. The plant is located approximately 16 km [10 mi] northwest of the Ludeman ISR Satellite Project, near the town of Glenrock. Owned and operated by PacifiCorp Energy, the plant was commissioned in 1958 and currently operates three units on a 1,011 ha [2,500 ac] site. The combined output of the three coal-fired units is 762 megawatts (MW) of electricity. (PacifiCorp, 2011a).

Additionally, there are two coal-fired power plants (Basin Electric's Dry Fork project and Black Hills Corporation's WYGEN 3 project) in operation near the town of Gillette, Wyoming, which are located approximately 145 km [90 mi] north of the proposed project. No additional coal-fired power plants are projected for operation within the Wyoming PRB by 2020, which occurs within the first 3 years of the life of the Ludeman ISR Satellite Project (BLM, 2011).

Wind Power

Southern Wyoming has significant potential for wind energy development, and Converse County supports commercial-scale, wind energy generation projects. There are five wind power projects within 80 km [50 mi] of the proposed Ludeman ISR Satellite Project:

- PacifiCorp's Glenrock, Glenrock III, and Rolling Hills Wind Projects provide power in the Wyoming PRB. Construction was completed on Glenrock's 66 1.5-MW turbines in 2008, another 26 1.5-MW turbines for Glenrock III in 2009, and 66 1.5-MW turbines for Rolling Hills in 2009. The wind farm cluster is located on 121 ha [300 ac] of the reclaimed Dave Johnston Coal Mine. Turbines associated with this cluster stretch from approximately 14.5 to 24 km [9 to 15 mi] northwest of the proposed Ludeman ISR Satellite Project area, generating up to 237 MW of energy (PacifiCorp, 2011b,c; PacifiCorp, 2017a).

- Duke Energy (through its subsidiary, Three Buttes Windpower, LLC) completed the Campbell Hill Windpower Project and began commercial operations in December 2009. The Campbell Hill Windpower Project is located approximately 24 km [15 mi] northwest of the proposed Ludeman ISR Satellite Project in Converse County and consists of 66 wind turbines generating 99 MW (PacifiCorp, 2015; PacifiCorp, 2017b).

- Duke Energy built the Top of the World Wind Energy Project, a 200-MW wind farm consisting of 110 turbines. Some turbines associated with this project are located approximately 2.4 km [1.5 mi] northwest of the proposed Ludeman ISR Project area and others extend as far as approximately 14 km [8.5 mi] away from the proposed project area. The project began commercial operation in 2010 (Duke Energy, 2017).

Additionally, Third Planet Windpower proposed the 150-MW Reno Junction Wind Project with 100 1.5-MW turbines. This proposed project would straddle an 18.5-km [11.5-mi] north–south stretch of Wyoming State Highway 50. The southern boundary of the proposed project is approximately 77 km [48 mi] north of the proposed Ludeman ISR Satellite Project area. The company received a construction and operation permit from the Wyoming Industrial Siting Council in July 2010, but it did not begin construction within 3 years of the date of the permit. Therefore, the permit was revoked in August 2013 (WDEQ, 2017a).

Sustainable Power Group (sPower) constructed an 80-MW wind project with 46 2.3-MW turbines south of Glenrock, Wyoming. This project straddles a north–south stretch of Mormon Canyon Road approximately 19 to 29 km [12 to 18 mi] southwest of the Ludeman ISR Satellite Project (WDEQ, 2017b). Operations began at Pioneer Wind Park I in October 2016 (spower.com). No other proposed wind energy projects have been identified in the cumulative effects study area.

Land disturbance for wind energy projects results from development of access roads, a turbine assembly pad, and a foundation pad for each wind turbine tower and can stretch several miles. Additional land disturbances result from installation of transformers and substations, underground electric and fiber-optic communications cables, one or more operations and maintenance facilities, meteorological towers, and transmission lines connecting the project to the regional grid. Much of the disturbance area is reclaimed immediately following construction, with long-term disturbance associated with permanent facilities (i.e., access roads, support facilities, and tower foundations). Wind-generating projects have an expected life of approximately 25 years, which could be extended based on market conditions and the overall condition of the infrastructure. Some soil redisturbance would occur at the time of decommissioning, followed by final soil reclamation (BLM, 2011).

5.1.2.6 Transportation Projects

The Dakota Minnesota and Eastern (DM&E) Railroad filed an application to construct the Powder River Basin Expansion Project with the Federal Surface Transportation Board (STB) in February 1998. As described in a 2001 EIS, the proposed project would include the construction and operation of a new rail line and associated facilities in east-central Wyoming and southwestern South Dakota (STB, 2001). The project would require the construction of temporary roads to access the rail line right-of-way, thus potentially increasing project-related construction traffic and accidents along the new rail line corridor. Potential effects from construction of this project would be similar to potential effects from construction of roads that were evaluated for the ISR facilities described in EA Chapter 4, including fugitive dust emissions, noise, incidental wildlife or livestock kills, increased sedimentation and degradation of surface water quality, and land surface and habitat disturbances. If approved and completed, the project would add coal-hauling rail capacity and establish a dedicated, direct route to transport coal from the Wyoming PRB to Midwest markets. The extension would add 418 km [260 mi] of rail line and connect the northern DM&E line to operating coal mines located south of Gillette, Wyoming. At this time, Canadian Pacific—DM&E's parent company—has not decided whether to build the extension (PR Newswire, 2014). The decision to build is contingent on several factors: (i) acquiring the necessary right-of-way to build the line, (ii) executing agreements with PRB mining companies for the right of DM&E to operate loading tracks and facilities, (iii) securing contractual commitments from prospective coal shippers to ensure that revenues from the proposed line are economical, and (iv) arranging financing for the project. The NRC staff identified no other major transportation projects within the 80-km [50-mi] study area.

5.1.2.7 Other Mining

Other mining activities are sparse in the 80-km [50-mi] study area; however, sand and gravel (aggregate), borrow material, stone, clay (shale and bentonite), and clinker (scoria) have been and are being mined (USGS, 2015). Aggregate mines cover extensive areas in the Wyoming PRB, but are less prevalent in the southern portion of the PRB (BLM, 2015b, BLM, 2007). Aggregate resources are widespread in the study area and are quarried near locations of

end-use to limit transportation costs. The nearest aggregate quarry to the proposed Ludeman ISR project is in Douglas, Wyoming (BLM, 2012a). The NRC staff assumes that other mining operations would use existing transportation corridors, but new access road construction is possible for some locations. BLM found that adverse cumulative impacts from quarry construction and operations would be minor or less; these include increased noise, fugitive dust, haul traffic and road infrastructure damage, visual and scenic effects, land surface disturbance, diesel emissions, the potential for impacts to water quality, threatened and endangered species, and cultural resources (BLM, 2012a). Based on the common use of sand and gravel and clinker for road maintenance and coal mining, aggregate mining is expected to continue for the next 15 to 20 years (WMA, 2015b).

5.1.2.8 Preconstruction Activities

On September 15, 2011, the NRC published a final rule in the Federal Register (FR) (76 FR 56951) to clarify the definitions of "commencement of construction" and "construction" with respect to materials licensing actions conducted under the NRC's regulations. This final rule became effective on November 14, 2011. The parts of the final rule that are applicable to the NRC's licensing action for the proposed Ludeman ISR Satellite Project are in 10 CFR 40.4 and 51.4 and 10 CFR 51.45.

Commencement of construction means taking any action defined as "construction" or any other activity at the site of a facility subject to the regulations in this part (i.e., 10 CFR Part 40) that has a reasonable nexus to (i) radiological health and safety or (ii) common defense and security. Construction means the installation of wells associated with radiological operations (e.g., production, injection, or monitoring well networks associated with ISR or other facilities); the installation of foundations; or in-place assembly, erection, fabrication, or testing for any structure, system, or component of a facility or activity subject to the regulations in this part that are related to radiological safety or security. The activities defined below are referred to by the NRC staff as "site preparation" or "preconstruction" activities. Uranium One has stated that certain preconstruction activities may be conducted prior to the issuance of an NRC license amendment for the proposed Ludeman ISR Satellite Project (Uranium One, 2017c). Uranium One provided the following list of preconstruction activities that may occur:

- Install groundwater monitoring wells to establish background information related to the environmental impacts of operations.
- Conduct site grading and excavation to prepare for the construction of the Ludeman satellite plant building.
- Erect fences and other access control measures.
- Excavate a storage pond.
- Upgrade the existing road to access the Ludeman satellite building.
- Construct a parking lot associated with the Ludeman satellite building.
- Construct secondary and tertiary access roads to Wellfield 1.

- Install a potable water system and sanitary sewer treatment facility, including a septic drain field.

- Procure or fabricate components or portions of the proposed facility at an offsite location.

Under 10 CFR 51.45, environmental reports prepared by applicants should include an analysis of cumulative impacts from preconstruction activities so that the NRC staff may conduct an independent analysis of those activities. However, Uranium One did not provide information about activity-specific impacts or mitigations from preconstruction activities they identified in response to the NRC staff's inquiry in the matter. The preconstruction activities previously listed are the same types of activities that the NRC staff considered in this EA's Chapter 4 impact analysis (e.g., site preparation for a satellite building and upgrading access roads). Because the NRC staff has evaluated the direct and indirect impacts of all of the proposed construction activities on each resource in Chapter 4, and these impact conclusions are incorporated into each of the resource-specific cumulative impact analysis in Sections 5.2 through 5.13, the potential impacts from these activities can be considered as having already been incorporated into this cumulative effects chapter as part of the site-specific impacts from the proposed Ludeman project. Although, as previously mentioned, a subset of these construction activities that satisfy the definition of preconstruction could be conducted prior to the issuance of an NRC license amendment for the proposed Ludeman ISR Satellite Project, the NRC staff, in general, does not expect that a change in the timing of these construction activities for the proposed project would significantly change the potential environmental impacts. Nonetheless, preconstruction activities have been included in the cumulative impact analyses to ensure that any potential unique impacts associated with conducting these construction activities prior to the issuance of a license amendment are considered. Additionally, the NRC staff assumes that the same mitigation measures that Uranium One has committed to for the construction phase described in Chapter 4 would also be applied during relevant preconstruction activities.

5.2 Land Use

The geographic 80-km [50-mi] study area considered for the analysis of cumulative impacts to land use incorporates all of Converse County. The timeframe selected for the cumulative impact analysis for the Ludeman ISR Satellite Project begins in 2013 and ends in 2030.

Other past, present, and RFFAs considered as part of the cumulative impacts analysis include: (i) livestock grazing, (ii) disturbed vegetation due to ongoing resource development, (iii) oil and gas development, (iv) coal mining, and (v) uranium resource extraction. Livestock grazing would be expected to continue with minor land use interruptions as new energy projects (e.g., oil and gas, uranium, or coal) are developed. Per Wyoming Department of Environmental Quality's (WDEQ's) applicable guidelines as part of the permitting process for coal and noncoal mining projects (WDEQ, 2017b), land surface would be reclaimed and reseeded as energy projects cease operations. Oil and gas production is expected to continue and increase through 2040 (EIA, 2015; EIA, 2017). Within the proposed project boundary there are three producing oil and gas wells, and within 3.2 km [2 mi] of the proposed project boundary, there are four producing oil and gas wells and one disposal (or injector) well that has been shut down (EA Section 3.1.3, Uranium One, 2016a; Uranium One, 2017e). Both coal mining and uranium resource extraction are expected to continue through the timeframe of the land use cumulative impact analysis. Because the current land use within the study area is expected to continue, the NRC staff concludes that the cumulative impact for other past, present, and RFFAs would have a MODERATE impact on land use.

The NRC staff determined that for all phases and liquid waste management options proposed for the Ludeman ISR Satellite Project, land use impacts would be SMALL (EA Section 4.2). This determination was based on expected activities that would occur at the Ludeman Project (e.g., livestock grazing, hunting, oil and gas production, reclamation of disturbed areas). Recreational attractions within an 80-km [50-mi] radius include Thunder Basin National Grassland, Fort Fetterman and Fort Casper historic sites, Lance Creek Fossil Area, Ayers Natural Bridge, Glendo State Park (and reservoir) and other state and county parks and trails, and the historic Bozeman Trail (Uranium One, 2017e). The Thunder Basin National Grassland offers activities such as biking, camping, hunting, hiking, horseback riding, and off-road vehicle use. In addition to the local recreation attractions, communities (Casper, Glenrock, and Douglas) within 80 km [50 mi] of the proposed project area provide a variety of recreational activities. Municipal and private campgrounds in these communities offer activities such as fishing, hiking, hunting, off-road vehicle use, horseback riding, biking, and picnicking. Other recreational areas provided in these communities include golf courses, rodeo grounds, parks, recreation centers, and swimming pools. The NRC staff assumes that both livestock grazing and hunting in the 80-km [50-mi] study area around the project site would continue throughout the project lifecycle. However, as discussed in Section 3.2, most of the land within the proposed project boundary is privately owned land, and hunting would be restricted over the life of the project to protect workers (Uranium One, 2017e). There are a small number of oil and gas wells within the proposed project boundary, and the licensee has stated that it does not anticipate any conflicts of mineral right access or infrastructure usage (Uranium One, 2017e).

Minimal surface disturbance would occur as a result of preconstruction activities associated with the proposed Ludeman ISR Project. Preconstruction activities would include topsoil stripping, excavation, backfilling, compacting, and grading to prepare a level surface to accommodate the satellite building, office/maintenance building, storage areas, ponds, and parking areas. These areas would be fenced to control access (Uranium One, 2017c). Preconstruction activities would also include construction of an access road to the satellite building. The NRC staff assumes that the entire amount of the planned land disturbance over the life of the proposed project discussed in the licensee's revised ER and TR (Uranium One, 2017d,e) includes preconstruction activities and that disturbances from preconstruction activities would be reclaimed either during the phased construction or during decommissioning. As described in EA Section 4.2 and Table 4-1, the maximum amount of land disturbed from the proposed Ludeman ISR Satellite Project would occur under Uranium One's liquid waste management Option 1 {377 ha [932 ac] of land}, which is within the range analyzed in the GEIS {50 to 750 ha [120 to 1,860 ac]} (NRC, 2009). Because preconstruction activities would not increase the amount of land disturbed that has already been evaluated by the NRC staff for the proposed project, the NRC staff consider these effects already addressed by the impact analysis.

Based on the analysis in Chapter 4 and the discussion of preconstruction activities, the NRC staff concludes that the Ludeman ISR Satellite Project would have a SMALL incremental effect on land use when added to the MODERATE cumulative impacts from other past, present, and reasonably foreseeable future projects.

5.3 Transportation

Cumulative impacts on transportation systems were evaluated for a geographic area comprising Converse, Campbell, Johnson, and Natrona Counties, Wyoming. This geographic area was selected because major transportation routes within the region (both Interstate and U.S. Highways) occur within these four counties. The cumulative impact analysis focused on

Uranium One's proposed use of highways, existing county roads, and access roads over the 2013 to 2030 timeframe.

Potential environmental impacts from transportation associated with the proposed Ludeman ISR Satellite Project are described in EA Section 4.3. As analyzed in that section, all phases (i.e., construction, operations, aquifer restoration, and decommissioning) of the proposed Ludeman ISR Satellite Project would have a SMALL impact on transportation, except during the construction phase (under Uranium One's preferred liquid waste management option and Option 1) where the proposed action would have MODERATE impacts on traffic on State Route 93 during the first year of construction. Potential impacts would be from vehicles traveling to and from the site carrying workers, equipment, supplies, and materials associated with construction, operations, aquifer restoration, and decommissioning of the proposed Ludeman ISR Satellite Project. The NRC staff assumed that commuting workers and commercial deliveries would travel from a variety of locations and would not all commute on the same road. Additionally, the proposed transportation activities during operations, aquifer restoration, and decommissioning would not noticeably increase traffic on local and regional roads and would present low hazards under normal and accident conditions.

Other past, present, and reasonably foreseeable future uranium recovery facilities in the vicinity of the proposed Ludeman ISR Satellite Project and within the broader regional area are described in EA Section 5.1.2. Within an 80 km [50 mi] radius of the Ludeman ISR Satellite Project, there is one licensed and operating ISR facility (Smith Ranch), one operating ISR expansion (Highland) and several other existing nonoperational or planned uranium recovery projects in various stages of development (EA Section 5.1.2.1). Cumulative transportation impacts would occur where transportation activities of these other ISR facilities overlap with impacts from the proposed action. Because the location of the proposed Ludeman ISR Satellite Project is distant from many of the proposed ISR facilities, the potential for overlapping transportation impacts is limited. The NRC staff identified two circumstances where the greatest potential for overlapping ISR transportation impacts exist: (i) local traffic on roads accessing the Ludeman site, and (ii) along the routes used to transport Ludeman ion exchange shipments to the Willow Creek ISR facility for processing. Local traffic impacts from those ISR facilities that were operational in 2011 (the year traffic data was collected) and that use the same roads that access the proposed Ludeman ISR Satellite Project (Smith Ranch, Highland) are reflected in the traffic counts considered in the direct and indirect traffic analysis in Section 4.3. If the Reynolds Ranch project became operational, the NRC staff assumes that it could have traffic impacts similar to the Ludeman Project, and, therefore, could double the projected traffic impacts evaluated in Section 4.3. This would then lead to MODERATE cumulative traffic impacts on State Route 93 but not on more heavily traveled roads. Future decommissioning activities at Smith Ranch could overlap with proposed Ludeman ISR Satellite Project activities and create periods of temporary increases in traffic on State Route 93 that could be MODERATE, although phasing of decommissioning activities would be expected to limit the intensity and duration of these periods.

Regarding ion exchange shipment routes, the potential for overlap in ion exchange traffic is primarily with Smith Ranch because that facility would receive shipments from North Butte and Ruth facilities that are both located along State Route 387. Based on available information, the NRC staff found that the number of estimated daily ion exchange shipments to Smith Ranch would be less than five, which is similar to the number of daily ion exchange shipments proposed for the Ludeman ISR Satellite Project (four). Therefore, the NRC staff concludes that the total number of projected ion exchange shipments along the proposed routes would not be sufficient to create a noticeable change in transportation impacts.

Other ongoing and RFFAs in the vicinity of the proposed Ludeman ISR Satellite Project, such as coal mining (EA Section 5.1.2.2) and oil and gas production (EA Section 5.1.2.3), would result in additional transportation impacts. A prior evaluation of other past, present, and RFFAs in the PRB (BLM, 2011) projected future development trends for conventional oil and natural gas, CBM, and coal mining to year 2030. Conventional oil and natural gas production was projected to increase from the present to year 2030 (BLM, 2011). CBM production is currently below levels that were previously projected (BLM, 2003) and are expected to decline between the current timeframe and 2030. Coal mining was noted as declining since 2009 and, while future uncertainties were noted, projected to increase by 2030 to at least the previous peak (BLM, 2009) levels (low estimate) or increase by as much as 38 percent above 2009 production levels (high estimate). These projections suggest that the level of activity, and therefore the combined transportation impacts from these activities, is unlikely to increase during the timeframe of the analysis. Therefore, potential impacts from other ongoing and RFFAs in the vicinity of the proposed Ludeman ISR Satellite Project on transportation would be SMALL.

Wind energy projects (EA Section 5.1.2.4) and transportation projects (EA Section 5.1.2.6) would also have an impact on transportation resources in the cumulative impacts study area. Wind energy projects would impact transportation on local roads; however, these impacts would be temporary. During the 1- to 2-year construction period for a wind energy project, the vehicles of 100 to 150 workers and vehicles used to transport construction equipment, blades, turbine components, and other materials to the site would cause a relatively short-term increase in the use of local roadways. Shipments of materials, such as gravel, concrete, and water, are not expected to significantly affect local primary and secondary road networks. Shipments of overweight and/or oversized loads are expected to cause temporary disruptions on primary and secondary roads used to access construction sites. It is possible that local roads could require fortification of bridges and removal of obstructions to accommodate overweight and oversized shipments. Once completed, wind energy projects would require a relatively low number of workers to operate and maintain. For example, the operation and maintenance of a 180 MW capacity wind energy project with about 150 turbines would require 10 to 20 workers. Consequently, transportation activities would be limited to a small number of daily trips by pickup trucks, medium-duty vehicles, or personal vehicles. Shipments of large components required for equipment replacement in the event of major mechanical breakdowns are expected to be infrequent. Transportation activities during wind project decommissioning would be similar to those during construction but would involve a much smaller workforce. Heavy equipment would be required for dismantling turbines and towers, breaking up tower foundations, and regrading and recontouring the site (BLM, 2005b).

The potential impacts on transportation resources from preconstruction activities for the proposed Ludeman Project would include transportation activities similar to the construction phase that would involve vehicles traveling to and from the site carrying workers, construction equipment and materials, and waste materials. Because preconstruction precedes operations, no operational transportation activities would be conducted. Because (i) preconstruction activities are similar but more limited than the construction activities already evaluated for the proposed project and incorporated into the cumulative impact analysis, and (ii) the preconstruction effects would be short-term with lower traffic than the proposed construction, the NRC staff considers that these SMALL impacts are already adequately addressed in the impact analysis.

Existing traffic data reflect the current regional cumulative demand for road capacity (EA Section 3.2; Uranium One, 2017e). A recent Wyoming Department of Transportation (WYDOT) freight study indicated that the state highway network overall has no significant traffic

congestion hotspots that affect freight performance and reliability and projected a modest increase in truck freight tonnage for top commodities (1.7 percent annual average rate of increase) from 2011 to 2025 (WYDOT, 2015). This rate of growth is similar to the 1.5 percent annual growth cited in the revised environmental report (ER) to WYDOT (Uranium One, 2017e). For the time period of analysis, considering the projected growth and estimated capacities of similar roadways (Kadrmas et al., 2010; SDDOT, 2000), the NRC staff concludes that the regional roads evaluated would have sufficient capacity to accommodate the increases in traffic from other RFFAs. The prevalence of truck traffic on several of the regional roads creates impediments to full traffic flow (e.g., trucks slowing moving up hills) (WYDOT, 2016) that would still be noticeable, as well as the temporarily MODERATE effects of the concentrated local ISR development traffic on State Route 93. Based on the preceding analysis, the NRC staff concludes that the cumulative impact on transportation within the transportation study area resulting from other past, present, and RFFAs would be MODERATE.

In conclusion, the overall cumulative impacts are the incremental impacts from the Ludeman ISR Satellite Project when added to the impacts from other past, present, and RFFAs. As described in Section 4.3 and Table 4-1, the incremental impacts of the proposed Ludeman ISR Satellite Project on transportation would be MODERATE during the first year of the construction phase (under Uranium One's preferred waste management option and Option 1) and otherwise SMALL for all other phases. The impacts from other past, present, and RFFAs would be MODERATE. Therefore, the NRC staff concludes that the proposed Ludeman ISR Satellite Project under Uranium One's preferred waste management option and Option 1 would have a MODERATE incremental effect when added to the MODERATE impacts on transportation resources from other past, present, and RFFAs in the study area and the overall cumulative effects would be MODERATE. Under liquid waste management Option 2, the proposed Ludeman ISR Satellite Project would have a SMALL incremental effect when added to the MODERATE effects of other past, present, and RFFAs resulting in MODERATE overall cumulative effects.

5.4 Geology and Soils

The geographic 80-km [50-mi] study area considered for the analysis of cumulative impacts to geologic and soil resources incorporates all of Converse County. The timeframe selected for the cumulative impact analysis for the Ludeman ISR Satellite Project begins in 2013 and ends in 2030.

Preconstruction activities (e.g., topsoil stripping, excavation, backfilling, compacting, and grading to prepare a level site) would disturb a minimal amount of soil (Uranium One, 2017c). Topsoil would be stripped, stockpiled, and stabilized to accommodate any ancillary buildings or parking areas. The primary impacts on geology and soils would result from earthmoving activities during the construction phase, which are discussed in EA Section 4.4.

Other past, present, and RFFAs that may affect geology and soils resources include the nine uranium recovery projects that are either proposed, existing, or currently undergoing decommissioning, as discussed in EA Section 5.1.2.1. Development of future ISR projects in the geological and soil resources study area would have impacts on geology and soils due to increased vehicle traffic, clearing of vegetated areas, soil salvage and redistribution, discharge of ISR-produced groundwater, and construction and maintenance of project facilities and infrastructure (e.g., roads, well pads, pipelines, industrial sites, and associated ancillary facilities) as well as changes to the chemical constituents in the rock resulting from uranium extraction. The NRC staff assumes that the development of future ISR projects within the

cumulative impacts study area would be similar to the proposed Ludeman ISR Satellite Project, with similar potential for impacts to geology and soils. The construction and operation of the infrastructure for these future projects, however, would be subject to the same monitoring, mitigation, and response programs required to limit potential surface impacts (e.g., erosion and contamination from spills) as those for the proposed Ludeman ISR Satellite Project. Reclamation and restoration of disturbed areas would mitigate loss of soil and soil productivity associated with ISR activities.

Additional other past, present, and future natural resource development activities that relate to geology and soils include livestock grazing, coal mining, and oil and gas. BLM (2010) estimated that by 2020, if the upper coal production estimates are met, coal mining activities would account for approximately 35 percent of the total disturbed area within the PRB (BLM, 2010). Surface-disturbing activities related to coal mining and oil and gas activities, such as construction of new access roads, drill pads, and overburden stripping, would have direct effects on geological resources. Reclamation and restoration of soils disturbed by historic and ongoing livestock grazing and exploration activities would mitigate loss of soil and soil productivity, and salvaged and replaced soil would become viable soon after vegetation is established. Direct effects on geology from these activities would include excavation from coal seams within the Fort Union Formation and relocation of disturbed bedrock and unconsolidated surficial materials associated with surface disturbances. Indirect effects of coal mining would include the construction of railroads, coal-fired power plants, major (230 kV) transmission lines, and coal technology projects (NRC, 2016b). Impacts from these activities include loss of soil productivity due primarily to wind erosion, changes to soil structure from soil handling, sediment delivery to surface water resources (i.e., runoff), and compaction from equipment.

In 2014, the Wyoming State Geological Survey (WSGS) reviewed existing seismic data to quantify the potential relationship between earthquakes and injection and disposal well activity in Wyoming (Larsen and Wittke, 2014). The WSGS maintains a database of earthquake events and receives real-time notices from the U.S. Geological Survey (USGS) Advance National Seismic System (ANSS) Composite Earthquake Catalog. In this study, the ANSS earthquake data and WDEQ and WOGCC injection well information from 1984 to 2013 were evaluated. This time period contained the best and most reliable ANSS earthquake data available for Wyoming. The WSGS identified six disposal sites containing either Underground Injection Control (UIC) Class II wells or a combination of UIC Class I and II wells that warranted interpretation for potential induced seismicity. WSGS concluded that the earthquakes that occurred at five of the sites were most likely the result of natural causes (e.g., volcanic activity or movement along a fault) and unrelated to injection or disposal well activities (Larsen and Wittke, 2014). At the remaining site, near Bairoil, Wyoming, in Sweetwater County, WSGS concluded that further evaluation is necessary to determine if some induced seismicity has occurred, or if seismic events recorded at the site are triggered by natural phenomenon. As documented in Larsen and Wittke (2014), if in the future there are areas with high seismic activity and/or a significant seismic event occurs in the vicinity of active injection or disposal wells, the WSGS would report it to the WOGCC and WDEQ and conduct further investigations to determine if induced seismicity is a possible cause. Based on the results of the foregoing WSGS study and the NRC staff's previous assessment of this information (NRC, 2016b), the NRC staff concludes that Class I disposal wells within the cumulative impact study area for geology and soils are unlikely to contribute to induced seismicity. Also, induced seismicity related to deep wastewater injection is unlikely because injection pressure at Class I deep disposal wells (DDWs) would be monitored and maintained at a level that would not exceed the fracture pressures specified in the UIC permit (Uranium One, 2017e), and the nearest mapped fault is greater than 6.4 km [4 mi] from the Ludeman ISR Satellite Project boundary (Uranium One, 2013a).

Surface-disturbing activities associated with ongoing and reasonably foreseeable future energy resource exploration and development (i.e., uranium, oil and gas, and CBM), would have direct impacts on geology and soils. Direct impacts would result from increased traffic, clearing of vegetated areas, soil salvage and redistribution, removal of coal resources, and construction of project facilities and infrastructure. Induced seismicity resulting from wastewater deep disposal wells would not be likely. Therefore, the NRC staff determines that the cumulative impacts on geology and soils within the study area resulting from other past, present, and RFFAs would be MODERATE.

As described in EA Section 4.4 and Table 4-1, all phases of Uranium One's liquid waste management options (i.e., preferred option, Option 1, and Option 2) at the proposed Ludeman ISR Satellite Project site would have a SMALL impact on geologic and soil resources. This is based on (i) commitments that all injection, monitoring, and production wells would be plugged and abandoned, in accordance with WDEQ rules and regulations; (ii) negligible impacts of the ISR process and groundwater sweep and recirculation processes on the host rock matrix; (iii) the low risk that project activities would induce earthquakes; (iv) the systems and procedures that would be in place to monitor and clean up soil contamination resulting from spills and leaks; and (v) the reclamation and reseeding of disturbed soils. Therefore, the NRC staff concludes that the proposed Ludeman ISR Satellite Project would contribute a SMALL incremental effect when added to the MODERATE cumulative impacts to geology and soils resulting from other past, present, and future actions.

5.5 Water Resources

The cumulative impact to surface and groundwater resources was evaluated within an 80-km [50-mi] radius of the proposed Ludeman ISR Satellite Project. The 80-km [50-mi] radius for the water resources study area encompasses the watersheds that would be potentially impacted by other past, present, and RFFAs. The timeframe for the analysis is 2013 to 2030.

Surface Water and Wetlands

The primary impact to surface water and wetlands from preconstruction activities listed in EA Section 5.1.2.8 would be degradation of surface water quality from increasing suspended sediment concentrations in runoff because of vegetation removal and soil disturbance. During preconstruction, potential impacts to surface water and wetlands would be subject to required Wyoming Pollutant Discharge Elimination System (WYPDES) stormwater permits issued by WDEQ and Clean Water Act Section 404 permits from the U.S. Army Corps of Engineers (USACE) for any activities that could potentially disturb jurisdictional wetlands. As part of the WYPDES stormwater permit, a Storm Water Pollution Prevention Plan (SWPPP) would be implemented to control stormwater runoff. The SWPPP would describe best management practices (BMPs) (e.g., silt fencing, sediment logs, straw bale check dams, diversion ditches, and culverts) that would be implemented to reduce the sediment load in runoff from disturbed areas until vegetation can be re-established. Section 404 permits include provisions that must be followed to mitigate impacts when conducting activities in or near jurisdictional wetlands.

Within the water resources study area, there are nine other uranium recovery projects that are either proposed, existing, or currently undergoing decommissioning (EA Section 5.1.2.1). Potential future ISR projects would necessitate new roads, power lines, facilities construction, underground pipeline installation, and well drilling, all of which could have adverse effects on surface water and wetlands. Impacts to surface water and wetlands at existing and potential future uranium recovery projects would be subject to mitigation through BMPs required as part

of WYPDES stormwater permits and USACE Section 404 permits previously described in this section for any activities that could potentially disturb jurisdictional wetlands. In addition, all NRC-licensed ISR projects (past, existing, and future) would be subject to NRC and WDEQ decommissioning requirements to reclaim and restore affected areas and resources (e.g., land, groundwater, and surface water) to preoperational conditions.

Surface water quality within the water resources study area may be impacted by livestock grazing. Livestock grazing is a source of nonpoint pollution to streams and wetlands. However, this potential impact to surface water quality in streams and wetlands would only occur during heavy rain events and would, therefore, be intermittent. In addition, poor management of livestock grazing (e.g., overgrazing) could restrict flow in ephemeral streams due to erosion and sedimentation from decreased vegetative cover in drainage areas.

Oil and gas production and exploration, coal mining, wind energy projects, and transportation projects have the potential to adversely impact surface water and wetlands within the water resources study area (EA Section 5.1.2). Impacts to surface water and wetlands would be from surface runoff as new facilities, infrastructure, roads, rail lines, power lines, and drill pads are constructed using heavy equipment. Runoff degrades surface water quality, causes erosion, and leads to siltation of streambeds and wetlands. Operators must obtain WYPDES permits from the WDEQ prior to conducting exploration, construction, and production activities. WYPDES permits include plans and programs for spill prevention and cleanup, erosion control, and stormwater management. In addition, USACE Section 404 permits are also required for any disturbances in or near jurisdictional wetlands.

Livestock grazing is expected to continue in the water resources study area and, as such, will continue to have the potential to degrade water quality in streams and wetlands. Construction activities associated with other ongoing and RFFAs, including uranium and oil and gas exploration and development, coal mining, wind energy projects, and transportation projects, would have potential impacts on surface water and wetland resources in cases where surface water features are present. Many or all of these activities would necessitate construction of new roads, power lines, facilities, and infrastructure, which would have the potential to degrade water quality and alter natural surface water flow systems. Therefore, the NRC staff have determined that the cumulative impact on surface water and wetlands within the surface water study area resulting from other past, present, and RFFAs would be MODERATE.

As described in EA Section 4.5 and Table 4-1, all phases of Uranium One's liquid waste management options (i.e., preferred option, Option 1, and Option 2) at the proposed Ludeman site would have a SMALL impact on surface water resources provided that NRC license conditions are met. Potential impacts would be mitigated through proper planning and design of facilities and infrastructure, the use of proper construction methods, and compliance with NRC license conditions. Prior to construction of the proposed project, Uranium One must obtain a WYPDES permit from WDEQ, which would include plans and programs for spill prevention and cleanup, erosion mitigation, surface water monitoring, and stormwater runoff control. Uranium One has committed to using BMP measures, in accordance with a WYPDES permit. Based on the foregoing analysis, the NRC staff concludes that the proposed Ludeman ISR Satellite Project would contribute a SMALL incremental effect when added to the MODERATE cumulative impacts to surface water and wetlands resulting from other past, present, and RFFAs.

Groundwater

As noted in EA Section 3.4.3, Lower Tertiary aquifers (EA Figure 3-1) have the potential for future industrial, stock, and domestic groundwater development (Uranium One, 2011b). The deep Upper Paleozoic aquifers (EA Figure 3-1) that potentially could be developed for municipal water supply, as described in EA Section 3.4.2, have not been characterized for that purpose (Trihydro, 2006).

One preconstruction activity that could affect groundwater is installing a potable water well and septic system, as described in Uranium One's revised ER Section 1.5.6.3 (EA Section 5.1.2.8). Any water well and septic system constructed at the Ludeman site would be permitted through the WDEQ permitting process. Uranium One did not specify which aquifer the licensee would target to provide potable groundwater. However, domestic groundwater surrounding the proposed Ludeman Project area is sourced from shallow sand aquifers at depths ranging from 1.5 to 110 m [5 to 360 ft] (EA Section 4.5). The NRC staff concludes that because preconstruction activities associated with groundwater would include installation of a single domestic well and a septic system, both which would be constructed and operated under WDEQ permitting criteria, the impact to groundwater from preconstruction activities would be SMALL.

Numerous existing and potential ISR facilities are present within the water resources study area (EA Figure 5-1). Confined sandstone beds in the Wasatch Formation are the uranium-bearing production aquifers at ISR facilities north of the proposed Ludeman ISR Satellite Project in Campbell and Johnson Counties. These facilities include Moore Ranch and Reno Creek. Impacts to groundwater resulting from interactions of ISR activities at these facilities and the proposed Ludeman Project are not likely, because these activities would be conducted in stratigraphically separated aquifers. Confined sandstone units in the Fort Union Formation are the uranium-bearing production aquifers at ISR facilities in Converse County. In addition to the proposed Ludeman Project, these facilities include Reynolds Ranch and Smith Ranch. As described in EA Section 3.4.2, production aquifers within the Fort Union Formation at the proposed Ludeman Project are discontinuous. To reduce the potential impact of ISR operations on groundwater quality in surrounding aquifers, ISR licensees are required to implement (i) underground injection control (UIC) programs administered by WDEQ; (ii) mechanical integrity test (MIT) programs on all production, injection, monitoring, and disposal wells; and (iii) excursion detection and control programs, under NRC regulations, to mitigate and remediate potential migration of lixiviant from production zone aquifers.

Oil and gas exploration, coal mining, wind energy projects, and transportation projects may contribute to impacts to groundwater resources within the water resources study area (EA Section 5.1.2). Impacts on groundwater resulting from interaction of ISR activities and oil and gas exploration and production are not likely, because these activities are conducted in stratigraphically separated aquifers. ISR activities at the proposed Ludeman ISR Satellite Project would take place in sandstone aquifers in the Fort Union Formation at depths of 16 to 210 m [53 to 690 ft]. Oil and gas production within 2 km [1.2 mi] of the proposed Ludeman ISR Satellite Project area is from the Cretaceous Niobrara Formation below the Lewis Shale at depths ranging from approximately 3,295 to 3,932 m [10.809 to 12,900 ft] (EA Table 3-3). There are no current or historic coal mines within the proposed project area and only two coal mines within 80 km [50 mi] of the proposed Ludeman Project area. The Antelope Mine boundary (operated by Cloud Peak Energy, LLC) is approximately 56 km [35 mi] northeast of the Ludeman ISR Satellite Project boundary, and the Dave Johnston coal mine boundary (operated by Glenrock Coal Co.) is located approximately 16 km [10 mi] northwest of the Ludeman ISR

Satellite Project boundary. The Dave Johnston coal mine has not produced coal since the year 2000. There are no CBM facilities within the project area or within 3.2 km [2 mi] of the proposed Ludeman Project boundary (Uranium One, 2017e).

The PRB Coal Review (BLM, 2008; BLM, 2012c,d; BLM, 2013a) provides a summary of the cumulative groundwater resource effects in the Wyoming PRB area for future years 2020 and 2030 as a result of ongoing coal mine dewatering and CBM development. The BLM estimated that CBM development would remove about 37 million ha-m [3 million ac-ft], less than 0.3 percent of the total recoverable groundwater {1.7 billion ha-m [nearly 1.4 billion ac-ft]} in the Wasatch and Fort Union Formations within the PRB. An estimated 15 to 33 percent of the removed groundwater would infiltrate the surface and recharge the shallow aquifers above the coal zones (BLM, 2008; BLM, 2012c,d; BLM, 2013a). BLM predicted that within the PRB, the redistribution of pressure within the coals after CBM water production ended would allow the hydraulic pressure head to recover within approximately 15 m [50 ft] or less of pre-project levels within 25 years after project completion (BLM, 2003). The complete recovery of water levels would take tens to hundreds of years, depending on the specific location. The BLM noted that the areal extent and magnitude of drawdown effects on coal zone aquifers and overlying or underlying sand units in the Wasatch Formation would be limited by the discontinuous nature of different coal zones within the Fort Union Formation and sandstone layers within the Wasatch Formation (BLM, 2003).

Impacts to groundwater from existing and potential wind energy projects within an 80-km [50-mi] radius of the proposed Ludeman ISR Satellite Project area (EA Section 5.1.2.4) would not be noticeable. During construction of wind energy projects, water would be required for mixing of concrete for tower foundations and support facilities and for dust control along access roads and other areas of disturbance around the turbines. Disturbed areas would be revegetated and reclaimed immediately following construction. Once a wind energy project is operating, minimal quantities of groundwater are needed (BLM, 2005b; BLM, 2011).

The proposed PRB Expansion Project (a railroad expansion project) (EA Section 5.1.2.6) would have an impact on groundwater. Groundwater would be used to suppress dust during rail and bridge construction activities. Once operational, the PRB Expansion Project would use negligible amounts of groundwater. Water demand during construction activities would be supplied by existing municipal and private wells. DM&E (the project proponent) would ensure that any wells that may be affected by project-related construction or preconstruction activities are appropriately protected or capped to prevent well and groundwater contamination (STB, 2001).

The NRC staff have determined that the cumulative impact on groundwater resources within the water resources study area resulting from other past, present, and RFFAs is MODERATE. This finding is based on ongoing and RFFAs that would (i) impact groundwater quality and quantity in the Fort Union Formation, which hosts uranium deposits in Converse County and is a source of water supply for domestic and stock watering purposes in the study area and (ii) potentially affect water quality in deep geologic formations that are used for disposal of liquid wastes. In addition, ongoing and RFFAs, such as ISR, wind energy projects, and transportation projects, would use groundwater to construct concrete foundations and support facilities and for dust suppression during construction and operations activities, which would potentially impact water quantity in regional and local aquifers in the study area.

As described in EA Section 4.5 and Table 4-1, all phases of Uranium One's liquid waste management options (i.e., preferred option, Option 1, and Option 2) at the proposed

Ludeman site would have a SMALL impact on groundwater resources provided that NRC license conditions are met. Under NRC regulations, ISR licensees are required to implement excursion detection, control, mitigation, and remediation plans to reduce the potential impact on groundwater quality and quantity outside the exempted production zone. WDEQ permitting requirements would protect groundwater in aquifers used for deep well disposal of liquid byproduct from the proposed project. After uranium production and aquifer restoration are completed and groundwater withdrawals are terminated at the proposed Ludeman ISR Satellite Project, groundwater levels would recover with time. Groundwater restoration would restore impacted aquifers at the proposed project to acceptable water quality levels. Therefore, the NRC staff concludes that the proposed Ludeman ISR Satellite Project would contribute a SMALL incremental effect when added to the MODERATE cumulative impacts to groundwater resources resulting from other past, present, and RFFAs.

5.6 Ecology

The cumulative impact to ecological resources was evaluated within an 80-km [50-mi] radius of the proposed Ludeman Satellite ISR Project. Activities occurring in this study area include livestock grazing, wildlife herd management, agriculture, hunting, uranium recovery, CBM production, wind energy, and oil and gas exploration (EA Section 5.1.2). In addition, a regional transportation project is planned for transporting coal. The timeframe for the analysis is from 2013 to 2040, which represents the license termination at the end of the decommissioning period and a 10-year vegetation recovery period. As stated in EA Section 4.6, vegetation in sagebrush shrubland communities could experience impacts from land-disturbing activities during decommissioning for 10 or more years. Therefore, the NRC has determined that 10 years in this cumulative impact analysis is adequate for accounting for vegetation recovery following decommissioning.

BLM conducted a cumulative effects analysis for vegetation and wildlife for the Wyoming PRB through 2030 (BLM, 2013a). The footprint of this analysis overlaps the northern portion of the 80-km [50-mi] radius around the proposed Ludeman ISR Satellite Project. BLM also conducted a cumulative effects analysis for the Casper Planning Area, but did not specifically identify the timeframe over which the analysis extends, other than that the long-term surface disturbances analyzed would be present following reclamation (BLM, 2007). In these analyses by BLM, potential effects to ecological resources within the study area, both flora and fauna, are similar to those described in EA Section 4.6 and include loss, alteration, or incremental fragmentation of habitat; displacement of and stresses on wildlife; modification of prey and predator communities; direct or indirect mortalities; reduction in forage productivity; degradation of water quality; and potential spread of invasive species and noxious-weed populations. Development activities in the study area could potentially reduce wildlife populations if habitats adjacent to the study area are at, or near, their carrying capacity (e.g., the maximum population an area will support) for a species, considering that there may be an unavoidable reduction or alteration of existing habitats (BLM, 2013a). For some species that require specific conditions for their habitats (e.g., small mammals), future populations would be strongly influenced by the quality and composition of the remaining habitats.

Terrestrial Ecology

BLM estimated that approximately 25,130 ha [62,097 ac] (approximately 0.73 percent) of the land surface in the Casper Planning Area, including wetland and riparian vegetation, would experience long-term surface disturbances following reclamation from all present and RFFAs, including mineral, energy, and transportation projects, land management activities, livestock

grazing, recreation, and the use of off-highway vehicles (BLM, 2007; BLM, 2013a). For the purpose of this analysis, the NRC staff assumes the same percentage of land surface {14,239 ha [35,186 ac], or approximately 0.73 percent} within the cumulative impacts study area would still be disturbed at the end of 2030 or the end of the licensed life of the Ludeman ISR Satellite Project. The NRC staff anticipates that the requirements of WDEQ-approved permits (i.e., weed management, timely revegetation, groundwater monitoring, and discharge water quality control) would ensure that vegetation and habitats support a stable ecosystem (WDEQ, 2006; WDEQ, 2012b). Federal laws and regulations protect the majority of birds found in the Wyoming PRB (EA Section 4.6), as do U.S. Fish and Wildlife Service (FWS) requirements under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). WDEQ may also enforce other mitigation measures for projects, such as speed limits, fencing, and overhead power line construction techniques that limit effects on wildlife, as well as timing and buffer stipulations. Therefore, with the exception of the Greater sage-grouse, the incremental impacts to cumulative impacts to terrestrial vegetation and wildlife from the proposed Ludeman ISR Satellite Project would be SMALL. Greater sage-grouse is a species that the FWS previously considered for listing on the Endangered Species Act (ESA), and which continues to be at risk because of population declines related to habitat loss and degradation, particularly in sagebrush shrubland vegetation. Oil and gas development is regarded as playing a major role in the decline of the Greater sage-grouse species (BLM, 2007; Taylor et al., 2012). As stated in EA Section 3.5, the nearest Greater sage-grouse lek is approximately 4.4 km [2.75 mi] northwest of the proposed project area, and the proposed Ludeman ISR Satellite Project site is not located within a Greater sage-grouse core population area, Priority Habitat Management Area, or connectivity corridor. The State of Wyoming Governor has established impact thresholds and has issued guidance and recommendations in an executive order for Greater sage-grouse management on private and public lands to limit project impacts (Mead, 2015). However, primarily due to impacts from the past, present, and reasonably foreseeable future oil and gas development activities in the 80-km [50-mi] radius around the Ludeman Project, the cumulative impacts from all other past, present, and RFFAs would be MODERATE to the Greater sage-grouse.

As discussed in EA Section 4.6 and summarized in Table 4-1, the potential impact on vegetation and terrestrial wildlife, taking into account the licensee's proposed mitigation measures for the proposed Ludeman ISR Satellite Project during all liquid waste management options (i.e., preferred option, Option 1, and Option 2) would be SMALL. Vegetation within the Ludeman Project area is primarily grassland plant communities. As described in EA Table 4-1, the maximum amount of vegetation and habitat expected to be disturbed from the proposed Ludeman ISR Satellite Project would occur under Uranium One's liquid waste management Option 1 {377 ha [932 ac]}, which is approximately 0.02 percent of the land located within a 80-km [50-mi] radius around the proposed Ludeman Project area. The NRC staff determines that based on the small amount of expected vegetation and habitat disturbance primarily to grassland plant communities within the study area, the impact from the proposed Ludeman ISR Satellite Project would be SMALL. Thus, the proposed project's incremental impacts to cumulative impacts would be SMALL when added to the SMALL cumulative impacts on terrestrial vegetation and wildlife from all past, present, and RFFAs in the cumulative impact study area. However, cumulative impacts to the Greater sage-grouse would continue to be MODERATE, even with the addition of the proposed Ludeman ISR Satellite Project.

Aquatic Ecology

BLM anticipates that the amounts of surface water produced from CBM and oil and gas projects within the Casper planning area and PRB would have little effect on surface water quantity flows

in the planning area (BLM, 2007; BLM, 2013a). Further, BLM determined that activities within the Casper Planning Area and the Dry Fork Cheyenne River and the Antelope Creek subwatersheds could impact surface water quality and downstream aquatic species due to soil erosion (BLM, 2007; BLM, 2013a). BLM determined that the contribution of coal-related development in the PRB under a high-production scenario by year 2030 would have low effects on fish in the PRB subwatersheds and is not expected to significantly impact surface water quality (BLM, 2013a). BLM anticipates that construction and operation of RFFAs within the PRB would be temporary, localized, and would not occur within stream channels and would not result in removal of ponds or reservoirs; thus, no direct loss or alteration of aquatic habitat would occur (BLM, 2013b). To assess the extent of cumulatively impacted aquatic resources as a result of the projects discussed in EA Section 5.1.2, the NRC staff also assumes, consistent with the BLM reports, that the effects from those projects would also not result in direct loss or alteration of aquatic habitat. In addition, all proposed activities in this study area would be regulated by a WYPDES permit and would comply with federal and state water quality regulations. Because the majority of the water uses in the PRB are for coal-related projects, which are not expected to significantly impact surface water quality, the NRC staff concludes that the cumulative impact on aquatic ecology resulting from all present and RFFAs in the 80-km [50-mi] radius around the proposed Ludeman Project would be SMALL.

As described in EA Section 4.6, because of the limited and ephemeral nature of surface water at the Ludeman site, the occurrence of aquatic species is also limited. No loss of aquatic habitat would result from planned ISR activities during any phase of the proposed Ludeman ISR Satellite Project, including in the North Platte River system. In addition, no surface water would be diverted and no process water would be discharged into an aquatic habitat. Surface water discharged under the preferred liquid waste option and Option 1 and stormwater runoff under all liquid waste management options would be managed through the SWPPP and a WYPDES permit (as discussed in EA Section 4.6) and subject to any NRC license conditions. The NRC staff concludes that the proposed Ludeman Project would have a SMALL incremental effect on aquatic ecology when added to the SMALL cumulative effects from all other past, present, and RFFAs in the cumulative impacts study area. This conclusion is based on the limited and ephemeral nature of surface water features within the Ludeman Project area and because of the mitigation requirements associated with the required regulatory permits and licenses.

Protected Species and Species of Concern

A number of protected species and species of concern are, or could be, potentially be present within an 80-km [50-mi] radius around the proposed Ludeman ISR Satellite Project area (FWS, 2017b; WGFD, 2017; EA Section 3.6). For the purpose of this cumulative assessment, protected species and species of concern are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Potential impacts to terrestrial protected species and species of concern from regional projects in the 80 km [50 mi] radius around the proposed Ludeman Project area would be similar to those impacts discussed previously in this section. Increased activity and noise from projects that occur within potential habitat for these species, especially during respective breeding seasons, could decrease a species' use of a habitat or the overall suitability of a habitat (BLM, 2007; BLM, 2013a). However, given the location of development activities compared with the geographical occurrence of many of these species, and with mitigating permit requirements and state policies and federal regulations in place (e.g., the ESA and MBTA), the cumulative impacts from all other past, present, and RFFAs to protected species would be SMALL.

As discussed in EA Sections 3.6 and 4.6, no federally listed threatened or endangered plant species or critical habitats are known to occur within the Ludeman ISR Satellite Project area. FWS species of concern, including black-tailed prairie dog, bald eagle, and Greater sage-grouse, could potentially occur within the Ludeman Project site (EA Section 3.6). However, for reasons explained in EA Section 4.6, due to licensee commitments and mitigation measures, federal regulations and state policies and permit requirements, the NRC staff concludes that the proposed Ludeman Project would have a SMALL impact on protected species and species of concern. Therefore, incremental impacts would also be SMALL when added to the SMALL cumulative impacts to protected species and species of concern from all other past, present, and RFFAs in the 80-km [50-mi] radius surrounding the proposed Ludeman ISR Satellite Project.

5.7 Air Quality

The NRC staff assessed cumulative impacts on air quality primarily within an 80-km [50-mi] radius study area around the proposed Ludeman ISR Satellite Project. The assessment of the impacts within the study area will be called the near-field analysis, and the assessment of the impacts beyond the study area will be called the far-field analysis. The timeframe for the analysis of cumulative impacts runs from 2013 to 2030.

Non-Greenhouse Gas Emissions

As described in EA Section 5.1.2, other past, present, and RFFAs that may contribute to pollutant emissions include uranium exploration and extraction, coal mining, oil and gas production, CBM development, energy projects, transportation projects, other energy projects, and ISR preconstruction activities. Air pollutants emitted by these sources potentially have cumulative impacts, including but not limited to, carbon monoxide, nitrogen oxides, sulfur dioxide, particulates, and volatile organic compounds from various types of combustion emissions and particulate matter from travel on unpaved roads.

Near-Field Analysis

The effects of other past and present activities on the air quality in the near-field are represented in the EPA's National Ambient Air Quality Standards (NAAQS) compliance status and air monitoring results. As described in EA Section 3.6.2, EPA currently designates the entire area within the study area as an attainment area for all pollutants. WDEQ operates and maintains five monitoring stations within the study area. The monitoring stations provide data needed to evaluate NAAQS compliance on an ongoing basis. EA Table B–9 contains monitoring results for these five stations. The Wyoming Ambient Air Monitoring Annual Network Plan 2017 reports that, based on the results from these five monitoring stations, the near-field air quality is in compliance with the NAAQS (WDEQ, 2017c).

The NRC staff's near-field analysis also considers the various RFFAs within the study area as identified in EA Section 5.3. The potential for the air emissions from the Ludeman ISR Satellite Project to overlap with other RFFAs is reduced by the following factors:

- Mobile and fugitive sources would generate the vast majority of emissions at the proposed Ludeman ISR Satellite Project (EA Appendix B, Table B–5), and these types of sources do not generate emissions continuously.

- Particulate matter PM_{10} is expected to be the primary pollutant at the Ludeman ISR Satellite Project and is mostly generated by travel on unpaved roads (EA Appendix B, Section B.3.3). Heavier particles (i.e., particulate matter PM_{10}) generated from travel on unpaved roads are the type of emission most likely to be removed from the air close to the generating source (Countess, 2001).

- Emission levels vary over the life of the Ludeman ISR Satellite Project. As depicted in EA Appendix B Table B–1, Uranium One estimates that many of the project years would generate lower emission levels than the peak year.

- Wind direction at the Ludeman ISR Satellite Project is predominantly from the west; however, winds are also common from the east-southeast [Uranium One's revised ER, Figure 3.6-18 (Uranium One, 2017e)]. The majority of the emission sources in the study area are located to the north and east of the Ludeman ISR Satellite Project area (EA Figure 5-1). Because of the wind direction, pollutants would travel from the Ludeman ISR Satellite Project area towards the other emission sources rather than from these other emission sources toward the Ludeman Project. In terms of overlapping effects, the air quality where these other sources occur would be affected by the additional emissions from the Ludeman ISR Satellite Project, rather than the air quality at the Ludeman ISR Satellite Project experiencing the additional emissions from these other sources.

According to information in EA Section 5.1.2.1, there are four ISR projects within the study area that are licensed and not operating. All four ISR projects are located north of the Ludeman Project. Three projects are near the boundary of the study area and the other is approximately 24 km [14.9 mi] away from the Ludeman ISR Satellite Project. The air emissions from other ISR projects are similar in nature to the air emissions from the Ludeman ISR Satellite Project, and the four factors identified previously limit the potential for overlapping impacts. Emissions from the proposed Ludeman ISR Satellite Project preconstruction activities would only be a fraction of the estimated project year one emission levels, and the year one emission levels are below the peak year emission levels (EA Appendix B, Table B–1). Furthermore, preconstruction air emissions are similar in nature to the air emissions from the other ISR projects, and the four factors previously identified would limit the potential for overlapping impacts. As noted in EA Section 5.1.2.2, four coal mines are located just south of Wright, Wyoming, near the border of Converse and Campbell Counties. Distance and wind direction limits overlap of potential impacts between the Ludeman ISR Satellite Project and the coal mines. As depicted in EA Figure 5-1, most of the highly favorable areas for oil and gas development within the study area occur north or east of the Ludeman Project, and the four factors previously identified limit the potential for overlapping impacts. One highly favorable area for oil and gas development occurs about 19.3 km [12 mi] to the west of the Ludeman ISR Satellite Project. All of the factors, except for wind direction, would limit potential overlap of impacts in this case. Although CBM development is common in the PRB, this form of mining has been on the decline since 2008. There are no plans for any new coal-fired power plants in the study area. A new wind energy project is being constructed near Glenrock. All of the factors previously identified, except for wind direction, would similarly limit potential overlap of impacts. Distance and wind direction limit the potential for overlapping impacts with the proposed DM&E Powder River Basin Rail expansion project. Potential overlapping impacts are further limited because the proposed rail project's emissions are not continuous and would be spread out over a large area rather than localized at one location. Other mining (e.g., sand, gravel, and bentonite) occurs in the study area. The area disturbed by this type of mining is relatively small, and the emissions are primarily generated from mobile and fugitive sources that do not operate continuously.

In summary, the NRC staff considers the ambient pollutant concentrations from other activities in the study area noticeable but not destabilizing. EPA currently designates the study area as in attainment for all pollutants, and recent monitoring results continue to support this classification. Based on the prior descriptions of the RFFAs, the NRC staff expects this trend to continue. Because of these reasons, the NRC staff determines that the cumulative impact on air quality within the study area resulting from other past, present, and RFFAs would be MODERATE.

Cumulative impacts on air quality for the near-field include incremental effects from the Ludeman ISR Satellite Project added to the aggregate effects of other past, present, and RFFAs. As discussed in EA Section 4.7 and Table 4-1, because of the estimated emission levels, associated airborne concentrations, and the proximity to nearby residences, the NRC staff concludes that the impacts to air quality for all liquid waste management options would be SMALL. When combining the incremental (SMALL) effects from the proposed Ludeman ISR Satellite Project with all other impacts from other past, present, and RFFAs in the study area (MODERATE), the NRC staff determines that the overall cumulative impact from the near-field nongreenhouse gas emissions would be MODERATE.

Far-Field Analysis

The collective emissions generated from all of the sources within the study area have the potential to affect receptors outside of the study area (i.e., the far-field). Analyses of the effects from regional emissions often focus on areas categorized as Class I because these areas have the greatest level of protection (i.e., the most stringent standards) under the Prevention of Significant Deterioration (PSD) program. Wind Cave National Park, the closest Class I area, is located about 193.1 km [120 mi] to the northeast of the Ludeman ISR Satellite Project.

The effects of past and present activities on the air quality in the far-field are represented in the NAAQS compliance status and air monitoring results. Wind Cave National Park is in attainment (40 CFR 81.342). According to the South Dakota Ambient Air Monitoring Annual Network Plan (SDDENR, 2016), recent pollutant concentrations at the Wind Cave site are below the applicable NAAQS. In addition to attainment status, air quality at Class I areas also considers visibility impairment. Wind Cave National Park has experienced visibility impacts according to the South Dakota Department of Environment and Natural Resources Regional Haze State Implementation Plan (SDDENR, 2011).

Future impacts on the air quality in the far-field are less well defined. In 2014, BLM published the most recent version of the PRB Coal Review (BLM, 2014), which modeled impacts from PRB regional emissions to Wind Cave National Park and other Class I areas. Based on the expected changes in regional emission levels, the modeled concentrations for all pollutants through 2030 are expected to remain unchanged or tend to decrease (BLM, 2014). In the recently published final EIS for the Buffalo Regional Management Plan (BLM, 2015b), BLM noted concerns about the quality of the emission inventory and modeling in the PRB Coal Review. BLM stated in the final EIS that they would not be using the PRB Coal Review air quality analysis to inform planning decisions for the Buffalo Regional Management Plan or for future projects in the planning area (BLM, 2015b). At this time, the NRC staff has not identified an appropriate information source to replace the PRB Coal Review air quality analysis.

The NRC staff concludes that current far-field impacts from all past and present actions are MODERATE because of the visibility impacts experienced at Wind Cave National Park. Based on the currently available information, the NRC staff expects future impacts to continue at a similar level. However, based on known flaws in the currently available information (BLM, 2014),

the NRC staff acknowledges the possibility that future impacts to air quality could be LARGE. Therefore, the NRC staff determines that the far-field cumulative impacts on air quality resulting from other past, present, and RFFAs could range from MODERATE to LARGE.

Although there is uncertainty concerning future impacts to the far-field, the contribution of the proposed Ludeman ISR Satellite Project to the far-field impacts is better understood. Uranium extraction only contributes a small portion of the overall emissions in the southern portion of the PRB. The only pollutant generated from uranium extraction activities that contributes more than one percent to the overall emission levels is nitrogen dioxide, which contributes 2 percent (BLM, 2015b). These percentages are based on all of the uranium extraction projects in the southern portion of the PRB, not just a single ISR facility like the Ludeman ISR Satellite Project. Based on the relative contribution of the project and overall uranium extraction activities to the regional nongreenhouse emission levels, the NRC staff concludes that the Ludeman ISR Satellite Project would have a SMALL incremental effect on the far-field air quality. When combining the incremental impacts from the Ludeman ISR Satellite Project with all the impacts from other past, present, and RFFAs in the study area, the NRC staff concludes that the cumulative impacts from the far-field nongreenhouse gas emissions would be MODERATE to LARGE.

Greenhouse Gas Emissions and Global Climate Change

This section addresses the impact of global climate change within the study area and evaluates the contribution of carbon dioxide from the proposed Ludeman ISR Satellite Project to the overall atmospheric greenhouse gas levels.

The impact magnitude resulting from a single source or a combination of greenhouse gas emission sources over a larger region must be placed in geographic context for the following reasons:

- The environmental impact is global rather than local or regional.
- The effect is not particularly sensitive to the location of the release point.
- The magnitude of individual greenhouse gas sources related to human activity, no matter how large compared to other sources, are small when compared to the total mass of greenhouse gases resident in the atmosphere.
- The total number and variety of greenhouse gas emission sources is extremely large, and the sources are ubiquitous.

Consequently, the NRC staff determined that an appropriate approach to address the cumulative impacts of greenhouse gas emissions (including carbon dioxide) is to recognize that

- Greenhouse gas emissions contribute to climate change.
- Climate change is best characterized as the result of numerous and varied sources, each of which might seem to make a relatively small addition to global atmospheric greenhouse gas concentrations.
- The extent of the analyses should be commensurate with the quantity of greenhouse gas emissions generated by the proposed action.

- Carbon footprint and resilience to climate change are relevant factors in evaluating distinctions between alternatives.

- Analysis may include both the proposed Ludeman Project's contribution to atmospheric greenhouse gas levels and the potential effects of climate change on the Ludeman Project.

Evaluation of cumulative impacts of greenhouse gas emissions requires the use of a global climate model. The U.S. Global Change Research Program (GCRP) report (GCRP, 2014) provides a synthesis of the results of numerous climate modeling studies. The NRC staff concludes that the cumulative impacts of greenhouse emissions around the world as presented in the GCRP report are an appropriate basis for its evaluation of cumulative impacts. Based primarily on the scientific assessments of the GCRP and National Research Council, the EPA Administrator issued a determination in 2009 (74 FR 66496) that greenhouse gases in the atmosphere may reasonably be anticipated to endanger public health and welfare, based on observed and projected effects of greenhouse gases, their effect on climate change, and the public health and welfare risks and effects associated with such climate change. Based on the effects set forth in the GCRP report and the emissions threshold criteria and general approach implemented in the final EPA "Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule" (75 FR 31514), the NRC staff concludes that the national and worldwide cumulative impacts of greenhouse gas emissions are noticeable but not destabilizing (i.e., MODERATE).

Proposed Ludeman ISR Satellite Project's Contribution to Atmospheric Greenhouse Gas Levels

The NRC staff considered that the proposed Ludeman ISR Satellite Project generates low levels of greenhouse gases relative to other sources. For the peak year, the Ludeman ISR Satellite Project would generate an estimated total of 6,085 metric tons [6,708 short tons] of carbon dioxide (EA Appendix B Table B–2). In the Tailoring Rule, EPA establishes thresholds for greenhouse gas emissions that define whether sources are subject to EPA air permitting. For new sources, the threshold is 90,718 metric tons [100,000 short tons] of carbon dioxide equivalents per year; and for modified existing sources, the threshold is 68,039 metric tons [75,000 short tons] of carbon dioxide equivalents per year. Because emission estimates are below the EPA thresholds, the NRC staff concludes that the Ludeman ISR Satellite Project would generate low levels of greenhouse gases relative to other sources (i.e., the project is not considered a large emitter or source of greenhouse gases) and would have a SMALL impact on air quality in terms of greenhouse gas emissions.

Mitigation is one response strategy for addressing climate change. The NRC staff acknowledges that any reduction of greenhouse gas emissions at the project level would be reflected in a reduction of the overall greenhouse gas levels. However, the need to implement mitigation for a given project should take into account the relative amount of greenhouse gases produced by that project. As described previously, the NRC staff concludes that the Ludeman ISR Satellite Project would generate low levels of greenhouse gases relative to other sources.

Cumulative impacts to greenhouse gas levels include the incremental effects from the Ludeman ISR Satellite Project when added to the aggregate effects of other past, present, and RFFAs. The NRC staff concludes that the Ludeman ISR Satellite Project would have a SMALL incremental impact on air quality in terms of greenhouse gas emissions when added to the MODERATE cumulative impacts anticipated from the greenhouse gas emissions from other past, present, and RFFAs. The NRC staff further concludes that the cumulative impacts to

greenhouse gas levels would be noticeable but not destabilizing (i.e., MODERATE), with or without the greenhouse gas emissions from the proposed Ludeman ISR Satellite Project.

The carbon footprint is a relevant factor when evaluating potential impacts for the various waste management options, as well as the No-Action Alternative. The greenhouse gas emission levels for the various waste management options only vary in project year 1, and the differences are minimal (Appendix B, Table B–6). The No-Action Alternative eliminates the Ludeman ISR Satellite Project as a source of gaseous emissions that would contribute to the ambient greenhouse gas levels. The elimination of all project-level greenhouse gas emission distinguishes the No-Action Alternative from the proposed action, which would generate low levels of greenhouse gases relative to other sources.

Potential Effect of Climate Change on the Ludeman ISR Satellite Project

The NRC staff acknowledges that climate change may cause impacts across a wide variety of resource areas, including air, water, ecological, and human health. The GCRP describes these potential impacts in the report Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment (GCRP, 2014). In this section, the discussion of impacts from climate change on the environment focuses on those aspects of climate change that may affect the Ludeman ISR Satellite Project (i.e., areas where the impacts of climate change and the proposed Ludeman Unit overlap).

Based on the information provided in EA Section 3.6.2.2, the NRC staff finds that the overall effect of projected climate change on the proposed Ludeman ISR Satellite Project would be SMALL. Any changes in temperature and precipitation over the much shorter project life are expected to be smaller. Uranium extraction associated with ISR facilities occurs below ground, whereas temperature and precipitation are parameters primarily associated with the surficial and atmospheric environment. Changes to groundwater availability are another potential overlapping effect associated with climate change because the Ludeman ISR Satellite Project would utilize groundwater. However, potential changes to the environment and resources at the Ludeman site, such as groundwater availability, are not expected to be altered over the life of the project in a manner that would change the magnitude of the environmental impacts from what has already been evaluated in this EA.

Resilience to climate change impacts is a relevant factor when considering distinctions between alternatives and various liquid waste management options. The No-Action Alternative would be the most resilient to climate change impacts because it essentially eliminates the possibility of overlapping impacts. In terms of evaporation rate, Option 2 is the most resilient of the liquid waste management options because it processes the least amount of wastewater by evaporation (i.e., Option 2 is least affected by any potential evaporation rate changes). In terms of water consumption, Option 2 is the least resilient because it consumes or removes more water from the environment (i.e., a small fraction of water is disposed deep underground rather than recycled by evaporation). However, these distinctions are minimal, and resilience to climate change is not expected to vary in a meaningful way among the liquid waste management options.

Mitigation is one response strategy for addressing climate change. The other major response strategy is adaptation, which refers to actions to prepare for and adjust to new conditions created by climate change. The need to implement adaptation for a given project should take into account the scope and magnitude of areas where impacts of climate change and the proposed project overlap, which for the proposed Ludeman Project are minimal. The NRC staff

is not aware of any adaptation measures for climate change impacts associated with the Ludeman ISR Satellite Project.

5.8 Noise

The cumulative impacts assessment for noise considered a study area that includes the proposed Ludeman ISR Satellite Project and an 8-km [5-mi] radius around the Ludeman Project boundary. This boundary was chosen because noise dissipates quickly from the source. As stated in GEIS Section 4.3.7, sound levels as high as 132 dBA will taper off to the lower limit of human hearing (20 dBA) at a distance of 6 km [3.7 mi] in the Wyoming East Uranium Mining region (NRC, 2009). The timeframe for the analysis is from 2013 to 2030.

The ongoing and RFFAs within the noise cumulative impacts study area include traffic noise, oil and gas activities, and uranium sites (Uranium One, 2017e). The eight oil and gas operations within 3.2 km [2 mi] of the proposed Ludeman Project generate noise during construction of drill pads, well drilling, and operation of compressor stations. Noise levels associated with drill pad construction and well drilling would be expected to decrease to 54 dBA at 610 m [2,000 ft] from the drill site (BLM, 2003). A noise level of 55 dBA is the level that protects human receptors against interference and annoyance with an adequate margin of safety (EPA, 1974). The uranium recovery projects that are either proposed, existing, or currently undergoing decommissioning could contribute to noise within the study area from additional traffic, construction and operations deliveries, and yellowcake and byproduct transport.

The closest human noise receptors (e.g., residences or communities) in the cumulative impacts noise study area are the residences of the Negley Subdivision, approximately 300 m [984 ft] from Wellfield 1, and the Leuenberger Ranch house, located approximately 800 m [2,640 ft] east of Wellfield 2 and 1,600 m [5,280 ft] east of the proposed satellite building. Noise levels would be expected to attenuate and return to background at distances of more than 300 m [1,000 ft] from the noise-generating activities. Small communities within an 80-km [50-mi] radius of the proposed project include Glenrock, Douglas, and Rolling Hills, as well as the larger nearby city of Casper and surrounding towns. The nearest cities are also too distant {further than 48 km [30 mi]} from the proposed project area and too far to consider as noise receptors.

Noise may also have impacts on wildlife. For further information on the cumulative impacts on terrestrial ecology and licensee mitigation measures and monitoring, see EA Section 5.6 and EA Chapter 6 (Mitigation and Monitoring). Additionally, noise levels would be mitigated by administrative and engineering controls to maintain noise levels in work areas below Occupational Safety and Health Administration (OSHA) regulatory limits. The NRC staff concludes that the cumulative impact of noise within the study area resulting from all ongoing and RFFAs would be SMALL, based on the sparsity of various other activities in the area and available mitigation controls.

Given the proposed location of the satellite facility to the nearest residences, the anticipated traffic to support the Ludeman ISR Satellite Project would not significantly increase noise to local roads within audible distance from residences. As discussed in EA Section 4.8, the potential effects as a result of noise at the proposed project resulting from concurrent activities (i.e., oil and gas activities, uranium projects, and vehicle traffic) expected to take place under all of Uranium One's liquid waste management options would be SMALL for all phases of the project. During preconstruction, noise impacts would be similar to those described for the construction phase (i.e., SMALL; EA Section 4.8). Because preconstruction activities are similar to the construction activities already evaluated for the proposed project and incorporated into

the cumulative impact analysis, the NRC staff considers these SMALL impacts are already adequately addressed. Therefore, the NRC staff concludes that the Ludeman ISR Satellite Project would have a SMALL incremental effect on noise when added to the SMALL cumulative impacts from all ongoing and RFFAs in the noise study area.

5.9 Historic and Cultural Resources

Cumulative impacts on historic and cultural resources were assessed within a study area that encompasses a 16-km [10-mi] radius around the proposed Ludeman ISR Satellite Project. This area delineates the geographic boundary used for the cumulative analysis of historic and cultural resources. The study area covers a larger spatial extent than either the direct or indirect area of potential effect (APE), to evaluate activities outside of the proposed project area. The assessment of cumulative impacts on historic and cultural resources beyond 16 km [10 mi] was not undertaken because, at this distance, the impacts on historic and cultural resources from the proposed Ludeman Project on other past, present, and RFFAs would be minimal. The timeframe for this analysis is 2013 to 2030, based on the estimated operating life of the proposed project.

Most of the cumulative impacts on historical and cultural resources in the study area were considered to be from future grazing activities and energy development (e.g., ISR projects, CBM projects, wind projects, and oil and gas operations), which are expected to continue at the same or reduced intensity for the foreseeable future. Potential impacts to cultural and historic resources could also result from increased land area access and surface-disturbing activities associated with new projects in the study area. Impacts from these activities would result primarily from the loss of or damage to historical, cultural, and archaeological resources; temporary restrictions on access to these resources; or from erosion and destabilization of land surfaces. As new developments start, the NRC staff anticipates that activities associated with surface-disturbing activities would be surveyed for historic and cultural resources, as appropriate. All applicants for ISR facilities would conduct appropriate historic and cultural resource surveys as part of pre-license application activities. Therefore, the NRC staff concludes that impacts to historical and cultural resources resulting from other past, present, and reasonably foreseeable future land use activities, ISR projects, CBM projects, and oil and gas operations would be SMALL to MODERATE. Impacts to cultural resources can be minimized for proposed projects located on federal or Tribal lands or that are part of a federal action, because such projects are subject to the National Historic Preservation Act (NHPA), the Section 106 consultation process, and other applicable statutes.

As discussed in EA Section 4.9, four sites (one watering station and three prehistoric stone feature sites) identified within the Ludeman Project site area are located in proximity to areas where construction activities would occur. Two of these resources have been recommended not eligible to the National Register of Historic Places (NRHP). As a result of tribal consultation, two other prehistoric stone feature sites (48CO3036 and 48CO3037) were determined eligible by the NRC. The WY SHPO (2018a) concurred with these determinations. As a result of these determinations, the NRC will require by license condition that Uranium One commit to avoid sites 48CO3036 and 48CO3037, which would result in no impact to the NRHP eligible sites from the Ludeman project, and reduce the potential cumulative impacts on those resources. The licensee commits to stop work and notify the NRC, the WY SHPO, and other appropriate agencies if previously unidentified sites are encountered during any phase of the project. As stated in EA Section 4.9, the NRC staff concludes that for all phases of the proposed Ludeman Project, including preconstruction activities, the impact to historical and cultural resources would be SMALL and there would be no impact to the NRHP eligible sites.

Based on this information, the NRC staff concludes that the cumulative impacts to historical and cultural resources as the result of the addition of the proposed Ludeman ISR Satellite facility to the Willow Creek license would have a SMALL incremental effect on the MODERATE cumulative impacts resulting from other past, present, and RFFAs.

5.10 Visual and Scenic Resources

Potential cumulative impacts to visual and scenic resources were assessed both at and within a 3.2-km [2-mi] radius around the Ludeman ISR Satellite Project. Beyond this distance, any changes to the landscape would be in the background distance zone for the purposes of Visual Resource Management (VRM) defined by BLM, and would be either unobtrusive or imperceptible to viewers (BLM, 1984; BLM, 1986). The timeframe evaluated for the cumulative impacts analysis is from 2013 to 2030.

Currently, human-made features within and in the immediate vicinity of the proposed project include roads, power lines, telephone and electric lines and poles, fence lines, and CBM and oil and gas wells, and reservoirs. The primary visible features on the landscape are oil and gas production facilities because of their vertical profile (i.e., they are taller than existing topography and vegetation). Energy development is expected to continue over the next 20 years within the PRB region. Other past, present, and RFFAs could include

- construction of uranium recovery facilities
- transportation infrastructure
- a coal-fired power plant
- major transmission lines
- coal technology projects
- wind power projects
- additional oil and gas facilities

Each of these activities could have an impact on visual and scenic resources, although these would be anticipated to be developed offsite and outside of the area analyzed for this visual and scenic resource assessment. Therefore, the NRC staff concludes that the cumulative impacts from other past, present, and RFFAs on visual and scenic resources, both at and within a 3.2-km [2-mi] radius around the Ludeman ISR Satellite Project would be SMALL.

As discussed in EA Section 4.10, potential effects from the Ludeman ISR Satellite Project activities would be mitigated by Uranium One's commitment to: (i) reclaim and reseed disturbed areas; (ii) use dust-suppression methods and neutral paint colors for structures; (iii) recontour surface disturbances that occur to blend in with the natural terrain; or (iv) use other measures that would reduce the visual and scenic impacts associated with the proposed project and that would be consistent with the VRM Class III objectives. During preconstruction, impacts to visual and scenic resources would be similar to those described for the construction phase (i.e., SMALL; EA Section 4.10). Because preconstruction activities are similar to the construction activities already evaluated for the proposed project and incorporated into the cumulative impact analysis, the NRC staff considers these SMALL impacts from preconstruction are already adequately addressed. Therefore, the NRC staff concludes that the Ludeman ISR Satellite Project would have a SMALL incremental effect on visual and scenic resources when added to the SMALL cumulative impacts from all other ongoing and RFFAs in the study area.

5.11 Socioeconomics and Environmental Justice

As described in EA Section 5.1.1, the timeframe for this cumulative socioeconomics resource impact analysis for the proposed Ludeman ISR Satellite Project begins in 2013 and ends in 2030. The geographic boundary that the NRC staff used to analyze potential socioeconomic impacts for the Ludeman ISR Satellite Project comprises Converse and Natrona Counties, where most workers and their families will reside during the life of the project (EA Sections 3.10 and 4.11).

For the proposed Ludeman ISR Satellite Project, the NRC staff considered demographics, population growth trends, median household income, per capita income, vacant housing units, employment, poverty, tax rates, and public services in Converse and Natrona Counties and each of Uranium One's proposed liquid waste management options (EA Sections 2.1.3, 3.10, and 4.11, and summarized in Table 4-1). The NRC staff considered BLM estimates (BLM, 2013a; BLM, 2010; BLM, 2007) and the NRC staff's prior determination of cumulative socioeconomic impacts for other ISR facilities (including preconstruction activities) expected to employ a similar number of maximum employees in the study area (NRC, 2016b). Based on these analyses, the NRC staff determines that the potential cumulative impact on socioeconomic resources resulting from other past, present, and RFFAs in Converse and Natrona Counties could range from SMALL to MODERATE. This determination is due to expected continued energy development within the study area through 2030, the boom and bust cycles of energy projects, and revenue from present and foreseeably future energy actions in the study area. Potential cumulative impacts to population, employment, and local finance would be SMALL to MODERATE, and potential cumulative socioeconomic impacts to housing, education, and public services would be SMALL.

Uranium One has stated that they anticipate directly employing a maximum of 151 people during the peak employment year (year 1) of Ludeman ISR Satellite Project, which is less than the annual peak number of employees (200 employees) evaluated in the GEIS (Uranium One, 2017d,e). For reasons detailed in EA Section 4.11, the NRC staff does not anticipate the proposed Ludeman ISR Satellite Project to have a significant effect on socioeconomic characteristics within the study area. The potential impacts on socioeconomic resources from preconstruction activities for the proposed Ludeman Project would include workers needed to construct access roads, a parking lot, etc. (EA Section 5.1.2.8). Because preconstruction activities are similar but more limited than the construction activities already evaluated for the proposed project and incorporated into the cumulative impact analysis, and the preconstruction effects would be short-term with fewer workers than the proposed construction phase, the NRC staff considers that these SMALL impacts are already adequately addressed in the impact analysis. Therefore, the NRC staff determined that the potential socioeconomic impacts from the proposed Ludeman ISR Satellite Project would be SMALL.

The NRC staff previously evaluated cumulative socioeconomic impacts for other ISR facilities expected to employ a similar number of maximum employees in the study area (NRC, 2016b) and determined that there would be a SMALL to MODERATE incremental impact. Because some of these facilities are located nearby and may use the same resources, moderate incremental impacts to population, housing, and education could occur as a result of the proposed Ludeman Project if employees working at the proposed project elected to relocate from larger communities such as Casper and reside in smaller communities such as Rolling Hills closer to the proposed project. As described in EA Section 3.10, several small communities under 1,000 people are located within 80 km [50 mi] of the proposed project where these potential moderate incremental impacts could occur. Therefore, the NRC staff conclude that the

proposed Ludeman ISR Satellite Project would contribute a SMALL to MODERATE incremental effect on socioeconomic resources when added to the SMALL to MODERATE impacts expected from other past, present, and RFFAs.

Environmental Justice

The geographic area considered in this cumulative environmental justice analysis includes a 6.4 km [4 mi] radius around the Ludeman ISR Satellite Project area, consistent with the NRC guidance described in EA Section 4.11. The cumulative environmental justice analysis begins in 2013 and ends in 2030. Other past, present, and RFFAs described in EA Section 5.1.2 could potentially contribute to cumulative disproportionately high and adverse human health or environmental effects in the cumulative impact study area. Potential impacts to minority and low-income populations would mostly consist of radiological effects; however, radiation doses from ISR facility operations in the study area are expected to be well below regulatory limits (EA Section 4.11, Public and Occupational Health). The NRC staff concluded in GEIS Section 6.3 that for ISR facilities located in the Wyoming East Uranium Milling Region, no minority and low-income population will experience a disproportionately high and adverse impact. For the analysis of the Ludeman ISR Satellite Project, the NRC staff confirmed that this conclusion is valid by comparing minority and low-income populations living within a 6.4-km [4-mi] radius around the proposed project area to minority and low-income populations living in Wyoming, Converse County, and Natrona County. The percentage of minority populations living within a 6.4-km [4-mi] radius around the proposed Ludeman ISR Satellite Project area are less compared to those minority populations recorded at the county level and above but comparable to the minority populations recorded at the State level. The percentage of low-income populations living within a 6.4 km [4 mi] radius around the proposed Ludeman ISR Satellite Project is lower than the low-income populations recorded at the county and State level. The NRC staff concludes in EA Section 4.11 that there would be no disproportionately high and adverse impacts on minority and low-income populations from the construction, operations, aquifer restoration and decommissioning of the proposed Ludeman ISR Satellite Project. Therefore, the proposed project would not contribute to disproportionate human health and environmental impacts on minority and low income populations within a 6.4-km [4-mi] radius around the proposed project.

5.12 Public and Occupational Health and Safety

Cumulative effects on public and occupational health and safety were evaluated within an 80-km [50-mi] radius around the proposed Ludeman ISR Satellite Project. This distance was chosen to be inclusive of areas in the region where uranium milling has been practiced. The timeframe for the analysis is 2013 to 2030 (EA Section 5.2) for the estimated operating life of the facility.

The public and occupational health and safety impacts from the proposed Ludeman ISR Satellite Project under all of Uranium One's liquid waste management options would be SMALL and are discussed in detail in EA Section 4.12 and summarized in Table 4-1. During normal activities associated with all phases of the project lifecycle, radiological and nonradiological worker and public health and safety impacts would be SMALL. Annual radiological doses to the population within 80 km [50 mi] of the proposed project would be far below applicable NRC regulations. Potential accident impacts to workers would be SMALL because the uranium processing (limited to ion exchange) would involve dilute uranium solutions, ion exchange resins, and no dried yellowcake. The licensee's NRC-approved Radiation Protection Program

(Uranium One, 2017d) would limit the overall impacts to workers from normal operations and accidents to SMALL.

Other past, present, and reasonably foreseeable future uranium recovery facilities in the vicinity of the proposed Ludeman ISR Satellite Project and within the broader regional area are described in EA Section 5.1.2.1. Within an 80-km [50-mi] radius around the proposed Ludeman ISR Satellite Project, there is one licensed and operating ISR facility and several other existing or planned uranium recovery projects in various stages of development. If constructed and operated, all of these facilities would have similar radiological and nonradiological impacts on public and occupational health and safety as those from the proposed Ludeman Project. These facilities would result in localized incremental increases in annual radiological doses to the nearby populations; however, these radiological doses are not expected to significantly overlap and accumulate with doses estimated from the proposed Ludeman Project, as described in the following analysis.

As stated in EA Section 4.12, during normal operations, Rn-222 (radon) would be the only significant radioactive airborne effluent at the proposed Ludeman ISR Satellite Project. The primary sources of Rn-222 would be wellfield and ion-exchange column venting and resin transfer operations. As further described in EA Section 4.12, the licensee's maximum calculated dose to a member of the public is at an existing residence located approximately 2.4 km [1.5 mi] east of the proposed satellite building and about 1.6 km [1.0 mi] east of proposed Wellfield 2 (Uranium One, 2017d). The maximum calculated dose is 0.0159 mSv/yr [1.59 mrem/yr] and is within the range of results from similar calculations at other operating ISR facilities in the United States (NRC, 2009). While these dose estimates apply to an ISR satellite project, they are also within the range of comparable dose estimates for full ISR facilities (NRC, 2009; NRC, 2010; NRC, 2011a,b; NRC, 2014). The indirect radiological effects of processing solutions at the Willow Creek Project were previously evaluated by NRC (2011c; NRC, 2013a) and would not accumulate with the estimated Ludeman radiological effects based on the distance between the two projects. The low magnitude of the calculated doses and the significant attenuation of dose with distance support the NRC staff's conclusion that the combined exposures from the proposed Ludeman ISR Satellite Project and other operating and potential ISR facilities in the study area would remain far below the 10 CFR Part 20 public dose limit of 1.0 mSv/yr [100 mrem/yr] and have a negligible contribution to the 6.2 mSv [620 mrem] average yearly dose received by a member of the public from all sources. Under accident conditions, the consequences of potential accidents would be limited and unlikely to interact or accumulate among the distant ISR sites in the region. GEIS analysis of three separate accident scenarios (thickener failure and spill, pregnant lixiviant and loaded resin spills, and yellowcake dryer accident release) estimate hypothetical public doses that are less than the NRC regulatory limits and produce minor potential impacts (NRC, 2009).

Additionally, several inactive and decommissioned conventional uranium mills are also within the 80-km [50-mi] radius (EA Section 5.1.2.1). However, because of their relative distances and site conditions, none of these projects are considered to represent an appreciable additional source of radiation exposure in or around the proposed Ludeman ISR Satellite Project area that would significantly increase the estimated radiation exposure from the proposed project. Other than the Dave Johnston coal-fired power plant, there are no major sources of nonradioactive effluent releases to the air or water-receiving bodies in the immediate area surrounding the proposed project. The Casper Intrastate Air Quality Control Region where the proposed Ludeman ISR Satellite Project is located is classified as an attainment area for each criteria pollutant (40 CFR 81.351), therefore, the air quality in and around the proposed site is considered good (Uranium One, 2017e). Based on the air quality information, the NRC staff

concluded that the Dave Johnston coal-fired plant would not contribute to the public and occupational health impacts of the Ludeman ISR Satellite Project. The potential effects from nonradiological releases on water and air resources are described in EA Sections 5.5 and 5.7.

The chemicals used at ISR facilities, including those proposed for use at the Ludeman ISR Satellite Project, were evaluated in the GEIS (NRC, 2009). The use of chemicals at ISR facilities is controlled under several regulations that are designed to provide adequate protection to workers and the public commensurate with the hazard. The handling and storage of chemicals at any such facilities would follow standard industrial safety standards and practices. Industrial safety aspects associated with the use of chemicals are regulated by the WDEQ and Wyoming Department of Workforce Services. Overall, the safety practices limit the potential for accidents, and the distances between ISR facilities in the region limit the potential for accumulation or interaction of impacts from potential accident consequences.

Other past, present, and RFFAs in the vicinity of the Ludeman ISR Satellite Project that could contribute to nonradiological public and occupational health and safety impacts include oil and gas exploration, coal mining, CBM, other mineral extraction activities, and energy projects (EA Section 5.1.2). Increased hazards to human health and safety would occur during development and operation of these projects from the inherent hazards associated with construction, operations, and maintenance activities. However, these hazards would be minimized by implementation of various mitigations, including complying with industry standards, using proper equipment, implementing access controls, developing and implementing health and safety programs involving procedures and training for normal operations and emergencies, and complying with applicable federal and state occupational and public safety regulations (BLM, 2012b; BLM, 2003). Hazardous materials that are likely to be used during these ongoing and reasonably foreseeable future projects include diesel fuel, gasoline, explosives, hydraulic fluids, motor oil/grease, solvents, water and well treatment chemicals, lead-acid batteries, biocides, herbicides, and compressed gasses used for welding (e.g., acetylene or propane) (BLM, 2012b). A large-scale release of diesel fuel or several of the other substances used at the projects may have implications for public health and safety. The location of the release would be the primary factor in determining its importance. Involved workers are the most likely to be affected by accidents involving hazardous materials; however, the risks of such incidents would be limited by the implementation of common safety practices and regulatory controls (BLM, 2012b; BLM, 2003). Based on the remote location of these other activities, the NRC staff concludes that the probability of a release within a populated area that could result in public injury or fatality would be low, as would any interaction or accumulation with applicable Ludeman ISR Satellite Project effects.

The potential impacts to public and occupational health and safety from preconstruction activities would include fugitive dust, combustion emissions, noise, and occupational hazards (EA Section 5.1.2.8). Based on the 10 CFR 40.4 definition of construction, the NRC considers prelicense construction activities with no nexus to radiological health and safety (or common defense and security) as preconstruction. Therefore, no radiological safety impacts from preconstruction are expected. Because preconstruction activities are similar to the construction activities already evaluated for the proposed project and incorporated into the cumulative impact analysis, and the preconstruction effects would be short-term (limited to the duration of the activities) and similar to or less than the effects from the proposed construction, the NRC staff considers these effects to already have been described.

Based on the preceding analysis, the NRC staff have determined that the cumulative impact on public and occupational health and safety in the study area resulting from all other past, present, and RFFAs is SMALL. As described in the preceding analysis, the estimates of combined radiological exposures from currently operating and proposed future ISR facilities in the study area are far below the regulatory public dose limit of 1.0 mSv/yr [100 mrem/yr] and have a negligible contribution to the 6.2 mSv [620 mrem] average yearly dose for a member of the public from all sources. Nonradiological exposures to workers and the general public from hazardous chemicals and materials resulting from other past, present, and RFFAs would be minimized by the application of common safety practices and compliance with applicable federal and state occupational and public safety regulations.

In conclusion, the overall cumulative impacts are the incremental impacts from the proposed Ludeman ISR Satellite Project when added to the impacts from other past, present, and RFFAs. As described in the preceding analysis, the incremental direct and indirect impacts of the proposed Ludeman ISR Satellite Project would be SMALL, and the impacts from all other past, present, and RFFAs would also be SMALL. Therefore, the NRC staff concludes that the proposed Ludeman ISR Satellite Project would contribute a SMALL incremental impact on the SMALL cumulative public and occupational health and safety impacts in the study area (assuming all appropriate mitigations are followed) resulting in SMALL overall cumulative effects.

5.13 Waste Management

The cumulative impacts on waste management resources are considered within an 80 km [50 mi] radius of the proposed Ludeman ISR Satellite Project. This distance was chosen to encompass nearby operating ISR facilities that could generate nonhazardous solid waste that would be destined for disposal at the same facility expected to be used by the proposed Ludeman ISR Satellite Project for disposal of similar waste. The timeframe for the analysis is 2013 to 2030.

Waste management impacts from the proposed Ludeman ISR Satellite Project under all of Uranium One's liquid waste management options would be SMALL and are described in detail in EA Section 4.13 and summarized in Table 4-1. The overall impacts from the disposal of liquid byproduct material at the proposed Ludeman ISR Satellite Project would be SMALL, based on (i) the licensee's commitment to provide adequate onsite disposal capacity in evaporation ponds; (ii) WDEQ-permitted surface water discharge of treated wastewater (or deep disposal well capacity, with permitting and regulatory controls); and (iii) compliance with NRC license conditions. Impacts associated with disposal of solid byproduct material would be SMALL, based on the required preoperational disposal agreement made between the licensee and the licensed disposal facility that would ensure adequate disposal capacity is available for the duration of the project. Impacts from disposal of nonhazardous solid waste would be SMALL during all phases of the proposed Ludeman ISR Satellite Project, based on estimated waste volumes and the available capacity of local landfills.

Other past, present, and reasonably foreseeable uranium recovery facilities in the vicinity of the proposed Ludeman ISR Satellite Project and within the broader regional area are described in EA Section 5.1.2. Within an 80 km [50 mi] radius of the proposed Ludeman ISR Satellite Project, there is one licensed and operating ISR facility (Smith Ranch-Highland) and several other existing or planned uranium recovery projects in various stages of development (EA Section 5.1.2.1). These existing and planned facilities would generate solid and liquid wastes similar to the proposed Ludeman ISR Satellite Project, which could contribute to waste

management effects within the cumulative impacts study area. The cumulative nonhazardous waste volume from the applicable licensed or planned ISR facilities and expansions in the study area within the vicinity of the Glenrock and Casper landfills during the time period of analysis was conservatively estimated to be approximately 99,000 m^3 [130,000 yd^3]. The NRC staff estimated this waste volume by assuming operational waste generation within the time period of analysis from Reynolds Ranch (12 years) and Smith Ranch (10 years) would be at the same rate as the proposed Ludeman ISR Satellite Project, plus additional waste from the full decommissioning of Smith Ranch, based on waste volume estimates in the most recent financial assurance estimate for Smith Ranch (Garoutte, 2017). The actual schedules and future operations at these ISR facilities are uncertain and subject to ongoing license renewal and future market conditions; therefore, the assumption of continuous operation both facilities is conservative. The aforementioned total volume of nonhazardous solid waste was found to be approximately 0.03 percent of the estimated remaining capacity of the Casper landfill of 315 million m^3 [412 million yd^3] (calculated by subtracting 7 years of annual disposal at the 2010 disposal rate from the 2010 capacity described in EA Section 3.12). Because the total estimated volume of nonhazardous solid waste from the proposed Ludeman ISR Satellite Project, when added to other current and proposed ISR projects in the region, is a small fraction of the remaining capacity of the Campbell County landfill in Gillette, Wyoming, the NRC staff concludes that the cumulative impact would be SMALL.

Generation of solid byproduct material at the planned and potential ISR facilities and expansions in the cumulative impacts study area could impact licensed disposal facility resources. Before ISR operations begin, the NRC requires ISR facilities to have an agreement in place with a licensed disposal facility to accept byproduct material; thereby ensuring adequate capacity is available. These agreements limit the impact on byproduct material waste management resources, resulting in a SMALL impact for the proposed Ludeman ISR Satellite Project and any other operating or planned ISR facilities.

Liquid byproduct material is typically managed at ISR facilities using onsite resources, such as Class I deep disposal wells and evaporation ponds. The licensee is proposing to use evaporation and permeate ponds and surface discharge at the proposed Ludeman ISR Satellite Project and (under liquid waste management Options 1 and 2) would request permits for up to six Class I deep disposal wells for disposal of liquid byproduct material resulting from the processing and treatment activities at the proposed Ludeman ISR Satellite Project. Additional deep disposal well, evaporation pond, and possibly surface discharge activities in the region by other operating or planned ISR facilities is expected as additional ISR facilities are licensed and operated. Use of onsite waste management resources would, therefore, effectively avoid impacts on offsite waste management resources. An exception is that the use of evaporation ponds and surface discharge would indirectly generate additional solid byproduct material that would have to be disposed offsite; however, the required preoperational disposal agreement with a licensed facility would ensure disposal capacity is available prior to generating the byproduct material and would mitigate impacts on waste management resources. Based on this analysis, the NRC staff concludes that the cumulative impacts on waste management resources from managing liquid byproduct material at the proposed Ludeman ISR Satellite Project, along with similar actions at present and reasonably foreseeable ISR projects, would be SMALL.

Other ongoing and RFFAs in the vicinity of the proposed Ludeman ISR Satellite Project, such as coal mining (EA Section 5.1.2.2) and oil and gas production (EA Section 5.1.2.3), would produce additional nonradiological waste materials. These projects would use and generate hazardous materials and would need to dispose of solid nonhazardous and hazardous wastes. Each project would also be responsible for complying with applicable federal and state

regulations and site-specific permitting requirements or conditions that control management of generated wastes. An evaluation of other past, present, and RFFAs in the PRB (BLM, 2011) projected future development trends for conventional oil and natural gas, CBM, and coal mining to year 2030. Conventional oil and natural gas production was projected to increase from the present to year 2030 (BLM, 2011). CBM production is currently below levels that were previously projected (BLM, 2003) and were expected to decline between the current timeframe and 2030. Coal mining was noted as declining since 2009, and while future uncertainties were noted, projected to increase by 2030 to at least the previous peak (2009) levels (low estimate) or increase by as much as 38 percent above 2009 production levels (high estimate). These projections suggest that the level of activity, and therefore combined waste generation from these activities, is unlikely to increase during the timeframe of the analysis. Additionally, coal mines are not large generators of hazardous waste (BLM, 2012d); therefore, hazardous waste generation and potential effects to disposal resources are not expected to change from these activities. Regarding the generation of nonhazardous solid waste, the annual volumes disposed at local landfills {106,280 m^3 [138,900 yd^3] at Campbell County landfill and 191,280 m^3 [250,000 yd^3] at the Casper landfill} approximate the current regional cumulative demand for disposal capacity, and the available landfills have projected capacity to operate beyond year 2030 (EA Section 3.12). Therefore, potential impacts from other ongoing and RFFAs in the vicinity of the proposed Ludeman ISR Satellite Project on these resources would be SMALL.

The potential impacts on waste management resources from preconstruction activities would include generating wastes similar to the wastes produced during the construction phase that would require handling, storage, and disposal. These include normal construction debris that would be classified as nonhazardous solid waste, hazardous waste, used oil, and domestic sewage. Because preconstruction precedes operations, no byproduct material would be produced. Because preconstruction activities are similar to the construction activities already evaluated for the proposed project and incorporated into the cumulative impact analysis, and the preconstruction effects would be short-term with lower waste generation than the proposed construction, the NRC staff considers these SMALL impacts are already adequately addressed.

Based on the preceding analysis, the NRC staff concludes that the cumulative impact on waste management resources resulting from all other past, present, and RFFAs in the study area would be SMALL. As described in the preceding analysis, the required disposal agreements for byproduct material from NRC-licensed ISR facilities would ensure disposal capacity would be available to all ISR facilities prior to operations. The projected cumulative volume of nonhazardous solid waste from the proposed Ludeman ISR Satellite Project, when combined with other current and potential future ISR facilities, is a small percentage of available disposal capacity within the analysis timeframe. Projected trends for oil and gas, CBM, and coal mining indicate these other regional activities suggest declining production, except for coal, which could grow modestly between the current timeframe and year 2030.

In conclusion, the overall cumulative impacts are the incremental impacts from the proposed Ludeman ISR Satellite Project when added to the impacts from other past, present, and RFFAs. As described, the incremental waste management impacts of the proposed Ludeman ISR Satellite Project would be SMALL, and the impacts from all other past, present, and RFFAs on waste management resources would also be SMALL. Therefore, the NRC staff concludes that the proposed Ludeman ISR Satellite Project would have a SMALL incremental effect when added to the SMALL impacts on waste management resources from other past, present, and RFFAs in the study area (assuming all appropriate mitigations are followed) resulting in SMALL overall cumulative effects.

6 MONITORING AND MITIGATION

Section 8.0 of the Generic Environmental Impact Statement (GEIS) for In-Situ Leach Uranium Milling Facilities (NRC, 2009), discusses development of monitoring programs for In Situ Uranium Recovery (ISR) facilities to verify compliance with standards for the protection of worker health and safety in operational areas and for protection of the public and environment beyond the facility boundary. Monitoring programs provide data on operational and environmental conditions so that prompt corrective actions can be implemented when adverse conditions are detected. These programs help limit potential environmental impacts at ISR facilities and the surrounding areas.

In accordance with the U.S. Nuclear Regulatory Commission (NRC) regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, Appendix A, Criterion 7, a preoperational monitoring program is required to establish facility baseline conditions. After establishing the baseline program, ISR facility operators are required to conduct an operational monitoring program to measure or evaluate compliance with standards and to evaluate the environmental impact of an operating ISR facility. Although guidance documents do not constitute requirements, NRC provides guidance for implementing monitoring programs at uranium mills, including ISR facilities that are acceptable to the NRC staff (NRC, 1980; NRC, 2011c).

Uranium One identified mitigation measures in its revised environmental report (ER) and technical report (TR) (Uranium One, 2017d,e) as well as in response to the NRC staff's requests for additional information (RAIs) (Uranium One, 2015a). Existing monitoring and mitigation programs included under the Willow Creek (WC) License SUA–1341 are further described in Section 2.5 of the Willow Creek license renewal environmental assessment (EA) (NRC, 2011c). Uranium One has provided major elements of a proposed monitoring program at the Ludeman ISR Satellite Project to NRC for review (Uranium One, 2015a; Uranium One, 2017e). The following sections are a summary of monitoring and mitigation programs that would apply to the Ludeman ISR Satellite Project if the requested license amendment is granted. During the development of the NRC staff's safety evaluation report (SER), the NRC staff may identify license conditions that apply to the Ludeman site as part of License SUA–1341, but those license conditions would not change the level of potential environmental impacts described in this EA.

6.1 Wellfield and Pipeline Flow and Pressure Monitoring

As described in Uranium One's revised technical report (Uranium One, 2017d), an extensive program of wellfield and pipeline flow and pressure monitoring would be installed at the proposed Ludeman ISR Satellite Project, using a methodology consistent with monitoring conducted at Willow Creek (NRC, 2011c). Injection and production well flowrates and pressures would be monitored at each header house to balance injection and production in each wellfield. Individual well flowrate readings would be recorded, and the overall wellfield flowrates would be balanced daily. All trunklines would be equipped with electronic pressure gauges. Wellfield and plant operators would be alerted if high or low pressure and flowrate alarms exceeded specified ranges. Automatic shutoff valves would stop flows in the event of significant changes of volume or pressure. Wellfield and pipeline flowrate monitoring would alert the operators to detect malfunctions that could lead to either wellfield infrastructure or pipeline failures, thereby minimizing the potential for impacts to groundwater (Uranium One, 2017d).

Evaporation pond leak detection systems at the Ludeman site would be inspected consistent with current requirements for inspections conducted at the Willow Creek project under NRC License SUA–1341 (Uranium One, 2017d).

6.2 Groundwater and Surface Water Monitoring

As discussed in GEIS Section 8.3, groundwater monitoring programs include use of production zone monitoring wells for identifying horizontal lixiviant excursions and wells monitoring aquifers that overlie or underlie the production zones for identifying vertical excursions (NRC, 2009). The density and spacing of wells that would monitor the production aquifers for horizontal excursions at the Ludeman ISR Satellite Project wellfields would be determined during future hydrogeologic assessments conducted of each proposed wellfield, the results of which would be documented in wellfield hydrogeologic data packages.

The groundwater monitoring program for the Ludeman ISR Satellite Project would be designed and implemented in the manner outlined in SUA–1341 License Condition 10.3 and the Willow Creek license renewal EA (Uranium One, 2017d; NRC, 2011c; NRC, 2016a). By license condition for Willow Creek, which also would apply to the Ludeman ISR Satellite Project, ore zone monitoring wells would be sampled 4 times with a minimum of 14 days between sampling to establish baseline water quality for each wellfield (Willow Creek License Condition 10.3; Uranium One, 2017d). The purpose of preoperational sampling is to document the overall preoperational groundwater quality of potentially impacted aquifers within the proposed wellfields under normal preoperational conditions.

During operations, groundwater monitoring would: (i) be designed to detect lixiviant excursions into the overlying and underlying aquifers and outside of the producing wellfield within the ore zone aquifers; (ii) include sampling of the overlying and underlying aquifer monitoring wells every 2 weeks; (iii) include analysis for chloride, total alkalinity, and conductivity, which are the excursion indicators; and (iv) measure and record static water levels. Uranium One would also submit quarterly static water level measurements and monitoring data to the Wyoming Department of Environmental Quality (WDEQ) and maintain copies onsite for NRC inspection (Uranium One, 2017d).

To ensure protection of surface water and groundwater from unexpected leaks, the licensee would monitor each production and injection well to detect a change in flowrate, pressure, or both, that would indicate a leak or rupture in the system. If a leak occurred, the system would be shut down, and remediation would be conducted, as appropriate. In addition, the licensee would conduct a series of daily, weekly, quarterly, and annual inspections on the evaporation ponds and install leak detection wells around the evaporation ponds (Uranium One, 2017d). As discussed in EA Section 4.5, if the requested license amendment is approved by NRC for the construction and operation of the Ludeman ISR facility, NRC would add a license condition requiring the licensee to install one groundwater monitoring well upgradient and three monitoring wells downgradient of both the evaporation pond and the permeate pond.

6.3 Preoperational Water Quality Monitoring

The licensee collected groundwater samples from wells located at the proposed Ludeman ISR site (EA Sections 3.5 and 4.5). The purpose of the preoperational sampling is to evaluate the overall groundwater quality within the proposed wellfields under normal preoperational conditions. The licensee also conducted four separate pumping tests of the ore-bearing aquifers to characterize aquifer behavior and isolation. Test results of the pumping wells provided a

preliminary baseline for groundwater behavior at the proposed wellfields. Information on water samples collected from groundwater wells can be found in the licensee's revised technical report and will be provided in the NRC staff's SER (Uranium One, 2017d).

6.4 Environmental Monitoring

From a preoperational vegetation sampling program and modeling activities that the licensee conducted at the Ludeman ISR Satellite Project in 2008, it concluded that the ingestion pathway would not be a significant contributor to radiological dose (Uranium One, 2015b). The licensee commits to collect at least three tissue samples per year during slaughter from livestock within 3 kilometers (km) [1.8 miles (mi)] of the project area, as specified in Regulatory Guide 4.14, prior to commencement of preconstruction activities to establish a baseline for later comparison (Uranium One, 2017d). There are no observed crops within or adjacent to the proposed project, so the licensee does not expect that harvesting of crop samples for testing will be required for the proposed license amendment (Uranium One, 2017d). No fish sampling is planned during operations, because there are no aquatic habitats that could be affected by the Ludeman ISR Satellite Project (EA Sections 4.5 and 4.6).

The licensee stated that it would conduct annual raptor surveys at the Ludeman ISR Satellite Project for the life of the project and within a 1.6 km [1 mi] radius of the project area to monitor for new and used nests that may be affected by ISR operations (Uranium One, 2017e).

6.5 Mitigation

The licensee has committed to using the same mitigation measures at the Ludeman ISR Satellite Project that are currently implemented at the Willow Creek Project, as applicable. For example, berms would be used to reduce soil erosion and runoff into ephemeral streams, and dust suppression would be used on roads. Table 6-1 lists the mitigation measures proposed by the licensee for each resource area. Further information on mitigation measures can be found in EA Chapter 4 and the licensee's revised ER and TR (Uranium One 2017d,e), and the responses to the NRC staff's requests for additional information (Uranium One, 2012; Uranium One, 2013a,b,c; Uranium One, 2014; Uranium One, 2015a,b; Uranium One, 2016a,b,c; Uranium One, 2017c).

While the NRC cannot impose mitigation outside of its regulatory authority under the Atomic Energy Act, the NRC staff has identified mitigation measures in EA Table 6-2 that could potentially further reduce environmental impacts from the proposed project. These additional mitigation measures are not requirements imposed upon the licensee and were not relied on for the impact determinations in this EA. For the purpose of the National Environmental Policy Act (NEPA), and consistent with 10 CFR 51.71(d) and 51.80(a), the NRC staff are disclosing measures that potentially would reduce or avoid environmental impacts that could be sustained from the additional activities of the proposed project.

Table 6-1. Summary of Mitigation Measures Proposed by Uranium One		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Land Use	Land disturbance	Use common corridors when locating access roads, pipelines, and utilities. Use existing roads and oil and gas development access roads, to the extent possible, to minimize construction of new access roads. Restore and re-seed disturbed areas as soon as practicable with an approved seed mix designed to stabilize soils from erosion and reduce the potential for exotic invasive plants. Develop wellfields sequentially and restore and reclaim wellfields after decommissioning to minimize land area impacted at any one time. Reclaim access roads constructed to access Ludeman facilities, unless exempted from reclamation by the request of respective landowners/lessees.
	Access restrictions	Coordinate with oil and gas production companies to limit interruptions in oil production activities. Establish surface use agreements with surface owners/lessees to provide mitigation or compensation for temporary loss of areas currently used for livestock grazing or crop production.
Transportation	Transportation safety	Develop a procedure to provide ongoing training to local emergency response personnel and municipal and county law enforcement personnel.

Table 6-1. Summary of Mitigation Measures Proposed by Uranium One (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Geology and Soils	Soils	Revegetate disturbed areas to minimize wind and water erosion. Salvage topsoil and manage soil disturbances and use best management practices (BMPs) (e.g., placement, sloping, and seeding of stockpiles) to prevent, in accordance with Wyoming Department of Environmental Quality (WDEQ) guidelines and conditions of the WDEQ Permit to Mine. Redistribute topsoil across disturbed areas to alleviate compaction prior to revegetation. Place soil stockpiles on the leeward hill sides when practicable and out of drainage channels to avoid excessive wind and water erosion. Build all soil stockpiles with slopes of 3:1 grade or flatter. Seed topsoil stockpiles during inactive periods. Direct drilling fluids and muds into mud pits to control the spread of fluids.

Table 6-1. Summary of Mitigation Measures Proposed by Uranium One (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Surface Water Resources	Water quality	Minimize surface water crossings. Construct access roads perpendicular to the direction of surface water flow. Develop and implement a spill response plan to contain spills and clean up the affected soil or surface water. Obtain WDEQ permit for controlled discharge of water (e.g., aquifer test discharge or pipeline hydrostatic testing discharge) to the surface. Seek authorization from U.S. Army Corps of Engineers and comply with Section 404 permitting requirements before conducting work in jurisdictional wetlands. Use practices such as riprap aprons or rock mulch to protect embankments from erosion. Reduce impacts from access road construction on ephemeral drainages consistent with a WDEQ Permit to Mine. Uranium One's Storm Water Pollution Prevention Plan, required as part of the Wyoming Pollutant Discharge Elimination System (WYPDES) permit, would control erosion, stormwater runoff, and sedimentation that could impact surficial waters (e.g., silt fencing, sediment logs, straw bale check dams, diversion ditches, and culverts). Collect monthly preoperational water quality samples from streams and quarterly preoperational water quality samples from impoundments.

Table 6-1. Summary of Mitigation Measures Proposed by Uranium One (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Groundwater Resources	Contamination and excursions	Plug wells in accordance with WDEQ and Wyoming State Engineer's Office requirements. Construct deep disposal wells according to WDEQ Class I disposal well construction standards. Uranium One's Storm Water Pollution Prevention Plan would control erosion and stormwater runoff that could impact near-surface aquifers. Adhere to a U.S. Nuclear Regulatory Commission (NRC)-required spill response and cleanup plan to contain and remediate affected soil or surface water. Train employees in spill detection, containment, and cleanup procedures. Locate all boreholes and wells within 305 meters (m) [1,000 feet (ft)] of a wellfield, if possible, and properly plug and abandon them.
Ecology	Fencing and screening	Construct wellfield fences in accordance with WDEQ Guideline 10 (WDEQ, 1994b).
	Transmission lines	Construct all new power lines using designs that meet or exceed current Avian Power Line Interaction Committee (2006) recommendations.
	Revegetation	Conduct weed control, as needed, during all phases of the project. Consult with the Converse County Weed and Pest District for BMPs to control weed infestation.
Air Quality	Fugitive dust from disturbed land and travel on unpaved roads	Apply dust suppression (chemical dust suppressant and water) for unpaved roads. Reclamation of disturbed lands.
	Combustion emissions from construction equipment engines	Tier 1 engines for drill rigs. Tier 3 engines for construction equipment.

Table 6-1. Summary of Mitigation Measures Proposed by Uranium One (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
	Acid fumes from satellite facility operations	Scrubber/demister on the hydrochloric acid tank to eliminate acid fume emissions.
Noise	Exposure of workers and public to noise	Implementing speed limits on access roads within the proposed project area. Restricting access road construction activities during night time hours. Install appropriate engineering controls that include protective enclosures for equipment to further reduce noise levels.
Cultural and Historic Resources	Disturbance of prehistoric archaeological sites and sites eligible for listing on the National Register of Historic Places	Prior to construction, develop an Unexpected Discovery Plan that would outline the steps required, in the event that unexpected historical and cultural resources are encountered at the site. Stop work upon discovery of previously undocumented historic and cultural resources, and notify appropriate Federal, Tribal, and State agencies.
Visual and Scenic		Constructing secondary access roads along existing topography to minimize cut/fill and reduce the visual contrast created by straight roads. Minimizing disturbed areas by minimizing access road widths, using existing county and other roads where possible. BMPs for erosion control, described under Geology and Soils, Surface and Groundwater Resources above, to limit surface disturbances to blend in with the natural terrain and to revegetate areas. Use dust suppressant to minimize fugitive dust. Select building materials and paint that complement the natural environment. Recontour wellfield, roads, drainage channels, satellite building and ponds, etc., to be consistent with preconstruction conditions.

Table 6-1. Summary of Mitigation Measures Proposed by Uranium One (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Socioeconomics	Effects on surrounding communities	Coordinate emergency response activities with local authorities, fire departments, medical facilities, and other emergency services before operations begin.
Occupational and Public Health and Safety	Effects from facility operation	Design task procedures to reduce potential accidents. Develop contingency plans with county and municipal governments to ensure adequate medical, fire, and emergency services are available in case of a major accident.
Waste Management	Disposal capacity	Wherever possible, equipment and facilities will be decontaminated for release for unrestricted use.
Land Use	Land disturbance	No additional mitigations identified beyond those committed to by licensee.
Transportation	Traffic reduction	Provide transportation services for workers or otherwise arrange carpooling.
	Transportation safety	Provide safe driver training for personnel and truck drivers. Use check-in/check-out or global positioning satellite technology to track shipments. Perform routine assessments of the road conditions.
Geology and Soils	Soils	Maintain a log of all spills occurring at the site, whether or not these spills are reportable to U.S. Nuclear Regulatory Commission (NRC) per Title 10 of the *Code of Federal Regulations* 40.60.

Table 6-2. Summary of Mitigation Measures Identified by NRC (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Ecology	Restoration/reclamation	Fence off areas with young vegetation, which would reduce these types of disturbances, where possible. Avoid disturbing wetlands and riparian habitat. Use effective weed control techniques approved by Wyoming Department of Environmental Quality (WDEQ).
	Fencing and screening	Employ operational practices (e.g., netting or screening) to deter birds and other wildlife from the mud pits if mud pits are not backfilled within 30 days. Construct all fences in accordance with Wyoming Game and Fish Department (2004) and WDEQ (1994b) construction technique guidelines. Limit liquid waste exposure to wildlife during operations by installing an avian-deterrent system to evaporation and permeate ponds before injuries or deaths are noted. Cover vent pipes with either netting or other methods to prevent bats, birds, or small mammals from being trapped.
	Transmission lines	Adhere to timing and spatial restrictions within specified distances of occupied and unoccupied migratory bird and raptor nests, as determined by appropriate regulatory agencies [e.g., U.S. Fish and Wildlife Service (FWS), Wyoming Game and Fish Division, and Bureau of Land Management]. Develop a written, FWS-reviewed bird mitigation and monitoring plan that is incorporated into the mine permit before beginning project activities.

Table 6-2. Summary of Mitigation Measures Identified by NRC (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Ecology (continued)	Reduce human disturbances	Conduct predisturbance surveys for migratory birds within 7 days of ground disturbances. Adhere to FWS-recommended buffer distances and timing stipulations to protect nesting raptors. Allow snakes and lizards that are encountered to retreat. Inform employees of applicable wildlife laws and penalties associated with unlawful taking and harassment of wildlife. Provide training to employees about (i) the types of wildlife in the area susceptible to collisions with motor vehicles, (ii) circumstances during which collisions are most likely to occur, and (iii) measures to take to avoid wildlife–vehicle collisions. Sign and gate, as needed, all new and improved roads related to the Ludeman project to minimize traffic. Comply with applicable State and local requirements to design or treat mud pits and ponds to prevent the development of favorable mosquito habitat (to reduce possible transmission of West Nile virus).
Air Quality	Fugitive dust from disturbed land and travel on unpaved roads and combustion emissions from construction equipment and vehicles	Limit access to construction sites, staging areas, and wellfields to authorized vehicles using designated, treated roads to reduce fugitive dust. To the extent practicable, avoid soil-disturbing activities and traveling on unpaved roads during periods of unfavorable meteorological conditions (e.g., high winds) to reduce fugitive dust. Apply erosion mitigation methods on disturbed lands to reduce fugitive dust. Minimize the construction and associated footprint of new and secondary access roads to reduce fugitive dust. Coordinate construction and transportation activities to reduce maximum dust levels.

Table 6-2. Summary of Mitigation Measures Identified by NRC (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Air Quality (continued)	Fugitive dust from disturbed land and travel on unpaved roads and combustion emissions from construction equipment and vehicles (continued)	Cover soil and debris carried by trucks to reduce fugitive dust. Perform road maintenance (i.e., promptly remove earthen material on paved roads) to reduce fugitive dust. Pave or put gravel on dirt roads and parking lots, if appropriate, to reduce fugitive dust. Develop and implement a fugitive dust control plan. Implement fuel-saving practices, such as minimizing vehicle and equipment idle time or utilizing a no-idle rule to reduce combustion emissions. Use vehicles that meet the latest emission standards to reduce combustion emissions. Use add-on controls, such as catalyst and diesel particulate filters, for drill rigs to reduce combustion emissions Ensure that diesel-powered construction equipment and drill rigs are properly tuned and maintained to reduce combustion emissions. Burn low-sulfur fuels in all diesel engines and generators to reduce combustion emissions. Implement an employee carpooling policy to reduce combustion emissions. Minimize travel to reduce both fugitive dust and combustion emissions. Limit the numbers of hours in a day that effluent-generating activities can be conducted to reduce both fugitive dust and combustion emissions. Train workers to comply with the speed limit, use good engineering practices, minimize soil disturbance. Implement any permit conditions or BMPs identified in the WDEQ air permit, if applicable, to reduce both fugitive dust and combustion emissions.

Table 6-2. Summary of Mitigation Measures Identified by NRC (Continued)		
Resource Area	**Activity**	**Proposed Mitigation Measures**
Noise	Exposure of workers and the public to noise	Restrict noise in work areas to levels that are below Occupational Safety and Health Administration regulatory limits. Limiting noise-generating activities to daytime hours when activities occur less than 305 m [1,000 ft] from a residence to keep noise levels at residences at background level.
Cultural and Historic Resources	Disturbance of prehistoric archaeological sites and sites eligible for listing on the National Register of Historic Places	No additional mitigations identified beyond those committed to by licensee.
Visual and Scenic	Potential visual intrusions in the existing landscape character	Limit the number of drill rigs operating during wellfield construction.
Socioeconomics	Effects on surrounding communities	No additional mitigations identified beyond those committed to by licensee.
Occupational and Public Health and Safety	Effects from facility operation	Design task procedures to reduce potential accidents. Develop contingency plans with county and municipal governments to ensure adequate medical, fire, and emergency services are available, in the event of a major accident.
Waste Management	Disposal capacity	No additional mitigations identified beyond those committed to by licensee.

7 AGENCIES AND PERSONS CONSULTED

The U.S. Nuclear Regulatory Commission (NRC) staff consulted with other agencies regarding the proposed action in accordance with NRC guidance in NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs" (NRC, 2003b). These consultations were intended to (i) ensure that the requirements of Section 7 of the Endangered Species Act and Section 106 of the National Historic Preservation Act (NHPA) were met and (ii) provide the designated State liaison agencies the opportunity to comment on the proposed action.

7.1 Wyoming State Historic Preservation Office

By letter dated December 3, 2015, the NRC (2015b) initiated NHPA Section 106 consultation with the Wyoming State Historic Preservation Office (WY SHPO). On September 1, 2017, the NRC staff contacted the Wyoming State Historic Preservation Office and requested review of the proposed Area of Potential Effect (APE) and Class III Cultural Resources report for the Ludeman In Situ Uranium Recovery (ISR) Satellite Project (NRC, 2017d). The WY SHPO responded via email on October 4, 2017, that it concurred with the direct and indirect APE. The NRC (2018c) submitted determinations of eligibility to the WY SHPO on March 23, 2018 for the sites identified in the Class III survey. The NRC's determinations were based on recommendations from the Class III Survey Report, input from Tribal consultation, and written comments from the Northern Cheyenne Tribe on the eligibility of sites 48CO3036 and 48CO3037. The WY SHPO concurred with the NRC's determinations of eligibility (WY SHPO, 2018a). Further discussion of the Section 106 review can be found in EA Sections 3.8 and 4.9.

7.2 U.S. Fish and Wildlife Service

On January 18, 2018, the NRC staff sent a letter to the U.S. Fish and Wildlife Service (FWS) in Cheyenne, Wyoming, describing the proposed action and requesting a list of threatened and endangered species and critical habitats that could potentially be affected by the proposed action (NRC, 2018a). FWS replied to NRC's letter on January 29, 2018 (FWS, 2018). NRC staff obtained a list of threatened and endangered species and critical habitats via the online Information, Planning, and Conservation (IPaC) system (FWS, 2017a) and compared the list to the FWS reply. The FWS identified two threatened plant species [*Ute ladies'-tresses* (*Spiranthes diluvialis*) and Western prairie fringed orchid *(Platanthera praeclara*)] that have the potential to be affected by the Ludeman ISR Satellite Project. The FWS further indicated that the proposed project, which is located within the Platte River System, may affect downstream populations of three bird species: (i) endangered whooping crane (*Grus americana*), (ii) endangered least tern (*Sterna antillarum*), and (iii) threatened piping plover (*Charadrius melodus*); and one fish species, the endangered pallid sturgeon (*Scaphirhynchus albus*). Discussions of these species can be found in EA Sections 3.5 and 4.6.

7.3 Wyoming Department of Environmental Quality

A copy of the Draft Environmental Assessment (EA) was provided to State of Wyoming Department of Environmental Quality (WDEQ) in Sheridan, Wyoming, for the opportunity to comment on the Draft EA. The NRC staff received 5 comments from the WDEQ Water Quality Division (WQD) (WDEQ, 2018d) and 19 comments from the Land Quality Division (LQD) (WDEQ, 2018e) (EA Table A–1). These comments are listed next, along with an NRC response (in italics) for each comment. Each response indicates whether the Draft EA was modified (as reflected in this final EA) as a result of the comment.

Comments from the WDEQ Water Quality Division:

"**Comments on the DEIS**. Sage Creek and Sand Creek are surface waterbodies located within the Project area. Wyoming Water Quality Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards identify Sage Creek and Sand Creek as Class 3B waterbodies designated for aquatic life, wildlife, recreation, agriculture, industry, and scenic value uses. The WQD requests the EA discuss water quality standards relevant to these waterbodies and any other waterbodies that may potentially be impacted by the project. Of particular interest is Chapter 1, Section 22(b) and (c), Radioactive Material, which identify radiological limits for Class 3B waters.

Although the surface water intakes for the Town of Douglas' municipal water system are not within the Project area, the system does have delineated source water areas that appear to intersect with the Project area according to the map on page 1-21 of the EA. Any activities that occur within the delineated source water areas have the potential to impact the public water supply, therefore the licensee should coordinate with the associated public water system to identify any local regulations that may be applicable to the Project."

Response: *The NRC acknowledges that Sage Creek and Sand Creek and other channels within the proposed project area are identified as Class 3B surface waters under WDEQ Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards. The individual water classifications for these water bodies and their use designations are listed in the Wyoming Surface Water Classification List (WDEQ, 2013b). Text was added to EA Section 3.4.3 to indicate that WDEQ Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards identify Sage Creek and Sand Creek as Class 3B surface waters.*

The NRC also acknowledges that WDEQ Rules and Regulations, Chapter 1, identifies water quality standards relevant to Class 3B surface waters, including radiological limits (see Chapter 1, Section 22, Radioactive Material). Under Chapter 1, Section 22(b), the total radium-226 concentration in Class 3B surface waters shall not exceed 60 pCi/L. Under Chapter 1, Section 22(c), in all Wyoming surface waters (including Class 3B waters), radioactive materials attributable or influenced by the activities of man shall not be present in the water or in the sediments in amounts which could cause harmful accumulations of radioactivity in plant, wildlife, livestock, or aquatic life. Text was added to EA Section 3.4.3 that discusses radiological standards pertaining to Class 3B surface waters as stipulated in Chapter 1, Sections 22(b) and 22(c).

In addition, the NRC has reviewed information on the location of surface water intakes for the Town of Douglas municipal water system on the North Platte River. The NRC has also reviewed information on the extent of Zone 1 (Accident Prevention or Sanitary Protection Zone) and Zone 2 (Attenuation Zone) protection areas associated with the surface water intakes. Zone 1 and Zone 2 protection areas have the highest potential for releasing contaminants that may reach the surface water intakes and impact water quality (Trihydro Corporation, 2006). Based on the NRC staff's review, the delineated Zone 1 and Zone 2 source water protection areas for the surface water intakes for the Town of Douglas municipal water system do not overlap the proposed project area. Therefore, activities associated with the proposed Ludeman ISR Satellite Project would have no impact on the quality of water reaching the surface water intakes for the Town of Douglas public water system. No additional changes were made to the EA in response to this portion of the comment.

Reference: Trihydro Corporation. "Wyoming Department of Environmental Quality Source Water Assessment Project – Final Project Report." Laramie, Wyoming: Trihydro Corporation. June, 2004.

"**Section 3.3.1 on Page 3-6**. The EA identifies the Lance Formation as the preferred target formation for disposal wells. However, a UIC Class I permit cannot be issued to inject into the Lance Formation at this time, because the Lance Formation overlies the Fox Hills Formation, which is a known underground source of drinking water (USDW) in the Powder River Basin. See Wyoming Water Quality Rules and Regulations, Chapter 27, Section 14 (a): "All Class I wells shall be situated such that they inject into a formation that is beneath the lowermost Underground Source of Drinking Water within one-quarter (1/4) mile of the well." In addition, injection into an aquifer containing a total dissolved solids concentrations less than 10,000 milligrams/liter would require a public notice in the Federal Register and United States Environmental Protection Agency authorization."

Response: *In the license amendment application request, Uranium One describes that it may include the installation of up to six Class I deep disposal wells at locations adjacent to the proposed wellfields throughout the proposed project area (EA Section 2.1.3). The NRC evaluated the potential impacts of the proposed action as represented in the license amendment application request. Section 2.1.7 of the EA describes that the Class I deep disposal well design and construction must meet WDEQ requirements and references Chapter 27 of the Wyoming Water Quality Rules and Regulations.*

Although EA Section 3.3.1 describes the Lance Formation as the licensee's preferred target for the Class I deep disposal wells, it also describes the Lewis Shale and Parkman Formation as secondary targets. As shown in ER Figure 3-1, these secondary targets underlie the cited Fox Hills Formation and, as noted in ER Section 3.3.1, the Parkman Formation exhibits total dissolved solid concentrations exceeding 10,000 milligrams per liter (mg/L) [10,020 parts per million (ppm)]. Therefore, the NRC's evaluation in the EA is not limited solely to the proposed target formation. Rather, the EA considers and evaluates a range of options that provide some flexibility to address current uncertainties about the outcome of future permitting actions.

Sections 3.12 and 4.12 in the EA state that before the Class I deep disposal wells can be operated, Uranium One must obtain a permit from WDEQ that authorizes drilling, completion, and operation of the wells, and that an aquifer exemption must be identified and requested by WDEQ and approved by the U.S. Environmental Protection Agency (EPA) for the aquifer (or portion thereof) that is the discharge zone for the disposal wells. State permitting actions, The WDEQ UIC Class I permit process and any final permit conditions would ensure that the Class I deep disposal wells would target an acceptable injection zone.

If deep disposal wells are not used at the proposed project, the impact analyses presented in the EA would remain applicable because the proposed evaporation ponds have been designed with sufficient capacity to accommodate all the liquid byproduct material waste streams, including those described in the EA as planned for deep well disposal.

No change was made to the EA beyond the information provided in this response.

"**Section 3.4.1 on Page 3-16**. The last sentence of the second paragraph states that "the North Platte River does not pass WDEQ surface water quality standards due to its high selenium levels." This segment of the North Platte River has been proposed to be removed from Wyoming's 303(d) List of impaired Waterbodies because data showed that the segment is

meeting its selenium criteria. The change in the status of this waterbody will be reflected in the final version of the 2016/2018 Wyoming Integrated 305(b) and 303(d) Report, which is expected in 2018. The WQD, therefore, requests that this sentence be updated to reflect the pending de-listing or removed from the EA."

Response: *The NRC acknowledges that the North Platte River has been proposed to be removed from Wyoming's 303(d) List of Impaired Waterbodies (WDEQ, 2018c) because data showed that it is meeting its selenium criteria. The NRC also acknowledges that this change will be reflected in the final version of Wyoming's 2016/2018 Integrated 305(b) and 303(d) Report expected in 2018. Text in EA Section 3.4.1 stating that the North Platte River does not pass WDEQ surface water quality standards due to its high selenium levels was removed. In addition, text in Section 3.4.3 stating that the North Platte River is an EPA 303(d)-classified stream because it does not pass WDEQ surface water quality standards due to elevated selenium concentrations was also removed.*

"**Section 3.4.1 and 3.4.2**. The EA describes surface water and groundwater quality sampling conducted by the licensee. According to the EA, several exceedances of EPA drinking water standards were detected during baseline sampling of surface waterbodies and domestic wells. If not done so already, the WQD recommends that the NRC inform the relevant landowners that their well water exceeds drinking water standards."

Response: *In its license amendment application, Uranium One described the background water quality data that was collected at the proposed Ludeman ISR Satellite Project. Uranium One reported that samples were collected for 22 wells in the Negley Subdivision and one additional well to the west of the proposed project area by a third-party contractor and tested by an independent laboratory. Uranium One also stated that the results of that sampling were sent directly to each of the land owners.*

"**Section 4.5 on Page 4-27**. The EA states that "the NRC will include a license condition requiring the licensee to install three groundwater monitoring wells upgradient and one monitoring well downgradient of both the evaporation pond and the permeate pond in the 110 Sand aquifer." The WQD requests that the monitoring wells should be located downgradient of the evaporation pond, not upgradient as stated here and elsewhere in the document. The WQD also notes that given the potential size of the evaporation ponds (stated as 54.3 surface acres and 68 million gallon capacity in Section 4.13), additional wells may be required to monitor the 110 Sand aquifer, which is the shallow sand below the evaporation pond and a source of water for the nearby Negley Subdivision. Additionally, the excursion parameters used by industry are chloride, total alkalinity, and conductivity. Uranium, gross alpha activity, radium-226, and selected metals should be added to the parameter suite if the evaporation pond is determined to be upgradient of the private water supply wells in the Negley Subdivision. In addition, the WQD would like to be consulted during development of a groundwater monitoring plan for the Project."

Response: *The description of the license condition in EA Section 4.5 specifying the installation position of monitoring wells in the 100 Sand aquifer for the evaporation and permeate ponds (i.e., three groundwater monitoring wells upgradient and one monitoring well downgradient) was an error in the Draft EA text. The text was corrected to read, "[t]he license condition will require the licensee to install one groundwater monitoring well upgradient and three monitoring wells downgradient of both the evaporation pond and permeate pond in the 100 Sand aquifer." This license condition (License Condition 10.24) is further documented in the NRC's Safety Evaluation Report (SER) for the proposed Ludeman ISR Satellite Project (NRC, 2018b). Text*

was revised in EA Section 4.5 to correctly state that the licensee will install one groundwater monitoring well upgradient and three monitoring wells downgradient of both the evaporation pond and permeate pond in the 100 Sand aquifer. This proposed monitoring is consistent with the NRC's recommended groundwater monitoring for impoundments, which is addressed in Regulatory Guide 4.14 (NRC, 1980).

The NRC staff acknowledges that WQD staff would like to be consulted during development of a groundwater monitoring plan for the project. In addition, the NRC staff recognizes that WQD staff have specific concerns with the number of monitoring wells and excursion parameters specified in the EA for monitoring of evaporation and permeate pond leaks to the 110 Sand aquifer. The NRC staff will require groundwater monitoring of the 110 Sand aquifer near the evaporation and permeate ponds, as required under 10 CFR Part 40 Appendix A Criteria 7A and 5B(1).

As described in EA Section 4.5, monitoring wells for the evaporation and permeate ponds will be required to be monitored in the same manner as required for excursion monitoring wells in License Conditions 10.4 and 11.2 of the Willow Creek Source Material License (SUA–1341), with the exception that the licensee will test the wells quarterly and the licensee will not be required to implement corrective actions, but instead will inform the NRC of the actions it will take to determine if the excursion is associated with leaks from the evaporation or permeate pond. License Conditions 10.4 and 11.2 specify that chloride, total alkalinity, and conductivity will be the excursion parameters tested in monitoring well samples. These excursion parameters were selected because they are highly mobile in groundwater and are representative indicators for early detection of impoundment leaks. WQD states that uranium, gross alpha activity, radium-226, and selected metals should be added to the parameter suite. However, radiological constituents, such as uranium and its decay products and metals (e.g., iron, strontium, radium, barium, cesium, and others) are influenced by adsorption processes as a result of pH changes, ion exchange, and oxidation-reduction reactions, which reduces their mobility in groundwater (Jenne, 1998).

Comments from WDEQ Land Quality Division:

"**Executive Summary, Land Use, page x**. Within this section, the NRC staff concluded that impacts to land use from the Ludeman Project would be SMALL. In later sections of the Draft EA, hunting and recreation impacts are considered and were found not to be significant due to the majority of the land within the proposed Ludeman Project area being privately owned. However, there is no discussion of hunting or recreational impacts in this section. It is suggested that this section of the Draft EA be revised to include a reference that hunting and recreation activities were considered by the NRC while evaluating land use impacts."

***Response**: Sections 3.1.2 and 4.1 of the EA describe limits and access restrictions on hunting and other recreational activities within the proposed Ludeman Project area imposed by private and State ownership of the land. Text was added to the Land Use section of the Executive Summary to indicate that hunting and other recreational activities would be limited within the proposed Ludeman ISR Satellite Project area because of access limits imposed by private and State ownership of the land.*

"**Executive Summary, Geology and Soils, page xi**. In the first paragraph, fifth line down from the top of the page, there is a statement describing the drill hole mud pit reclamation, which reads, "*pits would be refilled with topsoil.*" This statement could be interpreted by readers that the entire depth of a mud pit would be backfilled with topsoil. These pits can be as much as

five (5) feet deep in drilling operations based on the experiences of LQD staff. Page OP 10-5 of the LQD's permit application for the Ludeman Project states, "*during excavation of mud pits associated with well construction, exploration drilling, and delineation drilling activities, topsoil will be separated from the subsoil with a backhoe. The topsoil will be removed and placed in a separate temporary stockpile, while the subsoil is removed and deposited next to the mud pit. When the use of the mud pit is complete, usually within 30 days, the subsoil will be re-deposited in the mud pit followed by replacement of topsoil*." This description is consistent with the LQD Rules & Regulations. The Draft EA should be revised to clarify the reclamation of drill hole mud pits in order to be consistent with the LQD Permit Application and the LQD Rules & Regulations."

***Response**: The NRC acknowledges that the statement referenced in the Executive Summary describing drill hole mud pit reclamation, which reads, "pits would be refilled with topsoil" is not consistent with the LQD's permit application for the Ludeman Project and LQD guidelines. The reclamation of mud pits is also described in Section 4.4, where it is stated, "After mud pit use is complete (usually within 30 days of excavation), the subsoil would be redeposited in the mud pit and the topsoil would be replaced (Uranium One, 2017e)." This statement is consistent with the LQD permit application for the Ludeman Project and mud pit reclamation requirements under LQD Guideline 4, Reference Document 6, Section VI. Text describing mud pit reclamation in the Geology and Soils section of the EA Executive Summary was revised to reflect language in EA Section 4.4, to be consistent with the permit application for the proposed Ludeman ISR Satellite Project and LQD guidelines.*

"**Executive Summary, Water Resources/Groundwater, page xii**. Within this section, there is a statement that, "*Uranium One would submit decommissioning plans, including detailed plans for plugging and abandoning wells to the NRC for review and approval*." These plans would also be submitted to the LQD. The Draft EA should be revised to include the LQD receiving well decommissioning plans for review and approval."

***Response**: The NRC staff agrees that Uranium One would submit decommissioning plans, including a detailed plan for plugging and abandoning wells, to both the NRC and WDEQ for review and approval. Text was added to the Water Resources subsection "Groundwater" of the EA Executive Summary to indicate that WDEQ would receive the decommissioning plan, including detailed plans for plugging and abandoning wells, for review and approval.*

"**Executive Summary, Historical and Cultural Resources, page xiii**. In this section, the NRC concluded that impacts to historical and cultural resources within the proposed Ludeman Project area would be "SMALL". Although the LQD has not received a final Class III Cultural Resources Inventory from Uranium One, the LQD was recently informed by Uranium One that a historical and cultural resources consultation with the North Cheyenne Tribe identified an archeological site of interest within the proposed Ludeman project area. This information should be referenced in this section of the Draft EA."

***Response**: Section 106 activities are being conducted separately from the NEPA review, and some of the activities were completed after the Draft EA was provided to WDEQ for comment. However because all Section 106 activities are now complete, the executive summary, Section 3.8.2, Section 4.1 (Table 4-1), and Section 4.9 were revised to reflect this information.*

Section 2.1.1, Site Location and Description, page 2-2. There are some "holes" within the project area where mining and surface disturbance is excluded. These are all lands in which the surface landownership is the BLM and Chapman University. It is suggested that this be

described in this section of the Draft EA and in any subsequent sections where the site location is described."

***Response**: The NRC acknowledges that there are "excluded areas" within the outer boundary of the proposed project area, as illustrated in Figure 2-1, and that surface ownership of these lands is held by BLM (federal ownership) or Chapman University (private ownership)* (Uranium One, 2013a)*. Text was added to Sections 2.1.1 and 3.1 describing surface ownership of the excluded areas within the proposed project area.*

"**Section 2.1.3, Construction and Wellfield Design, page 2-4**. This section of the Draft EA includes the statement that, "*Although information about Wellfield 2 was provided in the licensee's reviewed TR and ER, aquifer confinement in Wellfield 2 has not been sufficiently demonstrated by Uranium One. NRC staff has therefore determined that the licensee has not provided a satisfactory characterization of the ore zone in Wellfield 2 to enable its inclusion in this licensing action. If NRC approves the licensee amendment requested by Uranium One to construct and operate the proposed Ludeman Project, NRC will not include authorization for construction or uranium recovery operations within Wellfield 2*". Despite Wellfield No. 2 not being authorized by the NRC, the Draft EA contains numerous discussions and references to the construction, operation, decommissioning, and surface reclamation of the proposed Wellfield No. 2. It is suggested that the entirety of the Draft EA be revised to indicate that Wellfield No. 2 will not be authorized by the NRC and is therefore excluded from the Ludeman Project."

***Response**: The NRC considered whether to evaluate the potential environmental impacts of Wellfield 2 as proposed in the revised ER and TR. The NRC held public meetings with Uranium One and submitted Requests for Additional Information to Uranium One with the intent to inform the NRC staff's understanding of the production zone aquifer at Wellfield 2. Uranium One's revised ER and TR describes activities and estimates for the proposed Ludeman ISR Satellite Project that are not all discretized by wellfield. For example, the estimated amount of fugitive dust emissions and radiological emissions include the construction and operation of all wellfields, including Wellfield 2. Thus, the EA's analyses of the potential impacts from those emissions are bounding. The NRC concluded in its SER (NRC, 2018b) that a safety review of Wellfield 2 could not be conducted until further information is provided by Uranium One. Although the NRC staff determined that Wellfield 2 will not be included in this proposed action, Uranium One could request a license amendment to operate in Wellfield 2 at a later date. To address this comment, text was added to EA Section 2.1.3 to clarify that because information for resource areas other than groundwater are provided for Wellfield 2 in the licensee's revised ER and TR, this EA includes the potential impacts from Wellfield 2 from the impacts to resource areas other than groundwater.*

"**Figure 2-1, Conceptual Site Layout of the Ludeman ISR Satellite Project, page 2-5**. This map is very difficult to read due to the font size and very small features on the map. It is suggested that the map be revised to either enlarge the font or configure the map to be divided up into sections."

***Response**: The NRC acknowledges that EA Figure 2-1 is difficult to read because of the font size and very small features. Figure 2-1 was revised to enlarge the font size and resized to improve its readability.*

"**Figure 2-2, Proposed Project Schedule for Ludeman ISR Satellite Project, page 2-6**. As noted in Comment #6 above, the NRC has made a determination that Wellfield 2 will not be

authorized. However, this bar graph contains the construction, operation, and restoration of Wellfield 2 beginning in year 1 (2018) and continuing through year 8. The bar graph should be revised to eliminate all Wellfield 2 components as it will not be constructed according to this Draft EA."

***Response**: Please refer to the NRC's previous response in this section that explains NRC's inclusion of Wellfield 2 in the EA.*

"**Section 2.1.6, Decontamination, Decommissioning, and Reclamation Activities, page 2-11**. This section includes the statement that, "*Uranium One must provide (and recalculate annually) financial surety for restoration, decommissioning, and reclamation for the overall project including the Ludeman ISR Satellite Project area, which is maintained in the form of a letter-of-credit in favor of the State of Wyoming*." It is believed that the NRC is referring to the Reclamation Performance Bond that is a requirement of all mining operations within the State of Wyoming. The WDEQ accepts several types of sureties for the purpose of securing funds sufficient to reclaim the site in the event of an operator forfeiture. It is suggested that this section of the Draft EA be revised to indicate all forms of reclamation performance bonds that are acceptable to the WDEQ-LQD."

***Response**: A letter-of-credit is a type of reclamation bond accepted by WDEQ and NRC currently maintained by Uranium One for the Willow Creek Project and is an acceptable financial surety arrangement for the proposed Ludeman ISR Satellite Project. The NRC acknowledges that there are other types of reclamation performance bonds that are acceptable to the WDEQ. Text in EA Section 2.1.6 was revised to indicate that financial surety is maintained in documentation acceptable to the NRC and WDEQ, such as a letter-of-credit in favor of the State of Wyoming.*

"**Comment on Section 2.1.6, Decontamination, Decommissioning, and Reclamation Activities, page 2-11**. The third paragraph references "*permanent storage areas*" in relation to topsoil operations. It is not known what this is in reference to as there should not be any permanent topsoil storage. It is suggested that the term "*permanent storage area*" be defined in the Draft EA."

***Response**: The term "permanent storage areas" in EA Section 2.1.6 is referring to storage areas for chemicals used in the ISR process (e.g., storage areas for carbon dioxide and oxygen gas cylinders). The term "permanent storage areas" was changed to "chemical storage areas" in EA Section 2.1.6.*

"**Section 2.1.6, Decontamination, Decommissioning, and Reclamation Activities, page 2-11**. This section includes a discussion of salvaging and stockpiling topsoil within the proposed Ludeman project area. A list of areas where topsoil is to be salvaged is provided as building sites, permanent storage areas, main access roads, pipeline installations, and wellfield header houses. There are items missing from the list including but not limited to, drill hole sites, well pads, impoundments, evaporation ponds, interior or temporary roads, and well access. It is suggested that this section be revised to state that topsoil will be salvaged from all surface disturbing activities on-site."

***Response**: The NRC agrees that there are missing items in the list of areas where topsoil is to be salvaged, such as ponds and wellfield infrastructure. Text in the EA Section 2.1.6 was revised as follows to be inclusive of all areas where topsoil is to be salvaged, "Topsoil would be salvaged from building sites (e.g., the satellite building), chemical storage areas, primary and*

secondary access roads, ponds, pipeline installations, and wellfield infrastructure (e.g., well pads and header houses), in accordance with WDEQ requirements (Uranium One, 2017e)."

"**Section 2.1.6, Decontamination, Decommissioning, and Reclamation Activities, page 2-11**. In this section, it is stated that "*salvaged topsoil would be stockpiled, seeded no later than the first fall or spring seeding season to minimize erosion, and later reapplied as needed"*. The LQD Rules & Regulations require that topsoil stockpiles be seeded immediately upon establishing them in order to prevent loss from wind and/or water erosion. This is typically accomplished by applying an approved temporary seed mix that has been approved by the LQD. It is suggested that this section be revised to indicate that topsoil stockpiles will have a temporary seed mix applied immediately in order to protect against topsoil loss due to wind and/or water erosion."

***Response**: The NRC acknowledges that under LQD guidelines for topsoil management and seeding [specifically Guideline 4, Reference Document 6, Section III, 2(g)], topsoil stockpiles are required to be seeded as soon as practicable in order to prevent soil loss from wind and/or water erosion. The NRC also acknowledges that soil loss from stockpiles is typically accomplished by applying an LQD-approved temporary seed mix. Text in the EA was revised to indicate that topsoil stockpiles would have a temporary seed mix applied as soon as practicable in order to protect against topsoil loss due to wind and/or water erosion.*

"**Figure 3-2, Watersheds and Surface Water Features in the Proposed Ludeman ISR Project Area and 3.2 km (2 mi) Buffer, page 3-14**. This map does not have a north arrow and should be added to the figure."

Response: The NRC agrees with the comment. A north arrow was added to EA Figure 3-2.

"**Figure 3-3, Subwatersheds, Surface Water Features, FEMA 100-year Flood Hazard Zones, Surface Water Rights and Sampling Locations at the Proposed Ludeman ISR Project, page 3-16**. This map does not have a north arrow and should be added to the figure."

Response: The NRC agrees with the comment. A north arrow was added to EA Figure 3-3.

"**Section 3.8, Cultural and Historical Resources, page 3-33**. The last two (2) sentences in the second paragraph appear to have an error. These sentences indicate that if the operator encounters any cultural resources, they are to contact SHPO immediately before proceeding and if they do NOT encounter any, they are also to contact SHPO before proceeding."

***Response**: The NRC agrees that there was an error in the sentence in the Draft EA Section 3.8, which reads, "If no historic properties are present or affected, the NRC is required to notify the Wyoming State Historic Preservation Office (WY SHPO) before proceeding." The discussion in this case is in regard to NRC responsibilities rather than licensee or operator responsibilities. As part of the environmental evaluation, the NRC would be required to document identification efforts and findings with WY SHPO if historic properties are present or affected. The sentence in Section 3.8 was revised to read, "*If historic properties are present or affected, the NRC is required to document identification efforts and findings with the Wyoming State Historic Preservation Office (WY SHPO) and to assess and resolve possible adverse effects of the undertaking before proceeding with licensing*."*

"**Section 4.4, Geology and Soil/Soil Impacts, page 4-19**. This section states that no topsoil would be stripped from wellfields. However, there would be some areas of topsoil stripping

within the proposed wellfields. This would include, but not be limited to, drilling pads for well installation, access road to individual wells, pipeline installation, trunk line installation, header houses, and monitoring well access for the purpose of collecting data. It is suggested that the statement referenced be revised to reflect that there will be topsoil stripping necessary within the individual wellfields and throughout the entire mine site."

***Response**: The NRC agrees that some topsoil stripping would occur during wellfield construction. Text was revised in EA Section 4.4 to indicate that some topsoil stripping would be necessary to construct wellfield infrastructure to include drilling pads, access roads, pipelines, and header houses.*

"**Section 4.4, Geology and Soil/Soil Impacts, page 4-20**. Topsoil stockpile protection measures are discussed in the second complete paragraph on this page. The LQD requires installation of a perimeter berm/toe-ditch around each topsoil stockpile. This protection method is not included in the list on this page of the Draft EA. It is suggested that a perimeter berm/toe-ditch around topsoil stockpiles be added on page 4-20 as it will be utilized on this site in order to comply with the LQD Rules & Regulations."

***Response**: The NRC recognizes that LQD guidelines for topsoil stockpiles [specifically Guideline 4, Reference Document No. 6, Section V(F)] require that stockpiles have containment berms or ring ditches to conserve the resource. Text was added to EA Section 4.4 stating that, "In accordance with WDEQ guidelines, a perimeter berm/toe ditch would be installed around each topsoil stockpile."*

"**Section 5.1.2.2, Other Past, Present, and Reasonably Foreseeable Actions/Coal Mining, page 5-5**. This section discusses that the School Creek Coal Mine is proposed to be constructed in the same area as the Proposed Ludeman Project. However, this mine has been in operation since 2009. All references to the School Creek Coal Mine should be revised to reflect that this mine is not proposed but is operational."

***Response**: The NRC acknowledges that the School Creek Coal Mine is currently permitted by WDEQ (Permit No. PT0764) and leased by the BLM (Lease* WYW172413*). The Draft EA identified the School Creek Mine as a potential mine because in 2016, the Wyoming Mining Association identified the School Creek Mine as a "potential" coal mining site, suggesting that the mine was not in operation (WMA, 2016). However, based on this comment from WDEQ that the School Creek mine has been in operation since 2009, text in EA Sections 5.1.2.2 and 5.7 were revised to clarify that there are four coal mines within 80 km [50 mi] of the proposed project.*

"Section 5.6, Ecology/Terrestrial Ecology, page 5-21. This section of the Draft EA includes an evaluation of impacts to birds and the vegetation necessary to support their habitat in the proposed Ludeman Project area. Federal laws and regulations are cited which provide protection to these birds including the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Area, and the Endangered Species Act. The Draft EA concludes that impacts, both incremental and cumulative, are SMALL for birds protected under these Federal laws and regulations. Sage grouse are also identified as being present in the proposed Ludeman Project area. This section asserts that oil & gas development in this area are causing impacts at the level of MODERATE to the Greater-sage grouse population and because the USFWS declined to place sage-grouse on any lists, there are no protections afforded to this species. Despite the decision of the USFWS, there are protections given to sage grouse based on Executive Order

No. 2015-4 signed by the Governor of Wyoming. It is recommended that the NRC include a discussion of Executive Order No. 2015-4 in this section of the Draft EA."

***Response**: The NRC agrees that the State of Wyoming has established impact thresholds and has issued guidance and recommendations in an executive order for Greater sage-grouse management on private and public lands to limit potential impacts from the proposed project. Text was added to EA Section 5.6 referencing the Governor's Executive Order No. 2015-4.*

8 LICENSE CONDITION CHANGES

Proposed changed in **BOLD**

Before engaging in any developmental activity not previously assessed by the U.S. Nuclear Regulatory Commission (NRC), the licensee shall administer a cultural resource inventory. All disturbances associated with the proposed development will be completed in compliance with the National Historic Preservation Act of 1966 (as amended) and its implementing regulations [Title 36 of the *Code of Federal Regulations* (36 CFR) Part 800], and the Archaeological Resources Protection Act of 1979 (as amended) and its implementing regulations [Title 43 of the *Code of Federal Regulations* (43 CFR) Part 7].

To ensure that no unapproved disturbance of cultural resources occurs, any work which results in the discovery of previously unknown cultural artifacts shall stop. The artifacts shall be inventoried and evaluated in accordance with 36 CFR Part 800, and no additional disturbance will be authorized until the licensee has received approval from the NRC to proceed.

Before engaging in any activity in T34N R73W that could physically disrupt or disturb inventoried cultural sites that have been designated as eligible for the National Register of Historic Places, the licensee shall ensure that such activity will avoid eligible Sites 48CO3036 and 48CO3037 by implementing a 100-foot buffer during all phases of the project.

9 CONCLUSION

Based on its review of the proposed action, and in accordance with the requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, the U.S. Nuclear Regulatory Commission (NRC) staff has determined that license amendment for the Willow Creek In Situ Recovery (ISR) Project license authorizing the construction and operation of the proposed Ludeman ISR Satellite Project would not significantly affect the quality of the human health, safety, and environment. In its license amendment request, Uranium One has proposed the addition of six production units on the Ludeman Project site, which is located in Converse County, Wyoming. No significant changes in Uranium One's authorized operations for the Willow Creek central processing plant, which is where the yellowcake produced at the Ludeman site will be processed, were requested. Provided that new or revised license conditions to NRC license SUA–1341 are followed, approval of the proposed action would not result in an increased radiological risk to public health or the environment. The NRC staff has determined that pursuant to 10 CFR 51.31, preparation of an environmental impact statement (EIS) is not required for the proposed action and, pursuant to 10 CFR 51.32, a finding of no significant impact (FONSI) is appropriate. Pursuant to 10 CFR 51.33, the NRC staff made an environmental assessment (EA) and FONSI. In doing so, the NRC staff determined that preparation of the EA and FONSI furthers the purposes of the National Environmental Policy Act (NEPA). The NRC staff performed an EA and, based on its results, the NRC is issuing a FONSI.

10 LIST OF PREPARERS

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11 REFERENCES

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20. “Standards for Protection Against Radiation.”

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20.1301. “Dose Limits for Individual Members of the Public.”

10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40. “Domestic Licensing of Source Material.”

10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40, Appendix A. “Criteria Relating to the Operation of Uranium Mills and to the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily from their Source Material Content.”

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51. “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51.91. “Final Environmental Impact Statement--Contents.”

23 CFR Part 772. *Code of Federal Regulations*, Title 23, *Highways*, Part 772. “Procedures for Abatement of Highway Traffic Noise and Construction Noise.”

36 CFR Part 60. *Code of Federal Regulations*, Title 36, *Protection of Historic Properties,* Part 60. “National Register of Historic Places.”

36 CFR Part 800. *Code of Federal Regulations*, Title 36, *Protection of Historic Properties,* Part 800. “Advisory Council on Historic Preservation Regulations.”

40 CFR Part 50. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Part 50. “National Primary and Secondary Ambient Air Quality Standards.”

40 CFR Part 81. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Part 81.342. “South Dakota.”

40 CFR Part 81. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Part 81.351. “Wyoming.”

40 CFR Part 261. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Part 261.3. “Definition of Hazardous Waste.”

40 CFR Part 264. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Part 264.221. “Design and Operating Requirements.”

40 CFR 1508.7. *Code of Federal Regulations*, Title 40, *Protection of Environment,* Part 1508.7. “Cumulative Impacts.”

40 CFR 1508.9. *Code of Federal Regulations*, Title 40, *Protection of Environment,* Part 1508.9. “Environmental Assessment.”

65 FR 76708. “National Primary Drinking Water Regulations; Radionuclides: Final Rule.” *Federal Register*. Vol. 65, No. 236. Washington, DC: U.S. Government Printing Office. December 7, 2000.

69 FR 52040. “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions.” *Federal Register*. Vol. 69, No. 163. pp. 52,040–52,048. Washington, DC: U.S. Government Printing Office. August 24, 2004.

70 FR 12710. “Final List of Bird Species to Which the Migratory Bird Treaty Act Does Not Apply.” *Federal Register.* Vol. 70, No. 49. Washington, DC: U.S. Fish and Wildlife Service. 2005.

74 FR 66496. “Endangerment and Cause or Contribute Findings for Greenhouse Gases.” *Federal Register*. Vol. 74, No. 239. pp. 66,496–66,546. Washington, DC: U.S. Government Printing Office. December 15, 2009.

75 FR 31514. “Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule.” *Federal Register*. Vol. 75, No. 106. pp. 31,514–31,608. Washington, DC: U.S. Government Printing Office. 2010.

76 FR 56951. “Licenses, Certifications, and Approvals for Materials Licensees.” *Federal Register*. Vol. 76, No. 179. pp. 56,951–56,966. Washington, DC: U.S. Government Printing Office. 2011.

ACHP. “Consultation With Indian Tribes in the Section 106 Review Process: A Handbook.” Washington, DC: Advisory Council on Historic Preservation. June 2012.

Anna, L.O. “Geologic Assessment of Undiscovered Oil and Gas in the Powder River Basin Province, Wyoming and Montana (Chapter 1).” Digital Data Series DDS–69–U. Reston, Virginia: U.S. Department of the Interior. U.S. Geological Survey. 2010.

APLIC. “Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006.” ML12243A391. Washington, DC: Edison Electric Institute (APLIC); Sacramento, California: California Energy Commission Avian Power Line Interaction Committee. 2006.

Arizona Public Service Company. “Application for *In Situ* Research and Development Testing License, Peterson *In Situ* Uranium Extraction Project, Converse County, Wyoming.” Prepared for the Wyoming Department of Environmental Quality Application for *In Situ* Research and Development Testing License. 1980.

Bishop, L.C. “Application for a Permit to Construct the Hildebrand Reservoir, and to Store the Unappropriated Water of the State of Wyoming.” 6 July 1909.

BLM. “Manual 8400 - Visual Resource Management.” ML12237A194. Washington, DC: Bureau of Land Management. 1984.

BLM. “Manual H–8410–1 Visual Resource Inventory.” ML12237A196. Washington, DC: Bureau of Land Management. 1986.

BLM. “Final Environmental Impact Statement and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project.” Buffalo, Wyoming: Bureau of Land Management. 2003. <https://archive.org/details/finalenvironment04buff> (31 October 2017).

BLM. “Task 1D Report for the Powder River Basin Coal Review Current Environmental Conditions.” ML12237A214. Casper, Wyoming: Bureau of Land Management. June 2005a.

BLM. “Chapter 5: Potential Impacts of Wind Energy Development and Analysis of Mitigation Measures.” Final Programmatic Environmental Impact Statement on Wind Energy Development on BLM-Administered Lands in the Western United States. FES 05-11. ML12243A271. Washington, DC: Bureau of Land Management, U.S. Department of the Interior. June 2005b.

BLM. “Approved Resource Management Plan and Final Environmental Impact Statement for the Casper Field Office Planning Area.” BLM/WY/PL-07/017+1610. Cheyenne, Wyoming: U.S. Department of the Interior, Bureau of Land Management. 2007. <https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=88608> (15 October 2017).

BLM. “Proposed Resource Management Plan and Final Environmental Impact Statement for Public Lands Administered by the Bureau of Land Management Rawlins Field Office.” ML12209A103. Rawlins, Wyoming: Bureau of Land Management, Rawlins Field Office. 2008.

BLM. “Final Environmental Impact Statement for the South Gillette Area Coal Lease Applications.” WYW172585, WYW173360, WYW172657, and WYW161248. Cheyenne, Wyoming: Bureau of Land Management. August 2009. <https://archive.org/details/southgilletteare01wwce> (1 November 2017).

BLM. “Final Environmental Impact Statement for the Wright Area Coal Lease Applications, Volume 1 of 2, Chapters 1–4.” Casper, Wyoming: Bureau of Land Management. July 2010. <https://archive.org/details/wrightareacoalle01unit> (1 November 2017).

BLM. “Task 2 Report for the Powder River Basin Coal Review – Past and Present and Reasonably Foreseeable Development Activities.” Casper, Wyoming: Bureau of Land Management, High Plains District Office. 2011. <https://eplanning.blm.gov/epl-front-office/projects/nepa/64842/78267/88481/18-Task2-Past.Present.ReasonableForeseeableDevelopment.pdf> (23 October 2017).

BLM. “Environmental Assessment of the Proposed Douglas Quarry Mineral Materials Expansion Project, Converse County, Wyoming.” WY–060–EA11–15. Casper, Wyoming: Bureau of Land Management, Casper Field Office. January 2012a.

BLM. “Interim Management Guidance for Migratory Bird Conservation Policy on Wyoming Bureau of Land Management (BLM) Administered Public Lands Including the Federal Mineral Estate.” Instruction Memorandum No. WY–2013–005. Cheyenne, Wyoming: U.S. Department of Interior, Bureau of Land Management. October 2012b.

BLM. “Task 1D Report for the Powder River Basin Coal Review Current Environmental Conditions.” Buffalo, Wyoming: Bureau of Land Management. December 2012c. <https://eplanning.blm.gov/epl-front-office/projects/nepa/64842/78267/88468/06Task1D-EnvConditions.pdf> (1 November 2017).

BLM. “Task 1D Report for the Powder River Basin Coal Review Current Environmental Conditions, Section 2.9 Hazardous Materials and Solid Waste.” Casper, Wyoming: Bureau of Land Management. December 2012d. <https://eplanning.blm.gov/epl-front-office/projects/nepa/64842/78267/88478/15-Task1D-chapter2.9.pdf> (30 October 2017).

BLM. “Task 3D Report for the Powder River Basin Coal Review Cumulative Environmental Effects.” Casper, Wyoming: Bureau of Land Management, High Plains District Office. 2013a. <https://eplanning.blm.gov/epl-front-office/projects/nepa/64842/78267/88488/25-Task3Dreport.pdf> (1 November 2017).

BLM. “Environmental Assessment for Uranerz Energy Corporation’s Proposed Hank Unit Uranium *In-Situ* Recovery Project, Campbell County, Wyoming.” WY–070–EA13–226. Buffalo, Wyoming: Bureau of Land Management, Buffalo Field Office. 2013b.

BLM. “Task 3A Report for the Powder River Basin Coal Review Cumulative Air Quality Effects.” Casper, Wyoming: Bureau of Land Management, High Plains District Office. 2014. <https://eplanning.blm.gov/epl-front-office/projects/nepa/64842/78263/88425/07Task3A.pdf> (1 November 2017).

BLM. “Re: Request for Information for the Ludeman ISR Satellite Project.” Email from Shane Gray, Biologist, BLM Buffalo Field Office to Kellee Jamerson, U.S. Nuclear Regulatory Commission. Attachments: Requested GIS Data.zip. Casper, Wyoming: Bureau of Land Management. May 2015a.

BLM. “Proposed Resource Management Plan and Final Environmental Impact Statement for the Buffalo Field Office Planning Area.” Buffalo, Wyoming: Bureau of Land Management. 2015b. <https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=48300> (1 November 2017).

CCSD. “Converse County School District #1.” Douglas, Wyoming: Converse County School District #1. 2017a. <http://converse1schools.org> (11 October 2017).

CCSD. “Converse County School District #2.” Glenrock, Wyoming: Converse County School District #2. 2017b. <http://www.converse2.org/> (11 October 2017).

CEQ. “Considering Cumulative Effects Under the National Environmental Policy Act.” ML12243A349. Washington, DC: Executive Office of the President, Council on Environmental Quality. January 1997.

Chapman, S.S., S.A. Bryce, J.M. Omernik, D.G. Despain, J. ZumBerge, and M. Conrad. “Ecoregions of Wyoming.” U.S. Geological Survey Map. Scale 1:1,400,000. 2004.

Cogema Mining Inc. “COGEMA Mining, Inc. Irigaray and Christensen Ranch Projects U.S. NRC License Renewal Application Source Material License SUA-1341.” ML081890414, ML081890415, ML12082A056, ML12206A436, ML092110692, ML103280266, ML083110405. Revisions submitted October 2008, July 2009, November 2010, March 2012, July 2012 (Note: last 3 were submitted by Uranium One USA, Inc. after change of control of license). Mills, Wyoming: Cogema Mining Inc. 2008.

Converse County. “Converse County Wyoming Land Use Plan.” 2015. <http://conversecounty.org/DocumentCenter/Home/View/466> (1 November 2017).

Countess, R. “Methodology for Estimating Fugitive Windblown and Mechanically Resuspended Road Dust Emissions Applicable for Regional Scale Air Quality Modeling.” ML13213A294. Westlake Village, California: Countess Environmental. 2001.

Crist, M.A. and M.E. Lowry. “Ground-Water Resources of Natrona County, Wyoming.” U.S. Geological Survey Water-Supply Paper 1897. Washington, DC: U.S. Government Printing Office. 1972.

Curry, W.H, III. “Type Section of the Teapot Sandstone.” *Geology and Energy Resources of the Powder River: 28th Wyoming Geological Association Annual Field Conference Guidebook.* R.B. Laudon; W.H. Curry, III; and J.S. Runge, eds. Laramie, Wyoming: Wyoming *Geological* Association. pp. 29–32. 1976.

de Bruin, R.H. “Oil and Gas Fields Map of the Powder River Basin, Wyoming.” ML13024A167. Laramie, Wyoming: Wyoming State Geological Survey. 2007.

Department of Energy (DOE). “Spook, Wyoming, Disposal Site.” Grand Junction, Colorado: U.S. Department of Energy, Office of Legacy Management. 2017. <https://www.lm.doe.gov/spook/sites.aspx> (9 January 2018).

DrillingEdge. “Converse County, WY Oil and Gas Well Locations.” Dripping Springs, Texas: DrillingEdge, Inc. 2017. <http://www.drillingedge.com/wyoming/converse-county> (9 October 2017).

Duke Energy. “Top of the World Windpower.” 2017. <https://www.duke-energy.com/our-company/about-us/businesses/renewable-energy/wind-energy/top-of-the-world-windpower> (9 October 2017).

EIA. “Annual Energy Outlook 2015 with Projections to 2040.” DOE/EIA-0383. Washington, DC: U.S. Environmental Protection Agency, Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels. 2015. <https://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf> (7 November 2017).

EIA. “Annual Energy Outlook 2017 with Projections to 2050.” DOE/EIA-0383. Washington, DC: U.S. Environmental Protection Agency, Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels. 2017. <https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf> (1 November 2017).

EPA. “Information on Levels of Environmental Noise Requisite to Protect Health and Welfare With an Adequate Margin of Safety.” EPA 550/9-74-005. ML12241A393. Washington, DC: U.S. Environmental Protection Agency. 1974.

EPA. “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion.” Federal Guidance Report No. 11. Washington, DC: U.S. Environmental Protection Agency. 1988.

EPA. “Assessment of Variations in Radiation Exposure in the United States.” Contract Number EP–D–05–02. ML12240A227. Washington, DC: U.S. Environmental Protection Agency. 2005.

EPA. “Exposure Factors Handbook, 2011 Edition.” EPA/600/R-090/052F. Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development. 2011.

EPA. “Final Rule—Prevention of Significant Deterioration and Title V Operating Permit Greenhouse Gas (GHG) Tailoring Rule Step 3 and GHG Plantwide Applicability Limits—Fact Sheet.” Washington, DC: U.S. Environmental Protection Agency. 2012.

EPA. “National Recommended Water Quality Criteria, Aquatic Life Criteria Table.” Washington, DC: U.S. Environmental Protection Agency. 2014. <http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm#notes> (9 November 2017).

FHWA. “Highway Traffic Noise: Analysis and Abatement Guidance.” FHWA–HEP–10–025. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. 2011. <https://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/analysis_and_abatement_guidance/revguidance.pdf> (11 October 2017).

FRA. “Horn Noise FAQ.” Washington, DC: Federal Railroad Administration. 2010. <https://www.fra.dot.gov/Page/P0599> (11 October 2017).

FWS. “Reserve Pit Management: Risks to Migratory Birds.” Cheyenne, Wyoming: U.S. Fish and Wildlife Service, Region 6. 2009.

FWS. “In Reply Refer To: 06E13000-2013-EC-0069 and 06E13000-2015-CPA-0086.” Letter [from FWS] (March 6) to Lydia Chang, U.S. Nuclear Regulatory Commission. Cheyenne, Wyoming: U.S. Fish and Wildlife Service. 2015.

FWS. “Wyoming ES—Outreach, Species of Concern.” Cheyenne, Wyoming: U.S. Fish and Wildlife Service, Wyoming Ecological Services. May 1, 2017a. <http://www.fws.gov/wyominges/Species_concern.php> (1 November 2017).

FWS. “List of Threatened and Endangered Species That May Occur in Your Proposed Project Location, and/or May Be Affected by Your Proposed Project.” Consultation Code: 06E13000-2016-SLI-0199. Cheyenne, Wyoming: U.S. Fish and Wildlife Service, Wyoming Ecological Services Field Office. May 24, 2017b.

FWS. “Species of Concern, Raptors in Wyoming.” Cheyenne, Wyoming: U.S. Department of Interior, Fish and Wildlife Service, Wyoming Ecological Services. Webpage Last Modified August 2017c. <http://www.fws.gov/wyominges/Species/Raptors.php> (1 November 2017).

FWS. “Western Prairie Fringed Orchid (Platanthera praeclara).” 2017d. <http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q2YD> (1 November 2017).

FWS. Letter from T. Abbott, U.S. Fish and Wildlife Service, to C. Román, NRC, RE: In Reply Refer To: 06E13000-2018-CPA-0054. Cheyenne, Wyoming: U.S. Fish and Wildlife Service, Wyoming Ecological Services Field Office. ML18057A219. January 29, 2018.

Garoutte, K. "NRC License SUA-1548, 2017-2018 Surety, Water Balance, Restoration Schedule." Letter (June 21) to A. Kock, U.S. Nuclear Regulatory Commission. ML17192A348, ML17192A349. Glenrock, Wyoming: Cameco Resources. 2017.

GCRP. "Climate Change Impacts in the United States: The Third National Climate Assessment." J.M. Melillo, T.C. Richmond, and G.W. Yohe, eds. ML14129A233. Washington, DC: U.S. Government Printing Office, U.S. Global Change Research Program. 2014.

Heidel, B. "Survey of Spiranthes diluvialis (Ute ladies'-tresses) in Eastern Wyoming (Campbell, Converse, Goshen, Laramie, Niobrara and Platte counties) 2005-2006." Laramie, Wyoming: Wyoming Natural Diversity Database. 2007. <https://www.uwyo.edu/wyndd/_files/docs/reports/wynddreports/u07hei04wyus.pdf> (24 May 2017).

HKM Engineering Inc. (HKM), Lord Consulting, and Watts & Associates. Northeast Wyoming River Basins Plan. Table 111-24. 2002.

Hodson, W.G., R.H. Pearl, and S.A. Druse. "Water Resources of the Powder River Basin and Adjacent Areas, Northeastern Wyoming." U.S. Geological Survey Hydrologic Investigations Atlas HA–465. Washington, DC: U.S. Geological Survey. 1973.

Jenne, E.A. "Adsorption of Metals by Geomedia." Academic Press, San Diego, California. 1998.

Kadrmas, Lee, and Jackson, Inc. "Campbell County Coal Belt Transportation Study." ML12240A251. Gillette, Wyoming: Kadrmas, Lee, and Jackson, Inc. August 2010.

Keroher, G.C. "Lexicon of the Geologic Names of the United States for 1936 to 1960. Part 3, P–Z." Washington, DC: Government Printing Office, U.S. Geological Survey. 1966.

KLJ. "Natrona County 2040: An Amendment to the 1998 Natrona County Development Plan." 2014. KLJ Engineering & Planning Services. <http://www.natronacounty-wy.gov/DocumentCenter/View/2332> (11 October 2017).

Larsen, M.C. and S.J. Wittke. "Relationships Between Injection and Disposal Well Activities and Known Earthquakes in Wyoming, from 1984 to 2013." Wyoming State Geological Survey Open File Report 2014-05. Laramie, Wyoming: Wyoming State Geological Survey. 2014.

Lowry, M.E. and J.F. Wilson, Jr. "Hydrology of Area 50, Northern Great Plains and Rocky Mountain Coal Provinces, Wyoming and Montana." U.S. Geological Survey Water-Resources Investigations Open-File Report 83-545. Washington, DC: U.S. Geological Survey. 1986. <https://pubs.usgs.gov/of/1983/0545/report.pdf> (1 November 2017).

Mead, M. “Greater Sage-Grouse Core Area Protection.” EO No. 2015-4. Cheyenne, Wyoming: Office of the Governor, State of Wyoming Executive Department. 2015. <https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Sage%20Grouse/SG_Executive_Order.pdf> (1 November 2017).

NCRP. “Ionizing Radiation Exposure of the Population of the United States.” Report No. 160. Bethesda, Maryland: National Council on Radiation Protection and Measurements. 2009.

NCSD. “Natrona County Schools.” Casper, Wyoming: Natrona County School District. 2015. <http://natronaschools.org/about/> (1 November 2017).

NOAA. “Storm Events Database Search Results for Wyoming, Converse County - Event Types: Flash Flood, Hail, High Wind, Thunderstorm Wind, Tornado.” Ashville, North Carolina: National Centers for Environmental Information. 2015. <http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=56%2CWYOMING> (1 November 2017).

NRC. NUREG–0489, “Final Environmental Statement Related to the Exxon Minerals Company, U.S.A. Highland Uranium Solution Mining Project, Converse County, Wyoming.” Docket No. 40-8102. Washington, DC: U.S. Nuclear Regulatory Commission. November 1978.

NRC. Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills.” Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission. April 1980.

NRC. Regulatory Guide 3.46, “Standard Format and Content of License applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining.” Washington, DC: U.S. Nuclear Regulatory Commission. June 1982.

NRC. NUREG–0925, “Final Environmental Statement Related to the Operation of the Teton Uranium ISL Project.” Docket No. 40-8781. ML13066A208. Uranium Recovery Field Office, Region IV. Washington, DC: U.S. Nuclear Regulatory Commission. August 1983.

NRC. “Environmental Assessment for Renewal of Source Material License No. SUA–1341, Cogema Mining, Inc. Irigaray and Christensen Ranch Projects, Campbell and Johnson Counties, Wyoming.” Docket No. 40-8502. Washington, DC: U.S. Nuclear Regulatory Commission. 1998.

NRC. NUREG–1569, “Standard Review Plan for *In-Situ* Leach Uranium Extraction License Applications.” Washington, DC: U.S. Nuclear Regulatory Commission. June 2003a.

NRC. NUREG–1748, “Environmental Review Guidance for Licensing Actions Associated with NMSS Programs, Final Report.” Washington, DC: U.S. Nuclear Regulatory Commission. August 2003b.

NRC. “Environmental Assessment for the Addition of the Reynolds Ranch Mining Area to Power Resources, Inc.’s Smith Ranch/Highlands Uranium Project Converse County, Wyoming.” Washington, DC: U.S. Nuclear Regulatory Commission. 2006.

NRC. “Environmental Assessment, Construction and Operation of *In Situ* Leach Satellite SR-2, Amendment No. 12 To Source Materials License No. SUA–1548, Power Resources Inc. Smith Ranch Highland Uranium Project (SR-HUP), Converse County, Wyoming.” ML073460801. Washington, DC: U.S. Nuclear Regulatory Commission. 2007.

NRC. Regulatory Guide 3.11, “Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities.” Rev. 3. Washington, DC: U.S. Nuclear Regulatory Commission. January 2008.

NRC. NUREG–1910, “Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities.” ML091480244 and ML091480188. Washington, DC: U.S. Nuclear Regulatory Commission. May 2009.

NRC. NUREG–1910, “Environmental Impact Statement for the Moore Ranch ISR Project in Campbell County, Wyoming.” Supplement 1. Supplement to the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities. Final Report. ML102290470. Washington, DC: U.S. Nuclear Regulatory Commission, Office of Federal and State Materials and Environmental Management Programs. August 2010.

NRC. NUREG–1910, “Environmental Impact Statement for the Nichols Ranch ISR Project in Campbell and Johnson Counties, Wyoming.” Supplement 2. Supplement to the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities. Final Report. ML103440120. Washington, DC: U.S. Nuclear Regulatory Commission, Office of Federal and State Materials and Environmental Management Programs. January 2011a.

NRC. NUREG–1910, “Environmental Impact Statement for the Lost Creek ISR Project in Sweetwater County, Wyoming.” Supplement 3. Supplement to the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities. Final Report. ML11125A006. Washington, DC: U.S. Nuclear Regulatory Commission, Office of Federal and State Materials and Environmental Management Programs. June 2011b.

NRC. “Final Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SUA–1341 for Uranium One USA, Inc. Irigaray and Christensen Ranch Projects (Willow Creek Project), Wyoming.” ML103270681. Washington, DC: U.S. Nuclear Regulatory Commission. July 2011c.

NRC. “Trip Report, Site Visit to the Ludeman Project Site and Stakeholder/Agency Meetings, August 6-9, 2012”. ML17353A157. Washington, DC: U.S. Nuclear Regulatory Commission. August 2012.

NRC. “Supplemental Environmental Assessment, License Renewal Application Source Material License SUA–1341, Uranium One USA, Inc., Willow Creek *In-Situ* Recovery Project Johnson and Campbell Counties, Wyoming.” ML12289A332. Washington, DC: U.S. Nuclear Regulatory Commission. January 2013a.

NRC. Safety Evaluation Report, License Renewal of the Willow Creek Uranium In Situ Recovery Project, Johnson and Campbell Counties, Wyoming, Source Materials License No. SUA–1341. ML13015A356. Washington, DC: U.S. Nuclear Regulatory Commission. March 2013b.

NRC. “U.S. Nuclear Regulatory Commission Requests for Additional Information Uranium One’s Ludeman Project Environmental Review of the License Application for a Source Material License.” ML12352A032. Washington, DC: U.S. Nuclear Regulatory Commission. January 2013c.

NRC. NUREG–1910, “Environmental Impact Statement for the Dewey–Burdock ISR Project in Custer and Fall River Counties, South Dakota, Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities, Final Report.” Supplement 4, Part 1. ML14024A477. Washington, DC: U.S. Nuclear Regulatory Commission. January 2014.

NRC. Pathfinder–Shirley Basin Uranium Recovery Facility. June 2015a. <https://www.nrc.gov/info-finder/decommissioning/uranium/is-pathfinder-shirley-basin.pdf> (1 November 2017).

NRC. Letter from L. Chang, NRC, to M. Hopkins, Wyoming State Historic Preservation Office, RE: Notification and Request for Consultation Regarding the Proposed Uranium One Ludeman In Situ Uranium Recovery Satellite Facility (Docket No.: 40-8052). ML15314A385. Washington, DC: U.S. Nuclear Regulatory Commission. December 3, 2015b.

NRC. “Willow Creek License No. SUA–1341 Amendment No. 5.” ML16173A142. September 2016a.

NRC. NUREG–1910, “Environmental Impact Statement for the Reno Creek *In-Situ* Recovery Project in Campbell County, Wyoming: Supplement to the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities, Final Report.” Supplement 6. Washington, DC: U.S. Nuclear Regulatory Commission. December 2016b.

NRC. Title I Program. July 2017a. <http://www.nrc.gov/materials/uranium-recovery/regs-guides-comm/title-i-program.html> (1 November 2017).

NRC. “License Applications for New Uranium Recovery Facilities, Expansions, Restarts, and Renewals.” Washington, DC: U.S. Nuclear Regulatory Commission. August 2017b. <https://www.nrc.gov/materials/uranium-recovery/license-apps/ur-projects-list-public.pdf> (1 November 2017).

NRC. “Locations of Uranium Recovery Sites Undergoing Decommissioning.” Washington, DC: U.S. Nuclear Regulatory Commission. September 2017c. <http://www.nrc.gov/info-finder/decommissioning/uranium/> (1 November 2017).

NRC. Letter from C. Román, NRC, to M. Hopkins, Wyoming State Historic Preservation Office, RE: Transmittal of Information Related to the Section 106 Consultation for the Proposed Ludeman *In-Situ* Uranium Recovery Satellite Project in Converse County, Wyoming (Docket Number 40-8502). ML1723A468. Washington, DC: U.S. Nuclear Regulatory Commission. September 1, 2017d.

NRC. Letter from C. Román, NRC, to T. Abbott, U.S. Fish and Wildlife Service, RE: Request for Information Regarding Endangered or Threatened Species and Critical Habitat for the Proposed License Amendment to Source Material License SUA–1341 for Uranium One Ludeman Uranium Recovery Satellite Project. ML17234A468. Washington, DC: U.S. Nuclear Regulatory Commission. January 18, 2018a.

NRC. Safety Evaluation Report License Amendment for the Ludeman Project to the Willow Creek In Situ Recovery Project Converse County, Wyoming." ML18059A919. Washington, DC: U.S. Nuclear Regulatory Commission. March 6, 2018b.

NRC. Letter from C. Román, NRC, to M. Hopkins, Ludeman In Situ Uranium Recovery Satellite Project: Recommendations of Eligibility for Historic Properties in Converse County, Wyoming (Docket Number: 040-8502). ML18065A866. Washington, DC: U.S. Nuclear Regulatory Commission. March 23, 2018c.

NRC. Letter from C. Román, NRC, to M. Hopkins, Determinations of No Effects for Uranium One Ludeman Satelitte - Converse County, Wyoming – Source Materials License Number SUA-1341 (SHPO File Number 0518RLC004). ML18187A322. Washington, DC: U.S. Nuclear Regulatory Commission. July 9, 2018d.

PacifiCorp. "Dave Johnston Plant." Portland, Oregon: PacifiCorp. January 2011a. <http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/EnergyGeneration_FactSheets/RMP_GFS_Dave_Johnston.pdf> (4 August 2016).

PacifiCorp. "Glenrock Wind Project." Portland, Oregon: PacifiCorp. November 2011b. <http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/EnergyGeneration_FactSheets/RMP_GFS_Glenrock.pdf> (1 November 2017).

PacifiCorp. "Glenrock III Wind Project." Portland, Oregon: PacifiCorp. November 2011c. <http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/EnergyGeneration_FactSheets/RMP_GFS_Glenrock_III.pdf> (1 November 2017).

PacifiCorp. "Three Buttes Windpower." Portland, Oregon: PacifiCorp. 2015. <http://www.pacificorp.com/es/re/tb.html> (1 November 2017).

PacifiCorp. "UM PacifiCorp's Renewable Portfolio Standard Oregon Compliance Report for 2016 and Motion for Protective Order." Portland, Oregon: PacifiCorp. June 2017a. <http://edocs.puc.state.or.us/efdocs/HAA/haa154136.pdf> (8 November 2017).

PacifiCorp. "Three Buttes Windpower." Portland, Oregon: PacifiCorp. November 2017b. <http://www.pacificorp.com/es/re/tb.html> (9 November 2017).

Peterson, J.A. "Stratigraphy and Sedimentary Facies of the Madison Limestone and Associated Rocks in Parts of Montana, Nebraska, North Dakota, South Dakota, and Wyoming." U.S. Geological Survey Professional Paper 1273-A. Washington, DC: Government Printing Office. 1984.

PR Newswire. "Canadian Pacific to Sell West End of its Dakota, Minnesota & Eastern Line to Genesee & Wyoming." Chicago, Illinois: PR Newswire. 2014. <https://www.prnewswire.com/news-releases/canadian-pacific-to-sell-west-end-of-its-dakota-minnesota--eastern-line-to-genesee--wyoming-238503711.html> (8 November 2017).

PRRIP. “Platte River Recovery Implementation Program.” Kearny, Nebraska: Platte River Recovery Implementation Program. 2016. <https://www.platteriverprogram.org/Pages/Default.aspx> (1 November 2017).

SDDENR. “South Dakota’s Regional Haze State Implementation Program.” ML12243A371. Pierre, South Dakota: South Dakota Department of Environment and Natural Resources. 2011.

SDDENR. “South Dakota Ambient Air Monitoring Annual Plan 2016.” South Dakota Department of Environment and Natural Resources. 2016. <http://denr.sd.gov/des/aq/aqnews/SD%20Annual%20plan%202016.pdf> (1 November 2017).

SDDOT. “South Dakota Interstate Corridor Study Phase I Summary Report.” Pierre, South Dakota: South Dakota Department of Transportation. December 2000. <http://www.sddot.com/resources/reports/Phase_I_Final_Report12_18.PDF> (1 November 2017).

Sharp, W.M. and A.B. Gibbons. “Geology and Uranium Deposits of the Southern Part of the Powder River Basin, Wyoming.” U.S. Geological Survey Bulletin No. 1147-D. Washington, DC: Government Printing Office. 1964.

Sonnenberg, S. and J. Taylor. “The Niobrara Petroleum System, Rocky Mountain Region (slide presentation).” Colorado School of Mines. 2017. <http://images.sdsmt.edu/learn/speakerpresentations/Sonnenberg.pdf> (1 November 2017).

STB. “Final Environmental Impact Statement, Finance Docket No. 33407—Dakota, Minnesota & Eastern Railroad Corporation, Construction into the Powder River Basin, Powder River Basin Expansion Project.” ML12243A381. Washington, DC: Surface Transportation Board, Section of Environmental Analysis. 2001.

Taylor, R.L., D.E. Naugle, and L.S. Mills. “Viability Analyses for Conservation of Sage-Grouse Populations: Buffalo Field Office, Wyoming, Final Report.” Missoula, Montana: University of Montana. 2012. <http://www.powderriverbasin.org/assets/Uploads/files/cbm-studies/PVA-Sage-Grouse-FinalReport.pdf> (1 November 2017).

Teton Exploration Drilling Company, Inc. (Teton). “Environmental Report for U.S. Nuclear Regulatory Commission, Source Material License Application, Uranium *In Situ* Leaching, Leuenberger Site, Converse County, Wyoming.” Docket No. 40-8781. ADAMS Legacy Accession No. 8201210086. Casper, Wyoming: Teton Exploration Drilling Company, Inc. 1980.

Trihydro Corporation. “Platte River Basin Water Plan Final Report.” Laramie, Wyoming: Trihydro Corporation. 2006. <http://waterplan.state.wy.us/plan/platte/2006/finalrept/Final_report.pdf> (1 November 2017).

True, J.B. “The State of Wyoming, Certificate of Appropriation of Water.” State Board of Control Certificate Record No. 39. Reservoir Permit No. 1556. January 1919.

Uranerz. “Nichols Ranch ISR Project. U.S. N.R.C Source Material SUA–1597 Jane Dough Amendment Volume IV: Environmental Report.” ML14164A323. Casper, Wyoming: Uranerz Energy Corporation. 2014.

Uranium One. “Re: Waste Issues.” Email (May 12) D. Wichers, Senior Vice President, *In-Situ* Recovery Operations to Shroff, Behram. ML101330405. Casper, Wyoming: Uranium One Americas. 2010.

Uranium One. Letter from J. Winter, Uranium One Americas, Inc., to John Buckley, NRC, dated February 11, 2011, RE: Submittal of Supplemental Information on Uranium One Americas, Inc. Ludeman Uranium ISR Project. ML110600403. Casper, Wyoming: Uranium One Americas. 2011a.

Uranium One. Letter from J. Winter, Uranium One Americas to NRC, dated December 3, 2011, RE: Submittal of Amendment Application to Source Material License SUA–1341 and supporting Technical and Environmental Reports for the Ludeman Project.” ML12010A178, Package No. ML120120182. Casper, Wyoming: Uranium One Americas. 2011b.

Uranium One. Letter from J. Winter, Uranium One Americas, Inc., to John Buckley, NRC, dated May 1, 2012, RE: SUA–1341 License Amendment Application for the Ludeman ISR Project Submittal of Responses to NRC Request for Additional Information Identified in Amendment Application Acceptance Review.” ML12128A244. Converse County, Wyoming. Casper, Wyoming: Uranium One Americas. 2012.

Uranium One. Letter from J. Winter, Uranium One Americas, Inc., to John Buckley, NRC, dated April 10, 2013, RE: Modifications to Uranium One Americas’ License Amendment Request for the Ludeman *In-Situ* Uranium Recovery Facility, Converse County.” Wyoming Docket No. 04008502. ML13106A238. Casper, Wyoming: Uranium One Americas. 2013a.

Uranium One. Letter from J. Winter, Uranium One Americas, Inc. to John Buckley, NRC, dated June 24, 2013, RE: Uranium One Request for Additional Information (RAI) response package for the Ludeman *In-Situ* Uranium Recovery Facility, Converse County.” Wyoming Docket No. 04008502 Amendment Application to SUA–1341. ML13191A248. Package No. ML131910354. Casper, Wyoming: Uranium One Americas. 2013b.

Uranium One. Letter from J. Winter, Uranium One Americas, Inc., to John Buckley, NRC, dated November 4, 2013, RE: Uranium One Response to August 8, 2013 Letter Suspending Review of the License Amendment Request for the Ludeman Project Docket No. 04008502 Amendment Application to SUA–1341.” ML13324A732, Package No. ML13324A599. Casper, Wyoming: Uranium One Americas. 2013c.

Uranium One. Letter from J. Winter, Uranium One Americas, Inc., to Elise Striz, NRC, dated March 13, 2014, RE: Response to the NRC Letter Dated December 23, 2013 Addressing Information Needed to Address the Requirements of 10 CFR 40.44 (RAI#1).” Ludeman Project-Docket No. 04008502 Amendment Application for SUA–1341. ML14079A127. Casper, Wyoming: Uranium One Americas. 2014.

Uranium One. Letter from S. Schierman, Uranium One USA to Elise Striz, NRC, dated June 8, 2015, RE: Request for Additional Information Responses for SUA–1341 License Amendment Application.” ML15170A372, Package No. ML15170A384. Casper, Wyoming: Uranium One Americas. 2015a.

Uranium One. “Uranium One USA–Technical Report, Request for Additional Information Response Package: Round 2, June 8, 2015.” ML15170A389. (Part of above package but separated to point to Negley Subdivision Analysis). Casper, Wyoming: Uranium One Americas. 2015b.

Uranium One. Letter from S. Schierman, Uranium One USA, to Elise Striz, NRC, dated March 3, 2016, RE: PM to PM Request for Additional Information for SUA–1341 License Amendment Application.” ML16077A100. Casper, Wyoming: Uranium One Americas. 2016a.

Uranium One. Letter from S. Schierman, Uranium One USA, to Elise Striz, NRC, dated April 19, 2016, RE: SUA–1341 License Amendment Application, License Application Open/Confirmatory Item Responses.” ML16133A299. Casper, Wyoming: Uranium One Americas. 2016b.

Uranium One. “Revised Response to NRC Meteorology and Air Quality Information Requests for the Ludeman ISR Project.” ML17059D016. Casper, Wyoming: Uranium One Americas. September 2016c.

Uranium One. “E-mail from S. Schierman, Uranium One USA., to E. Striz and K. Jamerson, NRC, dated Feb 22, 2017, RE: Ludeman Baseline Met Data.” ML17059C720 and attachment ML17059C724. Casper, Wyoming: Uranium One Americas. 2017a.

Uranium One. “E-mail from S. Schierman, Uranium One USA., to E. Striz, K. Jamerson, NRC, dated Feb 22, 2017, RE: Referenced Documents.” ML17059D007. Casper, Wyoming: Uranium One Americas. 2017b.

Uranium One. “Letter from S. Schierman, Uranium One USA, to Elise Striz, NRC, dated April 13, 2017, RE: Response to February 22, 2017 Public Meeting Comments for Ludeman SUA–1341 License Amendment.” ML17109A249. Casper, Wyoming: Uranium One Americas. 2017c.

Uranium One. “Letter from S. Schierman, Uranium One USA, to Elise Striz, NRC, dated June 28, 2017, RE: SUA–1341 License Amendment Application-Revised Technical Report.” ML17192A359, Package ML17192A357. Casper, Wyoming: Uranium One Americas. 2017d.

Uranium One. “Letter from S. Schierman, Uranium One USA, to Elise Striz, NRC, dated August 31 2017, RE: SUA–1341 License Amendment Application–Revised Environmental Report.” ML17261A460. Casper, Wyoming: Uranium One Americas. 2017e.

Uranium One. “Our Operations.” Casper, Wyoming: Uranium One Americas Inc. 2017f. <http://www.uranium1.com/our-operations> (9 November 2017).

USACE. “Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region.” ERDC/EL TR–08–12. Vicksburg, Mississippi: U.S. Army Corps of Engineers Engineer Research and Development Center. 2008. <http://www.dtic.mil/docs/citations/ADA479138> (1 November 2017).

USCB. “American Fact Finder.” Washington, DC: U.S. Census Bureau. 2017. <http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml> (1 November 2017).

USDA. “Soil Survey Manual.” U.S. Department of Agriculture Handbook 18. Washington DC: U.S. Department of Agriculture. 1993. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/tools/?cid=nrcs142p2_054262> (1 November 2017).

USDA. “Selenium-Accumulating Plants.” Washington, DC: U.S. Department of Agriculture. 2006. <http://www.ars.usda.gov/Main/docs.htm?docid=9979> (1 November 2017).

USDA. “Census of Agriculture, County Profile, Converse County, Wyoming.” Washington, DC: U.S. Department of Agriculture, National Agricultural Statistics Service. 2012. <https://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/Wyoming/cp56009.pdf> (1 November 2017).

USGS. “Radioactive Elements in Coal and Fly Ash: Abundance, Forms, and Environmental Significance.” Fact Sheet FS-163-97. Reston, Virginia: U.S. Geological Survey. 1997. <pubs.usgs.gov/fs/1997/fs163-97/FS-163-97.html> (1 November 2017).

USGS. “2010-2011 Minerals Yearbook.” Reston, Virginia: U.S. Geological Survey. June 2015. <https://minerals.usgs.gov/minerals/pubs/state/2010_11/myb2-2010_11-wy.pdf> (1 November 2017).

WDAI. “Population for Wyoming, Counties, Cities, and Towns: 2010 to 2030.” Cheyenne, Wyoming: Wyoming Department of Administration and Information. 2011. <http://eadiv.state.wy.us/pop/wyc&sc30.htm> (1 November 2017).

WDAI. “Population, Employment, Earnings, and Personal Income Trends.” Cheyenne, Wyoming: Wyoming Department of Administration and Information. 2015. <http://eadiv.state.wy.us/wef/eps.html> (11 November 2017).

WDEQ. “Guideline No. 1, Topsoil and Overburden.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Land Quality Division. 1994a. <http://deq.wyoming.gov/media/attachments/Land%20Quality/Guidelines/Guideline_1_Topsoil_(8_1994)_reformat.pdf> (14 December 2015).

WDEQ. “Guideline No. 10, Fencing.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Land Quality Division. 1994b.

WDEQ. “Noncoal Rules and Regulations, Chapter 3–Noncoal Mine Environmental Performance Standards.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality Land Quality Division. April 2006.

WDEQ. “Air Quality Division Chapter 6, Section 3, Operating Permit, Wyoming Department of Environmental Quality Air Quality Division.” Permit No. 3-2-148. Cheyenne, Wyoming: Wyoming Department of Environmental Quality. September 2008. <http://deq.wyoming.gov/media/attachments/Air%20Quality/Title%20V/Permits%20Issued/aqd-permitting-titlev_pacificorp-dave-johnston-final-permit-3-2-148_2008-0902.pdf> (1 November 2017).

WDEQ. “Water Quality, Chapter 26–Well Construction Standards.” Rules and Regulations, Water Quality Program. Cheyenne, Wyoming: Wyoming Department of Environmental Quality Water Quality Division. July 2012a.

WDEQ. “Coal Rules and Regulations, Chapter 4–Environmental Performance Standards for Surface Coal Mining Operations.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality Land Quality Division. December 2012b.

WDEQ. “Land Quality, Non Coal, Chapter 11–*In Situ* Mining.” Rules and Regulations, Land Quality Program. Cheyenne, Wyoming: Wyoming Department of Environmental Quality Land Quality Division. July 2013a.

WDEQ. “Wyoming Surface Water Classification List.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Water Quality Division. Updated July 26, 2013b.

WDEQ. “Vegetation Requirements for Exploration by Dozing, Regular Mines and *In Situ* Leaching, Guideline No. 2.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Land Quality Division. June 4, 2014. <http://deq.wyoming.gov/media/attachments/Land%20Quality/Guidelines/Guidelines-02_Vegetation_Guide-2.pdf> (8 November 2017).

WDEQ. “Permit Regulations for Discharges to Wyoming Surface Waters.” Rules and Regulations, Water Quality Program, Chapter 2. Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Water Quality Division. March 2015a.

WDEQ. “Guideline No. 8, Hydrology, Coal and Noncoal.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Land Quality Division. May 2015b. <http://deq.wyoming.gov/media/attachments/Land%20Quality/Guidelines/Guidelines-08_Hydrology-Coal-and%20Noncoal-Guide-8.pdf> (8 November 2017).

WDEQ. “Underground Injection Control Program Class I and V Wells.” Rules and Regulations, Water Quality Program.” Chapter 27. Cheyenne, Wyoming: Wyoming Department of Environmental Quality. September 2015c.

WDEQ. “TFN 5 5/149; Uranium One USA, Inc. (UI), Ludeman In Situ Uranium Permit Application, T5 Review.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality. February 24, 2016a.

WDEQ. “Wyoming Department of Environmental Quality: Air Quality Division: Standards and Regulations: Ambient Standards: Chapter 2.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Air Quality Division. December 2016b. <http://deq.wyoming.gov/media/attachments/Air%20Quality/Rule%20Development/Proposed%20Rules%20and%20Regulations/AQD_Rule-Development_Chapter-2-Ambient-Standards-IBR-draft_03-18-15-Clean.pdf> (9 October 2017).

WDEQ. “Reno Junction Wind Energy Project.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality. 2017a. <http://deq.wyoming.gov/isd/application-permits/resources/reno-junction-wind-energy-project/> (1 November 2017).

WDEQ. “Pioneer Parks I and II.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality. 2017b. <http://deq.wyoming.gov/isd/application-permits/resources/pioneer-parks-i-ii/> (4 November 2017).

WDEQ. “Wyoming Ambient Air Monitoring Annual Network Plan 2017.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality. 2017c. <http://deq.wyoming.gov/media/attachments/Air%20Quality/Monitoring/Annual%20Network%20Plans/2017_Network_Plan_FINAL.pdf> (5 October 2017).

WDEQ. “Air Quality, Chapter 6–Permitting Requirements.” Rules and Regulations, Air Quality Program. Cheyenne, Wyoming: Wyoming Department of Environmental Quality Air Quality Division. February 2018a.

WDEQ. “Guideline No. 4–*In-Situ* Mining, Attachment III Topsoil and Subsoil Management and the Associated Erosion Control at Uranium *In-Situ* Leaching Operations.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality. March 2018b.

WDEQ. “Wyoming’s Draft 2016/2018 Integrated 305(b) and 303(d) Report.” Cheyenne, Wyoming: Wyoming Department of Environmental Quality, Water Quality Division. March 2018c. <http://deq.wyoming.gov/media/attachments/Water%20Quality/Water%20Quality%20Assessment/Reports/2016-2018_Proposed-Draft-Integrated-305B-and-303D-Report.pdf> (18 April 2018).

WDEQ. Letter from D. Waterstreet, Wyoming Department of Environmental Quality Watershed Protection Program, to A. Waldron, NRC, RE: Ludeman ISR EA. Cheyenne, Wyoming: Wyoming Department of Environmental Quality. ML18101A500. April 2, 2018d.

WDEQ. Letter from J. Powell, Wyoming Department of Environmental Quality, to A. Waldron, NRC, RE: Review of the Draft Environmental Assessment for the Uranium One USA, Inc. Proposed Ludeman *In Situ* Uranium Mining Project in Converse County Wyoming. Cheyenne, Wyoming: Wyoming Department of Environmental Quality. ML18108A193. April 13, 2018e.

WDOR. “State of Wyoming Department of Revenue 2015 Annual Report.” Cheyenne, Wyoming: Wyoming Department of Revenue. 2015. <https://0ebaeb71-a-84cef9ff-s-sites.googlegroups.com/a/wyo.gov/wy-dor/2015AnnualReport.pdf?attachauth=ANoY7coVzMmurtaqn2yftHSIsTBN8cKgQ9wGFgqWA4mZTg0_fTfA7-qQLPCEgXX1GfSx0cIHjVLO4fch7xxwxwUnsEZTKNHmLJxv53iFPBKn9rJWn8B8E32kxbsCLNqaqLtZTQpWb3G9IqwBsyayaN8FJ_MiJ3aaM0DxQScjwU22RjjBQPrRcTZCKwcWgmyxx_z3Le2Dgk1-oeq_epq0ZlVtJd-Kvo-Ybw%3D%3D&attredirects=0> (1 November 2017).

Weimer, R. “Spatial Dimensions of Upper Cretaceous Sandstones, Rocky Mountain Area.” *Geometry of Sandstone Bodies*. pp. 82–97. Tulsa, Oklahoma: American Association of Petroleum Geologists. 1961.

WGFD. “Fencing Guidelines for Wildlife.” Revised Version, Habitat Extension Bulletin No. 53. Sheridan, Wyoming: Wyoming Game and Fish Department. 2004. <https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Extension%20Bulletins/B53-Fencing-Guidelines-for-Wildlife.pdf> (11 September 2017).

WGFD. “SG Lek Observations 1948-2016.” Non-public. Sheridan, Wyoming: Wyoming Game and Fish Department. 2016.

WGFD. “2017 Wildlife Action Plan.” Sheridan, Wyoming: Wyoming Game and Fish Department. 2017.

Whitcomb, H.A., T.R. Cummings, and R.A. McCullough. “Ground-Water Resources and Geology of Northern and Central Johnson County, Wyoming.” Water Supply Paper 1806. Washington, DC: Government Printing Office. 1966.

Whitehead, R.L. “Groundwater Atlas of the United States—Segment 8, Montana, North Dakota, South Dakota, Wyoming.” U.S. Geological Survey, Hydrologic Investigations Atlas 730-I. Reston, Virginia: U.S. Geological Survey. 1996.

WMA. “The 2014–2015 Concise Guide to Wyoming Coal.” Cheyenne, Wyoming: Wyoming Mining Association. 2015a. <http://www.wyomingmining.org/wp-content/uploads/2014/09/2014-15-Concise-Guide-to-Wyoming-Coal.pdf> (1 November 2017).

WMA. “Recent News: Bentonite.” Cheyenne, Wyoming: Wyoming Mining Association. 2015b. <http://www.wyomingmining.org/minerals/bentonite/> (1 November 2017).

WMA. “2016 Wyoming Coal Overview.” Cheyenne, Wyoming: Wyoming Mining Association. 2016. <http://www.wyomingmining.org/wp-content/uploads/2013/10/2016-WCIC-Wyoming-Coal-Overview_FINAL.pdf> (2 November 2017).

WOGCC. “Report to the Joint Minerals, Business and Economic Development Committee.” Casper, Wyoming: Wyoming Oil and Gas Conservation Commission. 2015. <http://legisweb.state.wy.us/InterimCommittee/2015/09-1022APPENDIXJ.PDF> (9 October 2017).

WOGCC. “Statistics for Converse County.” Casper Wyoming: Wyoming Oil and Gas Conservation Commission. 2017. <http://wogcc.state.wy.us/StatsForCounty2.cfm?oops=1> (9 October 2017).

WSGS. “Wyoming’s Oil and Gas Resources, Summary Report.” Laramie, Wyoming: Wyoming State Geologic Survey. 2015. <http://www.wsgs.wyo.gov/products/wsgs-2015-oilgas-summary.pdf> (1 November 2017).

WSGS. “Powder River Basin: Oil and Gas Geology, Past Production, and Future Development.” Laramie, Wyoming: Wyoming State Geologic Survey. January 2017a. <http://www.wsgs.wyo.gov/docs/wsgs-web-powder-river-basin.pdf> (1 November 2017).

WSGS. “Petroleum & Other Liquid.” Laramie, Wyoming: Wyoming State Geologic Survey. October 2017b. <https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm> (1 November 2017).

WYDOT. “Statewide Freight Plan Wyoming.” Cheyenne, Wyoming: Wyoming Department of Transportation. September 2015. <http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Planning/Freight%20Plan/WyomingSFPW-Addenda2017-Web.pdf> (23 October 2017).

WYDOT. “Interactive Transportation System Map.” Cheyenne, Wyoming: Wyoming Department of Transportation. 2016. <apps.wyoroad.info/itsm/map.html> (1 November 2017).

Wyoming Office of State Lands and Investments. “Wyoming Biomass Inventory: Animal Waste, Crop Residue, Wood Residue, and Municipal Solid Waste.” Cheyenne, Wyoming: Office of State Lands and Investments, Wyoming State Forestry Division. 2007.

Wyoming State Engineer’s Office (WSEO). “RE: *In-Situ* Recovery Extraction Wells – Ludeman Project Area.” Letter from Matthew J. Hoobler, Wyoming State Engineer’s Office to Scott Schierman, Uranium One. Cheyenne, Wyoming. November 2015.

Wyoming Water Division No. 1, District No. 16. “Proof of Appropriation of Water.” State Board of Control, Reservoir Permit No. 1556. March 1918.

Wyoming Weed and Pest Council. “Wyoming Weed & Pest Control Act State Designated Weed List.” Gillette, Wyoming: Wyoming Weed & Pest Council. 2017. <https://www.wyoweed.org/weeds/state-designated-weeds> (10 October 2017).

WY SHPO. Letter from R. Currit, to C. Román, NRC, RE: Uranium One, Inc., Ludeman In Situ Uranium Recovery Satellite Project. Determination of Eligibility for Properties within the Direct Area of Potential Effect (Docket Number 40-8502) (SHPO File #0518RLC004). ML18149A524. Cheyenne, Wyoming: Wyoming State Historic Preservation Office. May 23, 2018a.

WY SHPO. Letter from R. Currit, to C. Román, NRC, RE: Uranium One, Ludeman Satellite Determination of Effects (Source Material License Number SUA–1341) (SHPO File #0518RLC004). ML18205A319. Cheyenne, Wyoming: Wyoming State Historic Preservation Office. July 17, 2018b.

APPENDIX A

CONSULTATION CORRESPONDENCE

APPENDIX A CONSULTATION CORRESPONDENCE

A.1 Consultation Correspondence

The Endangered Species Act of 1973, as amended, and the National Historic Preservation Act of 1966 require that federal agencies consult with applicable state and federal agencies and groups prior to taking action that may affect threatened and endangered species, essential fish habitat, or historic and archaeological resources. Additional information regarding consultations with the U.S. Fish and Wildlife is provided in EA Section 7.2. Additional information regarding consultations with tribes is provided in EA Section 3.8.2. This appendix contains consultation documentation related to these federal acts.

Table A–1. Chronology of Consultation Correspondence

Author	Recipient	Date of Letter	ADAMS Accession Number
U.S. Nuclear Regulatory Commission (L. Camper)	Fort Belknap Community Council (T. King)	July 30, 2012	ML12138A247
U.S. Nuclear Regulatory Commission (L. Camper)	Cheyenne River Sioux Tribe (K. Keckler)	August 8, 2012	ML12219A109
U.S. Nuclear Regulatory Commission (L. Camper)	Chippewa Cree Tribe (B. Sun Child)	August 8, 2012	ML12219A118
U.S. Nuclear Regulatory Commission (L. Camper)	Flandreau-Santee Sioux Tribe (A. Reider)	August 8, 2012	ML12219A236
U.S. Nuclear Regulatory Commission (L. Camper)	Kiowa Indian Tribe of Oklahoma (R. Twohatchet)	August 8, 2012	ML12219A277
U.S. Nuclear Regulatory Commission (L. Camper)	Lower Brule Sioux Tribe (M. Jandreau)	August 8, 2012	ML12219A287
U.S. Nuclear Regulatory Commission (L. Camper)	Crow Tribe (C. Black Eagle)	August 8, 2012	ML12219A124
U.S. Nuclear Regulatory Commission (L. Camper)	Crow Creek Sioux Tribe (B. Sauze)	August 8, 2012	ML12219A173
U.S. Nuclear Regulatory Commission (L. Camper)	Standing Rock Sioux Tribe (C. Murphy)	August 8, 2012	ML12220A026
U.S. Nuclear Regulatory Commission (L. Camper)	Northern Arapaho (J. Shakespeare)	August 8, 2012	ML12219A311
U.S. Nuclear Regulatory Commission (L. Camper)	Rosebud Sioux Tribe (R. Bordeaux)	August 8, 2012	ML12219A320
U.S. Nuclear Regulatory Commission (L. Camper)	Fort Peck Tribes (A.T. Stafne)	August 8, 2012	ML12219A246
U.S. Nuclear Regulatory Commission (L. Camper)	Eastern Shoshone Tribe (M. LaJeunesse)	August 8, 2012	ML12219A147
U.S. Nuclear Regulatory Commission (L. Camper)	Santee Sioux Tribe of Nebraska (R. Trudell)	August 8, 2012	ML12219A345
U.S. Nuclear Regulatory Commission (L. Camper)	Sisseton-Wahpeton Tribe (R. Shephard)	August 8, 2012	ML12219A369
U.S. Nuclear Regulatory Commission (L. Camper)	Cheyenne and Arapaho Tribes (J. Prairie Chief-Boswell)	August 8, 2012	ML12219A078
U.S. Nuclear Regulatory Commission (L. Camper)	Spirit Lake Tribe (R. Yankton)	August 8, 2012	ML12219A379
U.S. Nuclear Regulatory Commission (L. Camper)	Oglala Sioux Tribe (J. Yellow Bird Steele)	August 8, 2012	ML12219A346

Table A–1. Chronology of Consultation Correspondence (Continued)			
Author	**Recipient**	**Date of Letter**	**ADAMS Accession Number**
U.S. Nuclear Regulatory Commission (L. Camper)	Northern Cheyenne Tribe (L. Spang)	August 8, 2012	ML12219A327
U.S. Nuclear Regulatory Commission (L. Camper)	Mandan, Hidatsa & Arikara Nation Three Affiliated Tribes (G. Tex Hall)	August 8, 2012	ML12220A035
U.S. Nuclear Regulatory Commission (L. Camper)	Yankton Sioux Tribe (T. Cournoyer)	August 8, 2012	ML12220A085
U.S. Nuclear Regulatory Commission (L. Camper)	Turtle Mountain Chippewa Tribe (M. St. Claire)	August 8, 2012	ML12220A048
U.S. Nuclear Regulatory Commission (L. Camper)	Pawnee Nation of Oklahoma (M. Gover)	March 12, 2013	ML13071A676
U.S. Nuclear Regulatory Commission (L. Camper)	Ponca Tribe of Nebraska (R. White)	March 12, 2013	ML13072A041
U.S. Nuclear Regulatory Commission (L. Camper)	Sisseton-Wahpeton Oyate Tribes (R. Shepherd)	March 12, 2013	ML13072A128
U.S. Nuclear Regulatory Commission (L. Camper)	Northern Cheyenne Tribe (J. Robinson)	March 12, 2013	ML13071A645
U.S. Nuclear Regulatory Commission (L. Camper)	Mandan, Hidatsa & Arikara Nation Three Affiliated Tribes (G. Tex Hall)	March 12, 2013	ML13072A154
U.S. Nuclear Regulatory Commission (L. Camper)	Lower Brule Sioux Tribe (M. Jandreau)	March 12, 2013	ML13072A280
U.S. Nuclear Regulatory Commission (L. Camper)	Kiowa Indian Tribe of Oklahoma (A. Poppah)	March 12, 2013	ML13072A203
U.S. Nuclear Regulatory Commission (L. Camper)	Cheyenne and Arapaho Tribes (J. Chief-Boswell)	March 12, 2013	ML13072A006
U.S. Nuclear Regulatory Commission (L. Camper)	Comanche Nation Tribe (W. Coffey)	March 12, 2013	ML13072040
U.S. Nuclear Regulatory Commission (L. Camper)	Flandreau-Santee Sioux Tribe (A. Reider)	March 12, 2013	ML13072A147
U.S. Nuclear Regulatory Commission (L. Camper)	Oglala Sioux Tribe (B. Brewer)	March 12, 2013	ML13071A653
U.S. Nuclear Regulatory Commission (L. Camper)	Eastern Shoshone Tribe (D. Sinclair)	March 12, 2013	ML13072A131
U.S. Nuclear Regulatory Commission (L. Camper)	Chippewa Cree Tribe (K. Blatt)	March 12, 2013	ML13072A035
U.S. Nuclear Regulatory Commission (L. Camper)	Cheyenne River Sioux Tribe (K. Keckler)	March 12, 2013	ML13052A578
U.S. Nuclear Regulatory Commission (L. Camper)	Turtle Mountain Band of Chippewa (R. McCloud)	March 12, 2013	ML13072A174
U.S. Nuclear Regulatory Commission (L. Camper)	Crow Tribe (D. Coyote)	March 12, 2013	ML13072A103
U.S. Nuclear Regulatory Commission (L. Camper)	Fort Belknap Tribe (T. King)	March 12, 2013	ML13072A162
U.S. Nuclear Regulatory Commission (L. Camper)	Shoshone-Bannock Tribes (N. Small)	March 12, 2013	ML10372A117
U.S. Nuclear Regulatory Commission (L. Camper)	Northern Arapaho Tribe (D. O'Neal, Sr.)	March 12, 2013	ML13071A636
U.S. Nuclear Regulatory Commission (L. Camper)	Confederated Salish & Kootenai Tribe (J. Durglo)	March 12, 2013	ML13072A062

Table A–1. Chronology of Consultation Correspondence (Continued)			
Author	**Recipient**	**Date of Letter**	**ADAMS Accession Number**
U.S. Nuclear Regulatory Commission (L. Camper)	Lower Sioux Tribe (D. Prescott)	March 12, 2013	ML13072A359
U.S. Nuclear Regulatory Commission (L. Camper)	Standing Rock Sioux Tribe (C. Murphy)	March 12, 2013	ML13072A137
U.S. Nuclear Regulatory Commission (L. Camper)	Blackfeet Tribe (W. Sharp, Jr.)	March 12, 2013	ML13071A668
U.S. Nuclear Regulatory Commission (L. Camper)	Santee Sioux Tribe of Nebraska (R. Trudell)	March 12, 2013	ML13072A107
U.S. Nuclear Regulatory Commission (L. Camper)	Spirit Lake Tribe (R. Yankton, Sr.)	March 12, 2013	ML13072A133
U.S. Nuclear Regulatory Commission (L. Camper)	Omaha Tribe of Nebraska (A. Sheridan)	March 12, 2013	ML13071A664
U.S. Nuclear Regulatory Commission (L. Camper)	Rosebud Sioux Tribe (C. Scott)	March 12, 2013	ML13072A065
U.S. Nuclear Regulatory Commission (L. Camper)	Crow Creek Sioux Tribe (B. Sazue, Sr.)	March 12, 2013	ML13072A119
U.S. Nuclear Regulatory Commission (L. Camper)	Apache Tribe of Oklahoma (D. Cabniss)	March 12, 2013	ML13071A646
U.S. Nuclear Regulatory Commission (L. Camper)	Fort Peck Tribes (F. Azure)	March 12, 2013	ML13072A179
U.S. Nuclear Regulatory Commission (L. Camper)	The Ute Tribe of the Uintah and Ouray Reservation (I. Cuch)	March 12, 2013	ML13072A195
U.S. Nuclear Regulatory Commission (L. Camper)	Yankton Sioux Tribe (T. Cournoyer, Sr.)	March 12, 2013	ML13072A269
Oglala Sioux Tribe (B. Brewer)	U.S. Nuclear Regulatory Commission (L. Camper)	March 29, 2013	ML13106A197
U.S. Nuclear Regulatory Commission (L. Camper)	Mandan, Hidatsa & Arikara Nation Three Affiliated Tribes (G. Tex Hall)	May 1, 2013	ML13122A142
U.S. Nuclear Regulatory Commission (L. Camper)	Santee Sioux Tribe of Nebraska (R. Trudell)	May 1, 2013	ML13114A794
U.S. Nuclear Regulatory Commission (L. Camper)	Turtle Mountain Band of Chippewa (R. McCloud)	May 1, 2013	ML13122A149
U.S. Nuclear Regulatory Commission (L. Camper)	Northern Arapaho Tribe (D. O'Neal, Sr.)	May 1, 2013	ML13122A030
U.S. Nuclear Regulatory Commission (L. Camper)	Crow Creek Sioux Tribe (B. Sazue, Sr.)	May 1, 2013	ML13123A138
U.S. Nuclear Regulatory Commission (L. Camper)	Comanche Nation Tribe (W. Coffey)	May 1, 2013	ML13122A437
U.S. Nuclear Regulatory Commission (L. Camper)	Eastern Shoshone Tribe (D. Sinclair, Jr.)	May 1, 2013	ML13123A146
U.S. Nuclear Regulatory Commission (L. Camper)	Yankton Sioux Tribe (T. Cournoyer, Sr.)	May 1, 2013	ML13122A193
U.S. Nuclear Regulatory Commission (L. Camper)	Apache Tribe of Oklahoma (D. Cabniss)	May 1, 2013	ML13122A054
U.S. Nuclear Regulatory Commission (L. Camper)	Oglala Sioux Tribe (B. Brewer)	May 1, 2013	ML13122A044
U.S. Nuclear Regulatory Commission (L. Camper)	Blackfeet Tribe (W.A. Sharp, Jr.)	May 1, 2013	ML13122A076
U.S. Nuclear Regulatory Commission (L. Camper)	Kiowa Indian Tribe of Oklahoma (A. Poppah)	May 1, 2013	ML13123A194

Table A–1. Chronology of Consultation Correspondence (Continued)			
Author	**Recipient**	**Date of Letter**	**ADAMS Accession Number**
U.S. Nuclear Regulatory Commission (L. Camper)	Fort Peck Tribes (F. Azure)	May 1, 2013	ML13123A183
U.S. Nuclear Regulatory Commission (L. Camper)	Cheyenne River Sioux Tribe (K. Keckler)	May 1, 2013	ML13122A311
U.S. Nuclear Regulatory Commission (L. Camper)	Flandreau-Santee Sioux Tribe (A. Reider)	May 1, 2013	ML13123A157
U.S. Nuclear Regulatory Commission (L. Camper)	Ponca Tribe of Nebraska (R. White)	May 1, 2013	ML13122A077
U.S. Nuclear Regulatory Commission (L. Camper)	Spirit Lake Tribe (R. Yankton, Sr.)	May 1, 2013	ML13122A121
U.S. Nuclear Regulatory Commission (L. Camper)	Pawnee Nation of Oklahoma (M. Gover)	May 1, 2013	ML13122A070
U.S. Nuclear Regulatory Commission (L. Camper)	Omaha Tribe of Nebraska (A. Sheridan)	May 1, 2013	ML13122A056
U.S. Nuclear Regulatory Commission (L. Camper)	Cheyenne and Arapaho Tribes (J. Chief-Boswell)	May 1, 2013	ML13122A297
U.S. Nuclear Regulatory Commission (L. Camper)	Rosebud Sioux Tribe (C. Scott)	May 1, 2013	ML13122A084
U.S. Nuclear Regulatory Commission (L. Camper)	Lower Brule Sioux Tribe (M. Jandreau)	May 1, 2013	ML13123A215
U.S. Nuclear Regulatory Commission (L. Camper)	Northern Cheyenne Tribe (J. Robinson)	May 1, 2013	ML13122A039
U.S. Nuclear Regulatory Commission (L. Camper)	Crow Tribe (D. Old Coyote)	May 1, 2013	ML13123A131
U.S. Nuclear Regulatory Commission (L. Camper)	The Ute Tribe of the Uintah and Ouray Reservation (I. Cuch)	May 1, 2013	ML13122A179
U.S. Nuclear Regulatory Commission (L. Camper)	Lower Sioux Tribe (D. Prescott)	May 1, 2013	ML13122A022
U.S. Nuclear Regulatory Commission (L. Camper)	Sisseton-Wahpeton Oyate Tribes (R. Shepherd)	May 1, 2013	ML13122A111
U.S. Nuclear Regulatory Commission (L. Camper)	Chippewa Cree Tribe (K. Blatt)	May 1, 2013	ML13122A429
U.S. Nuclear Regulatory Commission (L. Camper)	Confederated Salish & Kootenai Tribe (J. Durglo)	May 1, 2013	ML13123A117
U.S. Nuclear Regulatory Commission (L. Camper)	Standing Rock Sioux Tribe (C. Murphy)	May 1, 2013	ML13122A133
U.S. Nuclear Regulatory Commission (L. Camper)	Shoshone-Bannock Tribes (N. Small)	May 1, 2013	ML13122A094
U.S. Nuclear Regulatory Commission (L. Camper)	Fort Belknap Tribe (T. King)	May 1, 2013	ML13121A172
U.S. Nuclear Regulatory Commission (L. Camper)	Fort Peck Assiniboine/Sioux Tribe (D. Youpee)	June 5, 2015	ML15155B413
U.S. Nuclear Regulatory Commission (L. Chang)	Northern Cheyenne Tribe (J. Walksalong)	June 5, 2015	ML15156A442
U.S. Nuclear Regulatory Commission (L. Chang)	Three Affiliated Tribes (E. Crows Breast)	June 5, 2015	ML15156A500
U.S. Nuclear Regulatory Commission (L. Chang)	Cheyenne River Sioux Tribe (S. Vance)	June 5, 2015	ML15155B273
U.S. Nuclear Regulatory Commission (L. Chang)	Chippewa Cree Tribe (A. Windy Boy)	June 5, 2015	ML15155B294

Table A–1. Chronology of Consultation Correspondence (Continued)			
Author	**Recipient**	**Date of Letter**	**ADAMS Accession Number**
U.S. Nuclear Regulatory Commission (L. Chang)	Cheyenne and Arapaho Tribes (L. Gray)	June 5, 2015	ML15155B235
U.S. Nuclear Regulatory Commission (L. Chang)	Flandreau-Santee Sioux Tribe (J.B. Weston)	June 5, 2015	ML15155B403
U.S. Nuclear Regulatory Commission (L. Chang)	Turtle Mountain Band of Chippewa (B. Nadeau)	June 5, 2015	ML15156A512
U.S. Nuclear Regulatory Commission (L. Chang)	Northern Arapaho Tribe (Y. Soldier Wolf)	June 5, 2015	ML15155B433
U.S. Nuclear Regulatory Commission (L. Chang)	Oglala Sioux Tribe (M. Catches Enemy)	June 5, 2015	ML15135A048
U.S. Nuclear Regulatory Commission (L. Chang)	Kiowa of Oklahoma (A. Tah-bone)	June 5, 2015	ML15155B420
U.S. Nuclear Regulatory Commission (L. Chang)	Yankton Sioux Tribe (E. Chytka)	June 5, 2015	ML15156A586
U.S. Nuclear Regulatory Commission (L. Chang)	Fort Belknap Tribe (M. Belgarde)	June 5, 2015	ML15155B408
U.S. Nuclear Regulatory Commission (L. Chang)	Eastern Shoshone Tribe (W. Ferris)	June 5, 2015	ML15155B397
U.S. Nuclear Regulatory Commission (L. Chang)	Standing Rock Sioux (W. Young)	June 5, 2015	ML15156A486
U.S. Nuclear Regulatory Commission (L. Chang)	Rosebud Sioux Tribe (R. Eagle Bear)	June 5, 2015	ML15156A453
U.S. Nuclear Regulatory Commission (L. Chang)	Lower Brule Sioux Tribe (C. Green)	June 5, 2015	ML15155B426
U.S. Nuclear Regulatory Commission (L. Chang)	Santee Sioux Nation (R. Thomas)	June 5, 2015	ML15156A465
U.S. Nuclear Regulatory Commission (L. Chang)	Crow Creek Sioux Tribe (D. Zephier)	June 5, 2015	ML15155B310
U.S. Nuclear Regulatory Commission (L. Chang)	Oglala Sioux Tribe (M. Catches Enemy)	June 5, 2015	ML15155B284
U.S. Nuclear Regulatory Commission (L. Chang)	Apsaalooke (Crow) Nation (E. Bullchief)	June 5, 2015	ML15155B385
U.S. Nuclear Regulatory Commission (L. Chang)	Sisseton-Wahpeton Oyate Tribes (D. Desorosiers)	June 5, 2015	ML15160A424
U.S. Nuclear Regulatory Commission (L. Chang)	Wyoming State Historic Preservation Office (M. Hopkins)	December 3, 2015	ML15314A385
U.S. Nuclear Regulatory Commission (C. Román)	Wyoming State Historic Preservation Office (M. Hopkins)	September 1, 2017	ML17234A468
U.S. Nuclear Regulatory Commission (C. Román)	Sisseton-Wahpeton Oyate Tribes (D. Desorosiers)	September 19, 2017	ML17249A682
U.S. Nuclear Regulatory Commission (C. Román)	Rosebud Sioux Tribe (R. Eagle Bear)	September 19, 2017	ML17249A681
U.S. Nuclear Regulatory Commission (C. Román)	Fort Belknap Indian Community (M. Blackwolf)	September 19, 2017	ML17249A674
U.S. Nuclear Regulatory Commission (C. Román)	Kiowa Indian Tribe of Oklahoma (K. Poolaw)	September 19, 2017	ML17249A676
U.S. Nuclear Regulatory Commission (C. Román)	Cheyenne River Sioux (S. Vance)	September 19, 2017	ML17249A670
U.S. Nuclear Regulatory Commission (C. Román)	Northern Arapaho (Y. Soldier Wolf)	September 19, 2017	ML17249A678

Table A–1. Chronology of Consultation Correspondence (Continued)			
Author	**Recipient**	**Date of Letter**	**ADAMS Accession Number**
U.S. Nuclear Regulatory Commission (C. Román)	Fort Peck Tribes Assiniboine and Sioux Tribes (D. Youpee)	September 19, 2017	ML17249A675
U.S. Nuclear Regulatory Commission (C. Román)	Turtle Mountain Band of Chippewa (E. Nadeau)	September 19, 2017	ML17249A686
U.S. Nuclear Regulatory Commission (C. Román)	Eastern Shoshone Tribe (J. Mann)	September 19, 2017	ML17249A672
U.S. Nuclear Regulatory Commission (C. Román)	Spirit Lake Tribe (E. Longie)	September 19, 2017	ML17249A683
U.S. Nuclear Regulatory Commission (C. Román)	Three Affiliated Tribes (E. Crows Breast)	September 19, 2017	ML17249A685
Cheyenne and Arapaho Tribes (V. Richey)	U.S. Nuclear Regulatory Commission (A. Waldron)	November 3, 2017	ML17345A449
U.S. Nuclear Regulatory Commission (C. Román)	U.S. Fish and Wildlife Service (T. Abbott)	January 18, 2018	ML18018A872
U.S. Fish and Wildlife Service (T. Abbott)	U.S. Nuclear Regulatory Commission (C. Román)	January 29, 2018	ML18057A219
U.S. Nuclear Regulatory Commission (C. Román)	Wyoming Department of Environmental Quality (R. Jones)	February 27, 2018	ML18064A331
Wyoming Department of Environmental Quality, Water Quality Division (D. Waterstreet)	U.S. Nuclear Regulatory Commission (A. Waldron)	April 2, 2018	ML18101A500
U.S. Nuclear Regulatory Commission (C. Román)	Wyoming State Historic Preservation Office (M. Hopkins)	March 23, 2018	ML18065A866
Wyoming State Historic Preservation Office (R. Currit)	U.S. Nuclear Regulatory Commission (C. Román)	May 23, 2018	ML18149A524
Wyoming Department of Environmental Quality, Water Quality Division (J. Powell)	U.S. Nuclear Regulatory Commission (A. Waldron)	June 18, 2018	ML18108A193
U.S. Nuclear Regulatory Commission (C. Román)	Wyoming State Historic Preservation Office (M. Hopkins)	July 9, 2018	ML18187A322
Wyoming State Historic Preservation Office (R. Currit)	U.S. Nuclear Regulatory Commission (C. Román)	July 17, 2018	ML18205A319

APPENDIX B

AIR QUALITY

APPENDIX B—AIR QUALITY

This appendix consolidates and supplements information about estimated air emission levels for the proposed Ludeman In Situ Recovery (ISR) Satellite Project from two documents: "Revised Response to NRC Meteorology and Air Quality Information Requests for the Ludeman ISR Satellite Project" (Uranium One, 2016) and "Addendum to Revised Response to NRC Meteorology and Air Quality Information Requests for the Ludeman ISR Project" (Uranium One, 2017b). Additional details beyond this summary appendix are contained in those two documents. This appendix contains two sections: B–1 Air Emission Inventory and B–2 Air Dispersion Modeling.

B.1 Air Emission Inventory

This section describes Uranium One's estimated emission inventory for the proposed Ludeman ISR Satellite Project. This description includes five sections: (i) peak year emissions; (ii) ISR phase emissions; (iii) source category emissions (e.g., fugitive dust, mobile combustion, and stationary); (iv) mitigation; and (v) liquid waste management options.

B.1.1 Peak Year Emissions

Uranium One's estimated annual air emissions for the proposed Ludeman ISR Project from all sources over the life of the proposed project [using the preferred liquid waste disposal option; see Environmental Assessment (EA) Section 2.1.7] are provided in EA Table B–1. During the life of the proposed project, ISR phases overlap, or occur simultaneously. The peak year accounts for the time when activities associated with the different ISR phases occur simultaneously, and, therefore, represents the maximum air emissions the proposed project would generate in any one project year. Project year 5 is the peak year for all air quality pollutants, except for volatile organic compounds (VOCs), which peak in project year 1. Thus, to simplify the EA analysis, the project year 5 VOC emission estimate was replaced with the project year one VOC emission estimate (the maximum value). The primary source of the VOC emissions in project year 1 is attributed to pickup trucks that would primarily support facilities construction (Uranium One, 2016). EA Table B–2 contains the peak year air emission estimates for the Ludeman ISR Satellite Project, and, as explained in EA Section 4.7, the air emission estimates used in the Generic Environmental Impact Statement (GEIS) (NRC, 2009) and Reno Creek Supplemental Environmental Impact Statement (SEIS) analyses (NRC, 2016).

B.1.2 ISR Phase Emissions

The air quality analysis for this EA examines the estimated air emissions for each phase of the proposed ISR project as well as the peak year air emission estimates. EA Table B–3 presents the estimated air emissions by ISR phase. The U.S. Nuclear Regulatory Commission (NRC) staff determined ISR phase emissions by using emissions data listed for individual project years in combination with the project schedule, which identified active ISR phases for each proposed project year (see footnotes in EA Table B–3 for details). EA Table B–4 compares the estimated annual air emission levels for the various ISR phases to the estimated peak year air emission levels.

Table B–1. Estimated Annual Emissions in Short Tons* for the Proposed Ludeman ISR Satellite Project (Preferred Liquid Waste Disposal Option) from Fugitive, Mobile, and Stationary Sources

Pollutant	Project Year												
	1	2	3	4	5†	6	7	8	9	10	11	12	13
Carbon Dioxide	1,277	6,301	6,301	6,708	6,708	1,859	1,859	1,859	1,859	1,859	1,859	1,453	1,976
Carbon Monoxide	6.7	28.3	28.3	30.6	30.6	5.9	5.9	5.9	5.9	5.9	5.9	3.7	9.6
Hazardous Air Pollutants	0.5	2.3	2.3	2.4	2.4	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.8
Nitrogen Oxides	10.0	35.4	35.4	38.7	38.7	8.4	8.4	8.4	8.4	8.4	8.4	5.1	12.7
Particulate Matter $PM_{2.5}$	14.2	15.1	18.0	20.2	21.4	9.8	8.5	7.8	7.1	6.4	5.7	3.4	6.1
Particulate Matter PM_{10}	107.5	103.2	122.6	138.6	146.6	69.0	59.9	55.3	50.8	46.2	41.7	24.5	41.2
Sulfur Dioxide	1.3	9.3	9.3	9.9	9.9	1.6	1.6	1.6	1.6	1.6	1.6	1.0	3.1
Volatile Organic Compounds	29.4	20.5	20.5	23.1	23.1	7.5	7.5	7.5	7.5	7.5	7.5	4.8	7.4

Source: Uranium One, 2016; Uranium One, 2017b

*Appendix table mass expressed in English units only (dual units used in EA text with metric being primary). To convert short tons to metric tons, multiply by 0.907.

†Peak year is project year 5 for all pollutants except volatile organic compounds where peak year is project year 1.

Table B–2. Estimated Annual Emissions in Short Tons* Used for the Ludeman EA, Reno Creek SEIS, and GEIS Analyses

Analysis	Pollutant							
	Carbon Dioxide	Carbon Monoxide	Hazardous Air Pollutants	Nitrogen Oxides	Particulate Matter $PM_{2.5}$	Particulate Matter PM_{10}	Sulfur Dioxide	Volatile Organic Compounds
Ludeman EA†	6,708	30.6	2.4	38.7	21.4	146.6	9.9	30.0
Reno Creek SEIS†	45,987	43.0	1.9	44.8	14.1	115.3	6.8	26.7
GEIS‡	Not available	70.2	Not available	84.0	1.1	11.0	7.0	10.8

Sources: Uranium One, 2016; Uranium One, 2017b; NRC, 2016; NRC, 2009

*Appendix table mass expressed in English units only (dual units used in EA text with metric being primary). To convert short tons to metric tons, multiply by 0.907.

†Peak year emission estimates as described in EA Appendix B Section B–1.1.

‡Construction phase emission estimates. Particulate emission estimate not specified as $PM_{2.5}$ or PM_{10}. The NRC staff conservatively assumed that the GEIS value was exclusively PM_{10}, and following the example in the Revised Response to NRC Meteorology and Air Quality Information Requests for the Ludeman ISR Project (Uranium One, 2016) estimated that the $PM_{2.5}$ emissions were 10 percent of the PM_{10} emissions.

Table B–3. Estimated Annual Emissions in Short Tons* for Each ISR Phase at the Proposed Ludeman ISR Satellite Project

Pollutant	ISR Phase			
	Construction†	Operation‡	Aquifer Restoration§	Decommissioning‖
Carbon Dioxide	4,848	1,453	406	1,976
Carbon Monoxide	24.6	3.7	2.2	9.6
Hazardous Air Pollutants	2.0	0.3	0.2	0.8
Nitrogen Oxides	30.3	5.1	3.3	12.7
Particulate Matter $PM_{2.5}$	11.7	3.4	2.3	6.1
Particulate Matter PM_{10}	78.7	24.5	17.2	41.2
Sulfur Dioxide	8.3	1.0	0.6	3.1
Volatile Organic Compounds	15.7	4.8	2.7	7.4

Source: Uranium One, 2016; Uranium One, 2017b

*Appendix table mass expressed in English units only (dual units used in EA text with metric being primary). To convert short tons to metric tons, multiply by 0.907.

†Construction phase emission estimates are calculated by subtracting project year 12 estimates (only operation phase active) from project year 2 estimates (both well field construction and operation phases active).

‡Operation phase emission estimates are from project year 12 since that is the only active phase during that project year.

§Aquifer Restoration phase emission estimates are calculated by subtracting project year 12 estimates (only operation phase active) from project year 11 estimates (both operation and aquifer restoration phases active).

‖Decommissioning phase emission estimates are from project year 13 since that is the only active phase in that project year.

Table B–4. Comparison (i.e., Percentage) of the Various ISR Phase Emission Levels Relative to the Peak Year Emission Levels for the Proposed Ludeman ISR Satellite Project

Pollutant	ISR Phase			
	Construction	Operation	Aquifer Restoration	Decommissioning
Carbon Dioxide	72.3	21.7	6.0	29.5
Carbon Monoxide	80.4	12.1	7.2	31.4
Hazardous Air Pollutants	83.3	12.5	8.3	33.3
Nitrogen Oxides	78.3	13.2	8.5	32.8
Particulate Matter $PM_{2.5}$	54.7	15.9	10.7	28.5
Particulate Matter PM_{10}	53.7	16.7	11.7	28.1
Sulfur Dioxide	83.8	10.1	6.1	31.3
Volatile Organic Compounds	52.3	16.0	9.0	24.7

Source: Modified from Uranium One; 2016; Uranium One, 2017b

B.1.3 Source Category Emissions

The three primary air emission source categories for the proposed Ludeman ISR Satellite Project are (i) fugitive dust, (ii) mobile combustion emissions, and (iii) stationary emissions. EA Table B–5 describes the relative contribution of each of the three source categories to the peak year emission levels. Fugitive dust comprises particulate matter generated from mobile sources traveling on unpaved roads and wellfields (hereafter called vehicle travel) and wind erosion from disturbed land. Particulate matter $PM_{2.5}$ is defined as particles that are 2.5 micrometers in diameter or smaller, and particulate matter PM_{10} is defined as particles which are 10 micrometers in diameter or smaller. The estimated number of hours during which mobile sources would be active and travel on unpaved areas would occur varies over the lifespan of the project; therefore, the estimated amount of fugitive dust emissions annually generated from vehicle travel also varies. The amount of fugitive dust emissions from wind erosion would be a function of the amount of disturbed land. The calculation for the estimated amount of dust generated by wind erosion is based on the net amount of bare land exposed, which accounts for both the amount of land disturbed as well as the amount of land reclaimed. The amount of combustion emissions from mobile sources also varies annually over the project lifespan because the number of hours during which mobile sources would be active varies for individual project years. Based on anticipated activities, point or stationary sources would be limited to space heaters, for which annual emissions would not vary over the project life.

B.1.4 Mitigation

The air emission inventory used in this EA incorporates the following mitigation measures that Uranium One commits to employ during the life of the proposed Ludeman ISR Satellite Project:

- Dust suppression for unpaved roads
- Reclamation of disturbed land
- Tier 1 engines for drill rigs
- Tier 3 engines for construction equipment

Chemical dust suppressant and water will be applied to the Ludeman ISR Satellite Project access road to minimize fugitive dust emissions from passenger vehicle and delivery truck traffic. This mitigation measure reduces fugitive dust emissions from the access road by 85 percent (Uranium One, 2016). Other project roads will be sprayed with water to minimize fugitive dust emissions from pickups, service vehicles, graders, and construction equipment. This mitigation measure reduces project road fugitive dust emissions by 50 percent (Uranium One, 2016). By reclaiming disturbed land as soon as practicable rather than waiting until the end of the project, the maximum amount of disturbed land in a single year is reduced from 372.3 hectares (ha) [920 acres (ac)] to 202.3 ha [500 ac], which equates to a 46 percent reduction in wind erosion emissions (Uranium One, 2016). The terms “Tier 1” and “Tier 3” refer to a phased program of standards mandated by the U.S. Environmental Protection Agency (EPA) that requires newly manufactured engines to generate lower pollutant emission levels. Higher tier numbers equate to stricter emission standards and lower pollutant levels. Depending on the pollutant and the horsepower of the engine, this mitigation reduces emission levels by 28 to 72 percent (NRC, 2016).

Table B–5. Relative Contribution (i.e., Percentage) of Each Source Category to the Peak Year Emission Levels for the Proposed Ludeman ISR Satellite Project			
Pollutant	**Percentage from Fugitive Sources**	**Percentage from Mobile Sources**	**Percentage from Stationary Sources***
Carbon Dioxide	0.0	98.0	2.0
Carbon Monoxide	0.0	99.7	0.3
Hazardous Air Pollutants	0.0	100.0	0.0
Nitrogen Oxides	0.0	99.7	0.3
Particulate Matter $PM_{2.5}$	90.2	9.8	0.0
Particulate Matter PM_{10}	98.5	1.5	0.0
Sulfur Dioxide	0.0	100.0	0.0
Volatile Organic Compounds	0.0	100.0	0.0

Source: Uranium One, 2016; Uranium, 2017b
*The value 0.0 does not mean there are no emissions of this pollutant from stationary sources. It means that the percentage of emission levels relative to the peak year are not greater than 0.05 percent (i.e., 0.1 percent when rounded up).

B.1.5 Liquid Waste Management Options

As described in EA Chapter 2.1.7, Uranium One proposes to manage liquid byproduct material using evaporation ponds, permeate ponds, deep disposal wells, and surface water discharge.

Option 1 would generate additional fugitive dust and combustion emissions relative to the preferred liquid waste management option. Fugitive dust emissions from wind erosion would increase under Option 1 because more land would be disturbed by the footprint of the deep disposal wells. Combustion emissions would increase because of the addition of the heavy drill rig used to drill the deep disposal wells. However, these additional emissions from liquid waste management Option 1 only occur in project year one, and project year one emissions are less than peak year emissions. Project year one and peak year emission estimates for the preferred liquid waste management option and Option 1 are presented in Table B–6.

Uranium One did not provide air emission estimates for Option 2. The NRC staff determined that Option 2 would generate less fugitive dust and combustion emissions relative to the preferred liquid waste management option for the following reasons. First, fugitive dust emissions from wind erosion would decrease because less land would be disturbed (EA Section 4.1). Second, combustion emissions would also decrease because less land disturbance would equate to less operating time for construction equipment, which would then result in a reduced amount of emissions. However, the emission reductions under the proposed liquid waste management Option 2 only occur in project year one (which are less than peak year emissions).

Table B–6. Project Year One and Peak Year Estimated Emissions in Short Tons* for the Preferred Liquid Waste Disposal Management Option and Option 1				
	Project Year One		Peak Year	
Pollutant	Preferred Option	Option 1	Preferred Option	Option 1
Carbon Dioxide	1,277	2,303	6,708	6,708
Carbon Monoxide	6.7	11.6	30.5	30.5
Hazardous Air Pollutants	0.5	0.91	2.4	2.4
Nitrogen Oxides	10.0	23.4	38.7	38.7
Particulate Matter $PM_{2.5}$	14.1	14.8	21.4	21.4
Particulate Matter PM_{10}	107.5	109.3	146.6	146.6
Sulfur Dioxide	1.3	8.5	9.9	9.9
Volatile Organic Compounds	29.4	30.0†	29.4	29.4

Source: Uranium One, 2016; Uranium One, 2017b
*Appendix table mass expressed in English units only (dual units used in EA text with metric being primary). To convert short tons to metric tons, multiply by 0.907.
†For purposes of this EA, the distinction between the preferred option and Option 1 volatile organic compound estimate is considered minor and not distinguished elsewhere in the EA.

B.2 Temperature, Precipitation, and Wind Data

The detailed onsite temperature, precipitation, and wind data summarized in EA Section 3.6 is provided in Tables B–7, B–8, and B–9.

Table B–7. Temperature Data for the Onsite and Douglas Weather Stations				
	Average Daily Temperature (°C)*		Average Daily Minimum Temperature (°C)*	Average Daily Maximum Temperature (°C)*
Month	Onsite	Douglas†	Douglas†	
January	−2.00	−4.00	−11.9	3.89
February	−7.35	−3.06	−10.8	4.72
March	1.23	1.66	−5.61	9.00
April	5.90	6.28	−1.44	14.1
May	11.2	11.7	3.66	19.7
June	15.6	17.3	8.83	25.7
July	21.6	21.4	12.6	30.4
August	19.7	20.4	11.2	29.6
September	15.3	14.1	5.22	23.1
October	10.7	7.28	−1.17	15.7
November	−1.38	0.78	−7.00	8.50
December	−1.71	−4.33	−11.7	3.06
Annual	7.40	7.44	−0.67	15.6

Sources: Modified from NOAA (2015) and Uranium One (2017a)
*To convert Celsius (°C) to Fahrenheit (°F), multiply by 1.8 and add 32.
†Douglas meteorological station data was collected over a 30-year period from 1981 to 2010.

Table B–8. Precipitation Data for the Onsite and Douglas Weather Stations			
	Precipitation (cm)*		Snowfall (cm)*
Time Period	Onsite†	Douglas‡	Douglas‡
January	0.71	1.63	20.3
February	0.23	1.98	27.9
March	0.81	2.74	32.3
April	1.70	4.50	24.6
May	2.39	8.10	3.3
June	4.52	5.13	0.0
July	4.27	3.61	0.0
August	2.18	2.36	0.0
September	1.55	3.00	4.8
October	0.94	3.61	11.9
November	0.84	1.80	12.4
December	0.02	1.12	21.8
Annual	20.17	39.57	159.5

Sources: Modified from NOAA (2015) and Uranium One (2017a)
*To convert centimeters (cm) to inches (in), multiply by 0.3937
†Onsite meteorological station baseline year data was collected over a one year period from February 2014 through January 2015 and snowfall data was not collected at the Ludeman meteorological station.
‡Douglas meteorological station data was collected over a 30-year period from 1981 to 2010.

Table B–9. Wind Data for the Onsite and Douglas Weather Stations						
	Average Wind Speed (km/hr)*		Maximum Hourly Wind Speed (km/hr)*		Wind Direction	
Time Period	Onsite†	Douglas AP‡	Onsite†	Douglas AP‡	Onsite†	Douglas AP‡
January	24.7	16.6	72.9	75.6	W	NW
February	23.7	16.9	73.5	77.2	W	NW
March	28.2	19.1	76.8	74.0	W	NW
April	25.5	20.0	69.5	70.8	W	NW
May	21.4	18.7	61.6	72.4	W	SE
June	21.3	17.1	67.3	74.0	W	SE
July	17.4	15.3	58.2	82.1	W	SE
August	17.8	15.3	57.8	77.2	W	SE
September	19.0	15.0	54.8	86.9	W	SE
October	22.9	16.2	62.0	75.6	W	NW
November	26.4	16.9	72.4	85.3	W	NW
December	23.8	16.1	62.9	74.0	W	NW
Annual	22.7	16.9	76.8	77.2	W	NW

Source: Modified from Uranium One (2013) and Uranium One (2017a)
*To convert kilometer per hour (km/hr) to miles per hour (mph), multiply by 0.6214
†Onsite meteorological station baseline year data was collected over a one year period from February 2014 through January 2015 and monthly wind direction based on seasonal wind roses (i.e., 3 month periods) rather than individual months.
‡Douglas meteorological station data was collected over a 30-year period from 1981 to 2010.

B.3 Air Dispersion Modeling

Site-specific air dispersion modeling was not conducted for the proposed Ludeman ISR Satellite Project. Therefore, the NRC staff used the site-specific air dispersion modeling conducted for the Reno Creek ISR Project to characterize the potential impacts at the proposed Ludeman Project from particulate matter emissions. The NRC staff determined that the Reno Creek site-specific air dispersion modeling can be used to characterize potential impacts from particulate matter emissions for the proposed Ludeman ISR Project for the following reasons: (i) both projects are ISR facilities and share many of the same activities and emission sources; and (ii) although Reno Creek was expected to have lower overall particulate emission levels compared to the proposed Ludeman Project, Reno Creek was expected to generate a greater amount of emissions from vehicle travel; and vehicle travel emissions rather than wind erosion emissions are what drives the modeling results or potential impacts. The remaining part of this section describes in greater detail the basis for the NRC staff's determination that the air dispersion modeling conducted for the Reno Creek ISR Project is appropriate to use for the proposed Ludeman ISR Satellite Project. Particulate matter is the only pollutant addressed in the application of the Reno Creek air dispersion modeling discussion to the analysis in this EA.

B.3.1 Similarities

Because the Reno Creek and Ludeman projects are both ISR facilities, both projects share many of the same planned activities and emission sources. Fugitive sources generate most of the particulate matter emissions, and mobile sources generate most of the other types of emissions (NRC, 2016). However, there are differences between the two projects that are addressed in the following sections.

B.3.2 Lack of Processing Facility

The proposed Ludeman ISR Satellite Project is an expansion to the Willow Creek ISR Project and would have no resin process facility, whereas the Reno Creek Project does have such a facility. However, stationary sources such as Reno Creek's resin processing facility would only generate a small percentage of overall particulate matter emissions. Less than 1 percent of particulate matter emissions are attributed to stationary sources for both the Reno Creek (NRC, 2016) and proposed Ludeman ISR projects (EA Table B–5).

B.3.3 Emission Level Distinction

The amount of overall fugitive particulate matter emissions generated by the proposed Ludeman ISR Satellite Project and the Reno Creek Project varies. For the peak year, Uranium One estimates that the proposed Ludeman Project would generate 133.0 metric tons [146.6 short tons] of particulate matter PM_{10} and 19.4 metric tons [21.4 short tons] of particulate matter $PM_{2.5}$, whereas the modeling conducted by the Reno Creek licensee estimated that 104.6 metric tons [115.3 short tons] of particulate matter PM_{10} and 12.8 metric tons [14.1 short tons] of particulate matter $PM_{2.5}$ (EA Table B–2) would be generated for the Reno Creek Project. Considering only overall particulate matter emission levels based on Uranium One's license amendment documents, the proposed Ludeman Project would be expected to generate higher pollutant concentrations and associated air quality impacts compared to the Reno Creek Project. However, the emission intensity estimated at the Reno Creek Project was expected to be higher than the proposed Ludeman Project. Emission intensity describes the amount (i.e., mass) of particulate matter generated over time (e.g., 1 hour) over a certain area (e.g., square meter). Two key factors are important to consider when comparing particulate

matter emissions between these two projects: (i) the distinction between the two projects concerning the amount of the particulate matter generated by vehicle travel and wind erosion, and (ii) the emission intensity levels associated with vehicle travel and wind erosion.

The amount of fugitive particulate matter emissions expected to be generated by vehicle travel and wind erosion varies for the two projects. EA Table B–6 compares the estimated amounts of fugitive particulate matter generated by the two projects during the peak year. For the proposed Ludeman ISR Satellite Project, wind erosion would generate about 40 percent of the fugitive particulate matter PM_{10} emissions and about 44 percent of the fugitive particulate matter $PM_{2.5}$ emissions (Uranium One, 2016). In contrast, wind erosion at the Reno Creek Project would generate about 5 percent of the fugitive particulate matter PM_{10} emissions and 7 percent of the fugitive particulate matter $PM_{2.5}$ emissions (NRC, 2016). Although the Ludeman Project is expected to generate more total particulate matter PM_{10} emissions, activities associated with the Reno Creek Project were expected to generate about 18 percent more particulate matter PM_{10} emissions from vehicle travel compared to the Ludeman Project {i.e., 96.9 metric [106.8 short] tons compared to 79.3 metric [87.4 short tons]} (EA Table B–10). The information provided in EA Table B–10 demonstrates that the estimated amount of particulate matter $PM_{2.5}$ generated by both projects are expected to be the same. The fact that the Reno Creek Project was expected to generate more vehicle travel emissions compared to the Ludeman Project is important because vehicle travel contributes a higher emission intensity compared to wind erosion emissions.

Table B–10. Estimated Annual Peak Year Fugitive Particulate Matter Emissions in Short Tons* for the Proposed Ludeman ISR Project and the Reno Creek ISR Project

Source	Particulate Matter $PM_{2.5}$ Mass (short tons)			Particulate Matter PM_{10}	
	Ludeman	Reno Creek		Ludeman	Reno Creek
Wind Erosion	8.5	0.9		57.0	5.8
Vehicle Travel†	10.7	10.7		87.4	106.8
Total	19.3	11.5		144.4	112.6

Sources: Uranium One, 2016; Uranium One, 2017b; NRC, 2016
*Appendix table mass expressed in English units only (dual units used in EA text with metric being primary). To convert short tons to metric tons, multiply by 0.907.
†Vehicle travel emissions are defined as fugitive particulate matter emissions from vehicle travel on unpaved roads and wellfields

For ISR projects in general, the emission intensity for particulate matter generated by vehicle travel is greater than that for wind erosion. Vehicle travel emissions are concentrated at project roads and wellfields, whereas wind erosion emissions are spread evenly throughout a project area. As a result, vehicle travel emissions disproportionally influence air dispersion modeling results. In other words, projects with emissions attributed to vehicle travel generate higher particulate matter concentrations when compared to projects with emissions attributed to wind erosion. Greater pollutant concentrations result in greater potential air quality impacts. Emission intensity values for specific projects account for (i) the overall emission levels, and (ii) the relative amounts of fugitive dust attributed to vehicle travel and wind erosion. For the proposed Ludeman Project, the emission intensity for vehicle travel is estimated to be about four times greater than that for wind erosion (Uranium One, 2017b). For the Reno Creek Project, the vehicle travel emission intensity was estimated to be more than ten times greater than that for wind erosion (Uranium One, 2017b).

For both ISR projects, vehicle travel emission levels are greater than wind erosion emissions levels; and as previously explained, vehicle travel emission intensities are greater than wind erosion emission intensities. For these two reasons, vehicle travel disproportionally influences air dispersion modeling results. The proposed Ludeman ISR Satellite Project has greater expected overall particulate matter emissions. However, the NRC staff concludes that it is still appropriate to use the site-specific modeling used for the Reno Creek Project to characterize the potential impacts from particulate matter for the proposed Ludeman ISR Project because (i) Reno Creek generates a greater amount of vehicle travel emissions than the proposed Ludeman ISR Project, and (ii) Reno Creek vehicle travel emission intensity is 10 times greater than the wind erosion emission intensity, whereas the proposed Ludeman ISR Project vehicle emission intensity is only 4 times greater than the wind erosion emission intensity.

B.3.4 Dry Depletion Implementation

The air dispersion modeling that the NRC staff used to estimate impacts at the Reno Creek Project implemented the dry depletion option because about 95 percent of the Reno Creek particulate matter PM_{10} emissions were from vehicle travel (EA Table B–10). The dry depletion option accounts for the fact that heavier particles (i.e., the particulate matter PM_{10}) from these types of fugitive emissions (i.e., mechanically generated emissions from vehicle travel) tend to settle out of the air relatively quickly as the dust plume disperses from the source.

Particle size distribution (i.e., the percentage of various particle sizes that compose the overall particulate matter fugitive emissions) varies for fugitive emissions from vehicle travel and wind erosion. Vehicle travel is composed of 10 percent particulate matter $PM_{2.5}$, whereas wind erosion is composed of 15 percent particulate matter $PM_{2.5}$ (Uranium One, 2017b). Vehicle travel emissions contain a greater fraction of heavier particles compared to wind erosion emissions. Vehicle travel generates about 60 percent of the proposed Ludeman ISR Project emissions compared to 95 percent for Reno Creek (EA Table B–10). Relative to the Reno Creek emissions, the Ludeman particulate matter emissions contain a greater fraction or percentage of particulate matter $PM_{2.5,}$ which tends not to settle out of the air as quickly as the heavier particulate matter PM_{10}.

The NRC staff concludes that the Reno Creek site-specific air dispersion modeling, which implemented the dry depletion option, can be used to characterize potential impacts from particulate matter emissions for the proposed Ludeman ISR Project for the following reasons:

- The Reno Creek Project generates a greater amount of vehicle travel emissions than the proposed Ludeman ISR Satellite Project.
- The Reno Creek Project vehicle travel emission intensity is ten times greater than the wind erosion emission intensity, whereas the proposed Ludeman ISR Satellite Project vehicle emission intensity is only four times greater than the wind erosion emission intensity.
- The proposed Ludeman ISR Project has a slightly higher fraction of particulate matter $PM_{2.5}$ because of a greater amount of wind erosion emissions. However, wind erosion emissions should settle preferentially over vehicle travel fugitive emissions because wind erosion emissions are generated at ground-level (i.e., zero release height), whereas vehicle travel emissions are generated at a slightly higher release height, which aids in transport.

The Addendum to Revised Response to NRC Meteorology and Air Quality Information Requests for the Ludeman ISR Satellite Project (Uranium One, 2017b) provides a greater level of detail concerning the use of the Reno Creek site-specific modeling to characterize potential impacts from particulate matter emissions for the proposed Ludeman ISR Project, even though the Reno Creek modeling implements the dry depletion option. The NRC staff's analysis of the potential impact to air quality from the Ludeman Project included review of this document, and NRC staff's conclusions regarding air quality impacts are provided in EA Section 4.7.

REFERENCES

NOAA. "Data Tools: 1981-2010 Normals—Monthly Normals—Douglas 1 SE, WY—View Station Report." Asheville, North Carolina: National Climatic Data Center. 2015. <http://www.ncdc.noaa.gov/cdo-web/datatools/normals> (1 November 2017).

NRC. NUREG–1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities." ML091480244 and ML091480188. Washington, DC: U.S. Nuclear Regulatory Commission. May 2009.

NRC. NUREG–1910, "Environmental Impact Statement for the Reno Creek *In Situ* Recovery Project in Campbell County, Wyoming: Supplement to the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities, Final Report." Supplement 6. Washington, DC: U.S. Nuclear Regulatory Commission. December 2016.

Uranium One. "Letter from J. Winter, Uranium One Americas, Inc. to John Buckley, NRC, dated June 24, 2013, RE: Uranium One Request for Additional Information (RAI) response package for the Ludeman *In Situ* Uranium Recovery Facility, Converse County." Wyoming Docket No. 04008502 Amendment Application to SUA–1341. ML13191A248. Package No. ML131910354. 2013.

Uranium One. "Revised Response to NRC Meteorology and Air Quality Information Requests for the Ludeman ISR Project." ML17059D016. September 2016.

Uranium One. "E-mail from S. Schierman, Uranium One USA., to E. Striz and K. Jamerson, NRC, dated February 22, 2017, RE: Ludeman Baseline Met Data." ML17059C720 and attachment ML17059C724. 2017a.

Uranium One. "Addendum to Revised Response to NRC Meteorology and Air Quality Information Requests for the Ludeman ISR Project." April 2017b.