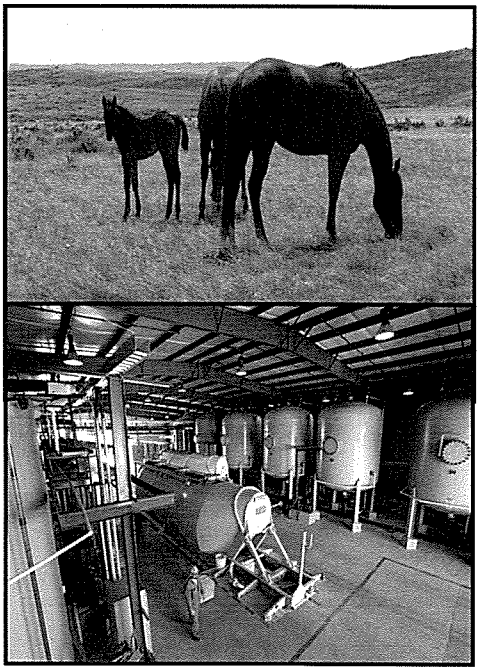
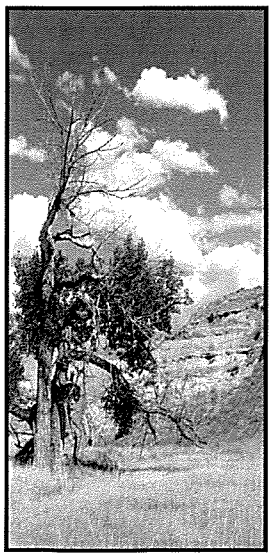
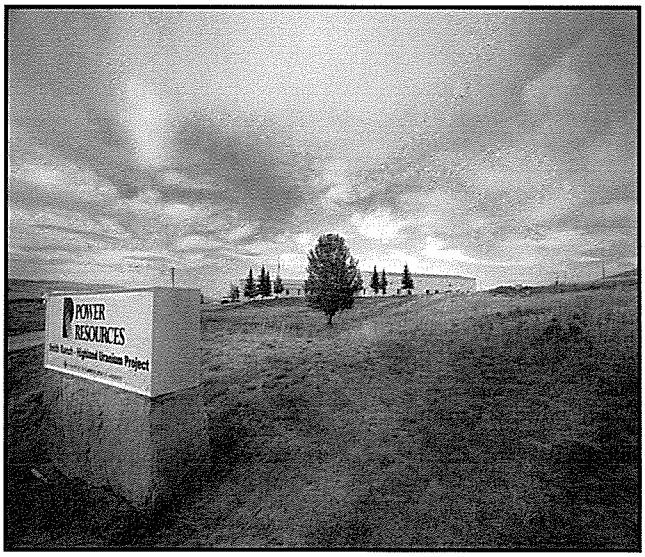
Nuclear Regulatory Commission
Source Material License No. SUA-1548
License Renewal Application
Environmental Report







Cameco

Lidstone and Associates, Inc.
Engineering, Geology, & Water Resource Consulting

VOLUME 1 of 1
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List of Acronyms

ACL	alternate control limit
ACS	American Community Survey
ALARA	as low as reasonably achievable
ALI	annual limit of intake
AML	Abandoned Mine Land (WDEQ)
Anadarko	Anadarko Petroleum Corporation
API	American Petroleum Institute
APD	Application for a Permit to Drill
AQD	Air Quality Division (WDEQ)
AQS	Air Quality System
ASTM	American Society for Testing and Materials
ASCM	alternate sediment control measures
AU	Assessment unit
BCR	benefit-cost ratio
bgs	below ground surface
BLM	Bureau of Land Management (U.S.)
BMP	Best Management Practices
BOE	barrels of oil equivalent
BPT	Best Practicable Technology
BTU	British thermal unit
$CaCO_3$	Calcite
Cameco	Cameco Resources (Power Resources, Inc.)
CAP	Corrective Action Plan
CBM	coal bed methane
CDL	Cropland Data Layer
CEQ	Council on Environmental Quality
CGA	Compressed Gas Association
Cleveland-Cliffs	Cleveland-Cliffs Iron Company
Coal Review	Powder River Basin Coal Review
CO	carbon monoxide
COE	Corps of Engineers (U.S. Army)
CPF	Central Processing Facility
CPP	Central Process Plant
CRSO	Corporate Radiation Safety Officer
DAC	derived air concentration
DDE	deep dose equivalent
DOT	Department of Transportation (U.S. / Wyoming)
EA	Environmental Assessment
EC	effluent concentration
EAD	Economic Analysis Division (WDAI)
EDX	energy dispersive X-ray
EHS	Environmental Health and Safety
EFD	East Fraser Draw
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (U.S.)
ER	Environmental Report
Everest	Everest Mineral Corporation
EXREFA	Extended Reference Area
FAP	Federal American Partners
FONSI	Finding of No Significant Impact
GPD	Gross Domestic Product
gpm	gallons per minute
GWS	groundwater sweep
H_2O_2	hydrogen peroxide

H_2S	hydrogen sulfide
H_2SO_4	Sulfuric acid
HCL	hydrogen chloride
HDPE	high density polyethylene
Highland	Highland Uranium Project
HPT	Health Physics Technician
HWA	Hayden-Wing Associates, LLC
I-25	Interstate 25
I-80	Interstate 80
I-90	Interstate 90
IGP	Industrial General Permit
IME	Inberg-Miller Engineers
IMPROVE	Interagency Monitoring of Protected Visual Environments
ISR	in situ recovery
IX	ion exchange
Km	kilometers
KMC	Kerr-McGee Corporation
KOH	potassium hydroxide
kV	kilovolt
Kw	kilowatts
LC	letters of credit
LLD	lower limit of detection
LQD	Land Quality Division (WDEQ)
LRA	License Renewal Application
LSA	low specific activity
LTM	long term monitoring
MBHFI	migratory bird of high federal interest
MCL	maximum contaminant level
MIT	mechanical integrity testing
MLRA	Major Land Resource Area
MSHA	Mine Safety and Health Administration
MW	megawatt
NA_2CO_3	sodium carbonate
NAAQS	National Ambient Air Quality Standards
Na_2S	sodium sulfide
$NaHCO_3$	sodium bicarbonate
NaHS	sodium hydrosulfide
NaOH	sodium hydroxide
NB	North Butte
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
NH_3	ammonia
NLCD	National Land Cover Dataset
NCV	Non-Cited Violation
NOAA	National Oceanic and Atmospheric Administration
NOV	Notice of Violation
NO_x	nitrogen oxide
NRC	U.S. Nuclear Regulatory Commission
NWS	National Weather Service
ORC	Operations Review Committee
O_2	oxygen
OSHA	Occupational Health and Safety Administration
PDC	polly diamond carbide
PLC	process logic controller
PM_{10}	particulate matter smaller than 10 micrometers
$PM_{2.5}$	particulate matter smaller than 2.5 micrometers

PMC	Pathfinder Mines Corporation
PRI	Power Resources, Inc.
PSD	Prevention of Significant Deterioration
PSR-1	Purge Storage Reservoir 1
PSR-2	Purge Storage Reservoir 2
PV	pore volume
PVC	polyvinyl chloride
PWS	Public Water System
QA	quality assurance
QC	quality control
R&D	Research & Development
RAMC	Rio Algom Mining Corp.
RCRA	Resource Conservation and Recovery Act
Real West	Real West Natural Resources Consulting
redox	reduction-oxidation
RMP	Resource Management Plan
RO	reverse osmosis
RSO	Radiation Safety Officer
RTV	restoration target value
RV	recreational vehicle
WSEO	Wyoming State Engineer's Office
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SER	Safety Evaluation Report
SERP	Safety and Environmental Review Panel
SFC	Sequoyah Fuels Corp.
SHEQ	Safety Health Environment and Quality (Manager)
SHEQMS	Safety Health Environment and Quality Management System
SHPO	State Historic Preservation Office (Wyoming)
SIA	Special Interest Area
SMC	Solution Mining Corp.
SO_2	sulfuric dioxide
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SR	Smith Ranch
Strathmore	Strathmore Minerals Corporation
SUA-1548	Source and Byproduct Materials License SUA-1548
SWPPP	Storm Water Pollution Prevention Plan
T&E	threatened and endangered
TCP	Traditional cultural property
TDS	total dissolved solids
TED	total effective dose
TEDE	total effective dose equivalent
TER	Technical Evaluation Report
Titan	Titan Uranium USA Inc.
TLD	Thermoluminescent dosimetry
TPQ	threshold planning quantity
TPS	Total petroleum system
TQ	threshold quantity
TR	Technical Report
TSP	total suspended particulate
TVA	Tennessee Valley Authority
U_3O_8	uranium
UBC	Uniform Building Code
UG	Urangesellschaft
UCL	upper control limit

UIC	underground injection control
UO_2	uranium dioxide
UPS	uninterruptible power supply
UPZ	uranium point zone
Uranerz	Uranerz USA, Inc.
USACE	U.S. Army Corps of Engineers
USDW	underground source of drinking water
USEIA	U.S. Energy Information Administration
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compounds
VRM	Visual Resource Management
WDAI	Wyoming Department of Administration & Information
WCC	West Canyon Creek
WDEQ	Wyoming Department of Environmental Quality
WFD	West Fraser Draw
WGFD	Wyoming Game and Fish Department
WHMA	Wildlife Habitat Management Area
WL	working level
WLM	working level month
WOGCC	Wyoming Oil & Gas Conservation Commission
WQD	Water Quality Division (WDEQ)
WYPDES	Wyoming Pollutant Discharge Elimination System
XRD	X-ray diffractometry

1.0 Proposed Activities

1.1 Purpose and Need for the Proposed Action

Power Resources, Inc. (PRI) dba Cameco Resources (Cameco) is requesting that the United States Nuclear Regulatory Commission (NRC) approve the license renewal application (LRA) for Source and Byproduct Materials License SUA-1548 (SUA-1548). The LRA was originally submitted to NRC on August 12, 2010. By letter dated February 4, 2011, NRC Staff provided Cameco with their acceptance review comments. Based on the acceptance review comments as well as comments provided by NRC Staff in meetings dated March 17, 2011 and September 19 and 20, 2011, Cameco is submitting this LRA for NRC review and approval. This submittal supersedes the August 12, 2010 submittal. Approval of this LRA will authorize Cameco to continue uranium in-situ recovery (ISR) operations at the Smith Ranch site and its related satellite facilities for an additional 10-year renewal period beginning August 12, 2010. Cameco is also requesting approval of the following items that are either new or have been changed since the last renewal:

1. Operations Plan for the Gas Hills Remote Satellite, including yellowcake slurry production, redesign of Evaporation Ponds 1 and 2, increase in satellite flow rate and the use of underground injection control (UIC) Class I disposal wells, as defined later in this section.
2. Operating Plan for the North Butte Remote Satellite, including redesigned surge ponds and satellite, increased satellite flow rate, use of UIC Class I disposal wells, removal of the slurry and dried product option at the satellite, as defined later in this section.
3. Flow rate increases at the Reynolds Ranch Satellite.
4. Refurbishment of the Highland Central Processing Facility (CPF) to allow processing of up to 1.4 million kilograms (3 million pounds) of dried yellowcake per year (approved into the license through the Operations Review Committee (ORC)/Safety and Environmental Review Panel (SERP) process.
5. Processing of toll shipments of loaded ion exchange (IX) resin and slurried yellowcake from other licensed uranium recovery facilities at the Highland CPF.

Cameco will also be receiving toll shipments of uranium-loaded IX resin from third party uranium recovery licensees to process into dried yellowcake. This material is no different than the material defined in Regulatory Issue Summary 00.23 as equivalent feed and should not require additional authorization from NRC to accept and process this type of material (see Section 1.5 of the Technical Report [TR]).

According to the World Nuclear Association, worldwide demand for uranium totals 62,500 metric tons (138 million pounds) per year (WNA, 2012). U.S. uranium mines produced 1,900 metric tons (4.2 million pounds) U_3O_8 in 2010, 2% more than in 2009. A total of four underground mines produced ore containing uranium during 2010, 10 less than during 2009. A total of four ISR operations produced solutions containing uranium (U.S. EIA, 2011). In 2011, SUA-1548 operations produced a total of 680 metric tons (1.5 million pounds) (Cameco Resources, 2011). As of October 12, 2011, SUA-1548 operations represent one of just 35 major uranium recovery operations in the United States that have submitted either an application for a license or license renewal, or a letter of intent to the NRC through Fiscal Year 2013. These 35 major uranium recovery operations include ISR, heap leach, and conventional extraction methodologies.

1.2 License Renewal Application Nomenclature

This Environmental Report (ER) together with the accompanying TR, provide the required information to allow approval of this LRA. **Figure 1.1, General SUA-1548 Location Map** presents a location map, including transportation routes, for SUA-1548 and consists of:

1. Converse County
   a. Smith Ranch, including all satellites and processing facilities associated with the Smith Ranch properties (**Figure 1.2, Site Location Map**)
2. Campbell County
   a. North Butte Remote Satellite
3. Fremont and Natrona Counties
   a. Gas Hills Remote Satellite
4. Johnson County
   a. Ruth Remote Satellite

Figure 1.2 presents more detailed information related to Smith Ranch and its contiguous satellite facilities. Smith Ranch incorporates the Converse County properties as individual satellites. The location of each satellite is presented on **Figure 1.2**. Because of the abundance and importance of historical information, this ER addresses three historic named properties that comprise the Converse County property, collectively referred to as Smith Ranch. They are:

a. Smith Ranch
b. Highland (aka The Highland Uranium Project)
c. Reynolds Ranch

The Central Processing Plant (CPP) is located on Smith Ranch. The Highland CPF and the Selenium Treatment Plant are both located within Highland (see **Figure 1.2**).

The typical ISR process is described in both the ER and the TR. Each property and/or remote satellite is comprised of several mine units, which consist of one or more contiguous uranium roll fronts. Injection and recovery wells are drilled and completed within these mine units. These injection and recovery wells are collectively called a well field or mine unit. Uranium is liberated from its natural mineral state and recovered from the groundwater at each recovery well and piped to a header house. Uranium-bearing fluids (pregnant lixiviant) are delivered from each header house to the CPP, a satellite, or remote satellite for further processing. The barren fluids, less a small bleed to maintain hydraulic control within the mine unit, are refortified with lixiviant reagents and returned to the mine unit to recover more uranium.

An IX facility is located within each of the satellites, CPP and the CPF (when refurbished), where the uranium is removed from the groundwater and loaded onto the surface of the IX resin. The Gas Hills Remote Satellite will also have the capability of producing yellowcake slurry. Uranium laden IX resin and/or slurry produced at the satellite or remote satellite facilities is transported via Wyoming Department of Transportation (DOT)-approved transport trailers to the CPP and/or the CPF (**Figure 1.2**) for final processing into yellowcake. Final processing at the CPP is accomplished using low heat rotary vacuum dryers. These vacuum dryers do not produce significant particulate emissions that can escape into the environment. Dried yellowcake is the commercial end product for SUA-1548. The CPF is a second processing plant under SUA-1548. It is currently (2011) inactive, but Cameco is in the process of refurbishing and upgrading this processing facility to allow additional capacity for IX and yellowcake

production. By letter dated September 15, 2011, Cameco advised NRC of their plans to renovate the Highland CPF. Phase I includes the dismantling and disposal of the Highland offices and extraneous equipment and materials outside the CPF building and the modernization of electrical services. Phase II includes the removal and replacement of tanks, vessels and piping within the CPF, and Phase III includes the removal and disposal of the existing calciner dryer and installation of at least two low temperature rotary vacuum dryers. The work has been reviewed and approved through the ORC/SERP process. Phase I started during the fourth quarter of 2011. Once operational, this facility will receive IX resin and/or slurry from the remote satellites as well as from third party licensed uranium recovery facilities. The CPF will have the capability to produce dried yellowcake, which will be transported by truck to a uranium conversion facility.

When a mine unit or a portion of a mine unit is exhausted of economically recoverable uranium, it is placed into groundwater restoration. This restoration process is described in Section 6.0 of the TR. During the production and restoration processes, a certain amount of liquid waste water is generated. Cameco utilizes several methods to handle and dispose of waste water, including evaporation ponds, UIC Class I disposal wells, and land application. Cameco is currently (January 2012) exploring the option of using UIC Class I disposal wells at the Gas Hills Remote Satellite to augment the planned evaporation methodologies. The Selenium Treatment Plant located at Satellite 2 (**Figure 1.2**) removes selenium and radium from "treated" process and bleed water prior to disposal by land application via a storage reservoir and pivot irrigator.

1.3 Document Format

Per discussions with NRC Staff, Cameco has prepared a comprehensive document that includes both past and current information applicable to this LRA. Cameco received an acceptance review dated February 4, 2011 and has incorporated NRC Staff comments identified as Enclosure 1 into this LRA. In that same letter, the NRC recommended that Cameco consider guidance provided in Regulatory Guide 3.46 (June 1982); NUREG-1748 (August 2003); and NUREG-1569 (June 2003). Cameco has prepared the current document to conform to this regulatory guidance. Since receiving the acceptance review comments, Cameco representatives have attended two public meetings with NRC Staff: a one day meeting in Washington DC on March 17, 2011 and a two day meeting and pre-submission license application review in Casper on September 19 and 20, 2011. Meeting minutes and NRC staff comments and recommendations made at these meetings were memorialized in NRC Staff memoranda dated respectively April 26, 2011 and October 28, 2011. Cameco has incorporated these suggestions into the LRA.

As stated above, this LRA consists of a TR and an ER. The TR is a stand-alone document that addresses the guidance provided by NUREG-1569 and NRC Regulatory Guide 3.46. The TR summarizes both new and historical technical information for SUA-1548. Cameco has provided a summary statement at the front of each chapter that describes what information is new and what information has been previously reviewed by the NRC. The TR appendices contain numerous detailed designs, construction specifications, and consultant reports to provide a complete 10-year history of SUA-1548.

This ER provides environmental baseline information and environmental assessments of the actions proposed in the LRA. The ER addresses the guidance provided in NUREG-1748 and contains cross references to a series of appendices that are part of the Wyoming Department of Environmental Quality (WDEQ) Permit to Mine for each facility within SUA-1548. Specifically, Cameco presents detailed baseline information to the WDEQ as part of their State of Wyoming permitting process. In recognition of the NRC's regulations at 10 CFR 51 implementing the National Environmental Policy Act (NEPA) for

baseline data as they pertain to the ER, Cameco has summarized this information in Section 3.0, Description of the Affected Environment and has referenced the detailed baseline reports as well as federal and state concurrences, which are part of the WDEQ application. To ensure that this supplemental information is available to the public and the NRC Staff, Cameco has incorporated one hard copy and one electronic copy of these documents as part of this LRA submittal.

1.4 2011 Historical Development and Current Status of Smith Ranch SUA-1548

Tables 10-1 through **10-4** in Section 10.0 of the TR summarize the federal and state permitting/licensing status of SUA-1548. SUA-1548 is currently (January 2012) in timely renewal. All Smith Ranch satellites and the Highland Satellites 2 and 3 (**Figure 1.2**) are fully operational and deliver uranium-laden IX resin to the CPP. The CPP processes the IX resin and produces dried yellowcake in accordance with the conditions and requirements of SUA-1548. The dried yellowcake is transported to a uranium conversion facility located in Port Hope, Ontario, Canada for further processing.

1.4.1 NRC License History

The previous SUA-1548 LRA was approved by the NRC in May 2001. The Licensee at that time was Rio Algom Mining Corp. (RAMC). In 2002, PRI entered into a Purchase Agreement to acquire the Smith Ranch Facility (SUA-1548) from RAMC and requested a direct transfer of control of SUA-1548 from RAMC to PRI in June 2002. The NRC approved the license transfer on July 11, 2002, as Amendment 3 to SUA-1548.

In March 2003, PRI requested that SUA-1511 (Highland) be combined with SUA-1548 (Smith Ranch) and that the surviving License be SUA-1548. At the same time, PRI requested that the Ruth/North Butte License SUA-1540 and the pending Gas Hills License Amendment to SUA-1511 also be added to the combined License SUA-1548. On August 18, 2003, the NRC issued Amendment 5 to SUA-1548 approving the consolidation of the Highland, Ruth and North Butte licenses into SUA-1548. The NRC disallowed inclusion of the Gas Hills facility on the premise that it would be premature since the NRC Staff had not yet completed their review of the amendment request. Once approved, the Gas Hills Remote Satellite would be amended into SUA-1548. The NRC subsequently approved the Gas Hills Remote Satellite as Amendment 6 to SUA-1548 on January 29, 2004.

In January 2005, PRI requested a license amendment to incorporate the Reynolds Ranch Satellite into SUA-1548. The NRC approved the request and issued Amendment 11 to SUA-1548 on January 31, 2007.

In October 2006, PRI requested a license amendment to allow construction and operation of the Smith Ranch Satellite SR-2. The NRC Staff approved the license amendment request and issued Amendment 12 to SUA-1548 on January 10, 2008.

In response to a Notice of Violation (NOV), PRI submitted a license amendment request dated March 20, 2008 requesting changes to Chapter 9 of the license application related to management organization and administrative procedures. The NRC Staff approved the license amendment request and issued Amendment 13 to SUA-1548 on August 18, 2008.

On March 12, 2009, NRC Staff issued Amendment 14 to SUA-1548 approving the financial surety update for the Gas Hills Remote Satellite.

On June 19, 2008, PRI requested an amendment to allow processing of third party uranium loaded IX resin at the Smith Ranch CPP. The NRC Staff approved the amendment request and issued Amendment

15 to SUA-1548 to allow a maximum of 365 toll shipments of third party uranium loaded IX resin to be delivered and processed at the Smith Ranch CPP each calendar year.

On December 31, 2008, PRI submitted a request for annual surety update approval for the Gas Hills, Ruth and North Butte Remote Satellite facilities. Additionally, this amendment requested approval for the addition of UIC Class I disposal well SR-HUP No. 10 (December 4, 2009). NRC Staff approved the amendment request and issued Amendment 16 on March 11, 2010.

These amendments are described in more detail in **Table 1-1, Summary of SUA-1548 Amendments Since Last Renewal** in Section 1.4 of the TR.

1.4.2 State of Wyoming Permitting History

Within the State of Wyoming, a separate mining and reclamation permit is required for each property. Historically Smith Ranch held a mining permit under WDEQ Permit No. 633 and Highland held a mining permit under WDEQ Permit No. 603. These permits are still active. In March of 2010, Cameco submitted to WDEQ a Combined Permit Application for Smith Ranch and Highland. Cameco received Completeness Review comments from the WDEQ and addressed these comments in May of 2011. As part of the May resubmission, Cameco incorporated the Reynolds Ranch property. Prior to this resubmission, the US Department of the Interior, Bureau of Land Management (BLM) approved Cameco's Plan of Operations and completed an Environmental Assessment (EA) of the proposed satellite and associated well fields at Reynolds Ranch. The BLM approved the Reynolds Ranch Plan of Operations and published their Finding of No Significant Impact (FONSI) in January 2011. The updated WDEQ permit application combining Permits 633 and 603 (Smith Ranch, Highland and Reynolds Ranch) into WDEQ Permit 633 is currently (January 2012) under technical review by the WDEQ.

SUA-1548 incorporates several remote satellite facilities, each of which is separately permitted by the State of Wyoming. The North Butte Remote Satellite WDEQ Permit to Mine 632 was originally issued to Uranerz USA, Inc. (Uranerz) in 1991. This permit was transferred from Uranerz to Pathfinder Mines Corporation (PMC) (aka Cogema) in 1992 and subsequently transferred to PRI in 2001. Cameco submitted updated baseline, operational and restoration information related to North Butte to WDEQ in April 2011. The permit update is currently in technical review. Cameco anticipates having the North Butte Remote Satellite in operation (pending NRC license condition approval and WDEQ Permit to Mine update approval) by 2013.

The Gas Hills Remote Satellite Permit to Mine was initially approved by the WDEQ in 2001 (Permit No. 687). Cameco submitted a permit update to WDEQ in 2009. The permit update is currently (December 2011) in the final stages of technical review. Additionally, BLM is preparing an Environmental Impact Statement (EIS) to address the ISR impacts to the land and water resources of the Gas Hills in accordance with NEPA regulations at 40 CFR 1500-1508 and BLM's Departmental Manual 516. It is anticipated that the EIS process will be completed in April 2012. Cameco anticipates that the Gas Hills Remote Satellite will be operational (pending NRC license condition approval, WDEQ Permit to Mine update approval, and BLM approval) by 2014.

The Ruth Remote Satellite Permit to Mine was initially approved by the WDEQ in 1990 as Permit No. 631 (Uranerz). This permit was first transferred to PMC and was later transferred to PRI in 2001. Cameco is not actively pursuing development of the Ruth Remote Satellite at the time of this LRA (January 2012). Prior to commencement of ISR activities, baseline environmental data, environmental impact analyses, and the operations and reclamation plans will be updated and provided to NRC.

1.5 Proposed Action: All SUA-1548 Licensed Facilities

Cameco is requesting that NRC Staff approve this LRA. This LRA includes updated technical information, detailed new technical information, a summary of SERPs, which have been subjected to numerous NRC inspections, updated MILDOS calculations and updated and new discussion on environmental resources, impacts and mitigative actions.

License Condition 10.2.1of SUA-1548 requires that before engaging in any commercial ISR activity *not previously assessed* by the NRC at the North Butte and Ruth Remote Satellites, Cameco must prepare a new *Operating Plan* in accordance with the guidance in NUREG-1569, for NRC review and approval and must also prepare and record an environmental evaluation of such activity.

On August 18, 2003, the NRC issued Amendment No. 5 to SUA-1548 approving the consolidation of the Highland, Ruth and North Butte licenses into SUA-1548. NRC had performed an environmental evaluation for North Butte in its 1990 EA which covered both the North Butte and Ruth facilities. Cameco may initiate operations of the North Butte remote satellite within the operating envelope previously reviewed and approved by the NRC Staff. Changes to plans at North Butte requiring additional evaluation include updated design plans for North Butte surge ponds and satellite facility as well as flow rate increases at the North Butte facility from the current approved flow rate of 17,034 to 23,000 liters/minute (4,500 to 6,000 gallons/minute). The MILDOS model has been revised to take into consideration the increased flow rate from 252 to 379 liters/second (4,000 to 6,000 gallons/minute), and that there will be no slurried or dried yellowcake produced at the North Butte Remote Satellite. Finally, the primary method for process waste water disposal will be UIC Class I disposal wells only rather than the previously assessed combination of disposal wells and solar evaporation ponds. The ponds to be built at North Butte will be used only to temporarily hold water to provide surge capacity for the disposal wells. All other aspects of the North Butte Remote Satellite Plan have not changed from the 1990 NRC Staff evaluation and EA. The above referenced changes are described within Sections 3.0, 4.0 and 6.0 of the TR and comprise Cameco's Operating Plan for the North Butte Remote Satellite. Cameco's EA of these changes is provided in the ER.

License Condition 10.3.2 of SUA-1548 requires that prior to the onset of commercial ISR activities at the Gas Hills Remote Satellite, Cameco must prepare a new Operations Plan in accordance with the guidance in NUREG-1569 for NRC review and approval. This requirement differs from the requirement for North Butte and Ruth in that it does not limit the submittal to *"those activities not previously assessed by the NRC"*.

NUREG-1569 provides guidance for the content of new license applications, renewals, and amendments. Figure 2 from NUREG-1569 describes the Operations plan as "Details on how a facility will be operated, and the basis for performance-based licenses." Several of the sections prescribed by the guidance and included in this LRA are useful for evaluating the overall context of Cameco's facilities within the affected environment. However, the *details on how the facilities will be operated and the basis for the performance-based license* are reflected in Sections 3 through 6 of NUREG-1569. These four sections require a description of the proposed facility, effluent control systems, operations, and restoration/decommissioning. Cameco therefore is defining Sections 3.0 through 6.0 as its updated Operations Plan for the Gas Hills Remote Satellite. The updated environmental evaluations encompassing these plans are provided in the ER.

Since Cameco is not actively developing the Ruth Remote Satellite at this time (January 2012) and available data for Ruth are limited, Cameco will defer submittal of an operating plan and updated environmental evaluation for Ruth until closer to the time of commencing operations. At that time,

Cameco will satisfy the outstanding requirement for the Ruth Remote Satellite in License Condition 10.2.1.

With this LRA, Cameco is also requesting authorization to increase the approved flow rate for the Reynolds Ranch Satellite from 17,000 to 23,000 liters/minute (4,500 to 6,000 gallons/minute.

Under the framework of this ER, Cameco has presented baseline data and information relating to the affected environment as well as a summary of potential impacts from the proposed action, and an evaluation of alternatives to the proposed action in accordance with NRC guidance provided in NUREG-1748. Cameco has completed an environmental evaluation of the proposed action and reasonable alternatives and is requesting that the NRC approve the proposed action.

SUA-1548 currently allows Cameco to receive and process up to 365 third party shipments of loaded IX resin at the CPP per calendar year. Within the framework of NRC's Equivalent Feed Policy (NRC-2011-0217), Cameco plans to receive third party shipments of loaded IX resin from other licensees at the refurbished Highland CPF. The loaded IX resin is no different than "equivalent feed" as defined in the Equivalent Feed Policy and should not require a license amendment to receive and process the material at the CPF or the CPP. Cameco is requesting that the NRC reauthorize the refurbished Highland CPF to receive slurried source material from third party licensees (toll processing) for the purpose of drying, packaging, and transporting the material to a uranium conversion facility on their behalf. This action was previously evaluated by the NRC Staff and subsequently approved on March 15, 1993 as Amendment No. 46 to NRC License SUA-1511 for the Highland Uranium Project (NRC, 1993).

1.6 Applicable Regulatory Requirements, Permits and Required Consultations

Prior to commencing operation at an ISR project in Wyoming, the operator must obtain a permit to mine, or an amendment to an existing permit, from the WDEQ. Additionally, because Wyoming is not a NRC Agreement state, a Source Material License or an amendment to an existing license must also be obtained from that agency. The Source Material License is a performance-based license and is valid for a 10-year period. Other State of Wyoming permits such as an Air Quality Permit, a Wyoming Pollutant Discharge Elimination System (WYPDES) Storm Water Discharge Permit, deep disposal well permit, etc., are also required and must be obtained prior to project start-up. Smith Ranch is an operating facility and has received all necessary state, local and federal permits and licenses. **Table 1-1, Smith Ranch Required Permits** lists the permits and licenses acquired for Smith Ranch. A listing of all state and federal permits and licenses required for the North Butte, Gas Hills and Ruth Remote Satellites are provided in **Table 1-2, North Butte Required Permits, Table 1-3, Gas Hills Required Permits, and Table 1-4, Ruth Required Permits**.

During the Reynolds Ranch amendment process, a Plan of Operations was submitted to the BLM in June 2009 in accordance with 43 CFR 3809. BLM approved the Plan of Operations on January 11, 2011. BLM performed an EA of the proposed amendment action, which was issued on January 7, 2011. NRC received the Reynolds Ranch amendment request in January 2005 and approved the amendment on January 31, 2007. Approval of the amendment request by WDEQ is pending.

There have been numerous official consultations held with the following agencies during the course of obtaining approval to operate and continuing to operate Wyoming ISR facilities: US Fish and Wildlife Service (USFWS), Wyoming Game and Fish Department (WGFD), Wyoming State Historic Preservation Office (SHPO), BLM, and the US Army Corps of Engineers (USACE). A record of these consultations is provided in **Table 1-5, Agency Consultations**.

1.7 References

Cameco Resources. 2011. Permit to Mine 633, Cameco Resources, Smith Ranch-Highland Uranium Project, 2010-2011 Annual Report.

U.S. Department of Energy, Energy Information Administration (EIA), 2011, Domestic Uranium Production Report, Data for 2010, report date June 2011. Available from website on the Internet as of January 2012: http://www.eia.gov/cneaf/nuclear/dupr/dupr.html.

U.S. Nuclear Regulatory Commission. 1993, Approval of Amendment No. 46 to SUA-1511 to allow receipt and processing of third party yellowcake slurry at the Highland Central Processing Facility, March 15, 1993.

U.S. Nuclear Regulatory Commission. 2011, Draft Regulatory Issue Summary, *Policy Regarding Submittal of Amendments for Processing of Equivalent Feed at Licensed Uranium Recovery Facilities;* Federal Register Notice NRC-2011-0217, Page 60941, September 30, 2011.

World Nuclear Association (WNA). 2012. World Nuclear Power Reactors and Uranium Requirements. Report date January 1, 2012. Available from website on the Internet as of January 2012: http://www.world-nuclear.org/info/reactors.html.

2.0 Alternatives

2.1 Detailed Description of the Alternatives

2.1.1 Proposed Action

As described in Section 1.0, the proposed action is to renew SUA-1548 for an additional 10-year period. Approval of this proposed action will allow Cameco to continue ISR uranium recovery operations at Smith Ranch and commence construction and operation of the North Butte, Gas Hills and Ruth Remote Satellites.

As presented in Section 3.3 of the TR the identified uranium ore bodies at Smith Ranch, and the North Butte, Gas Hills, and Ruth Remote Satellites have been shown to be amenable to the ISR process. The ISR process involves the circulation of a recovery solution (lixiviant) consisting of native groundwater infused with oxidizing and complexing agents, which is pumped into the ore zone through injection wells. Uranium dissolves into the recovery solution and is pumped to the surface using recovery wells. The recovered solution is passed through pressurized, down-flow IX columns where the uranium attaches to synthetic IX resins. After the uranium attaches to these resins, it is removed from the resin using a strong brine solution. Uranium is then precipitated, washed, filtered, pressed and dried into the final product-yellowcake.

Once uranium has been removed from the groundwater solution, this groundwater, less a small bleed rate which is treated and disposed, is re-infused with the oxidizing and complexing reagents and re-circulated through the recovery zone in a continuous process until the economically recoverable uranium resources in a given zone is removed. After uranium recovery is complete, groundwater in that area is restored to meet groundwater protection standards presented in 10 CFR 40, Appendix A, Criterion 5(B)(5) on a parameter-by-parameter basis using best practicable technology (BPT). If restoration activities are unable to achieve the background or maximum contaminant levels (whichever is greater) in Criterion 5(B)(5), a license amendment application request will be submitted to NRC for approval of alternate control limits (ACL), but only after demonstrating that there are no specific hazards and the restored constituent concentrations are as low as reasonably achievable (ALARA). After successful groundwater restoration has been achieved, all associated surface facilities will be subject to decontamination and decommissioning, and final reclamation requirements such that, ultimately, there will be no visual evidence of site use and the entire disturbance area can be released for "unrestricted use."

As part of this application, Cameco is requesting the following:

- Operations Plan for the Gas Hills Remote Satellite, including yellowcake slurry production, redesign of Evaporation Ponds 1 and 2, increase in satellite flow rate from 45,000 to 51,000 liters/minute (12,000 to 13,500 gallons/minute) and the use of underground injection control (UIC) Class I disposal wells, as defined later in this section.
- Operating Plan for the North Butte Remote Satellite, including redesigned surge ponds and satellite, increased satellite flow rate from 17,000 to 23,000 liters/minute (4,500 to 6,000 gallons/minute), use of UIC Class I disposal wells, removal of the slurry and dried product option at the satellite, as defined later in this section.
- Flow rate increases at the Reynolds Ranch Satellite from 17,000 to 23,000 liters/minute (4,500 to 6,000 gallons/minute).

- Refurbishment of the Highland CPF to allow processing of up to 1,400,000 kilograms (3,000,000 pounds) of dried yellowcake per year (approved into the license through the ORC/SERP process.
- Processing of toll shipments of slurried yellowcake from other licensed uranium recovery facilities at the Highland CPF. This action was previously evaluated by the NRC and approved on March 15, 1993 as Amendment 46 to Source and Byproduct Materials License SUA-1511 for the Highland Uranium Project.

With this ER, Cameco is presenting affected environment baseline data, a summary of potential impacts from the proposed action, and an evaluation of alternatives to the proposed action in accordance with NRC guidance provided in NUREG-1748. An environmental evaluation has also been completed. Cameco is requesting that the NRC approve the proposed action and environmental information and analysis for SUA-1548.

2.1.2 No-Action Alternative

10 CFR Part 51 as adopted by the NRC under NEPA requires that Cameco assess the no-action alternative. If the NRC chooses to deny the renewal of SUA-1548, Cameco would be forced to cease recovery operations at Smith Ranch and complete groundwater restoration, decontamination and decommissioning, and reclamation in a timely manner, leaving a valuable mineral commodity undeveloped. This denial would also affect the continued development of mineral resources at the North Butte, Gas Hills, and Ruth Remote Satellites. Each of these three remote satellites would go into immediate reclamation. Cameco currently has contracts for the sale of SUA-1548 uranium to be used as fuel in nuclear reactors. Denial of the LRA will impair Cameco's ability to deliver on these contracts and will have an impact on both national and international efforts to become independent of fossil fuels as a power generation source. Finally, denial of this LRA would result in significant adverse financial and economic growth impacts to Converse, Campbell, Fremont, Johnson, and Natrona Counties, where the sites are located, due to loss of tax revenue and jobs.

2.1.3 Alternative Action

In contrast to the ISR process, alternative extraction methods would most likely follow a more conventional open pit or underground mining extraction system. Conventional mining practices have been historically employed within portions of the SUA-1548 license area specifically: Smith Ranch (including Highland) and the Gas Hills. Conventional resource extraction would require creating an open pit or underground mine that extends down to the ore stratum. The uranium ore would be removed, loaded and transported to processing facilities. Historically an open pit was used to develop a highwall face and underground techniques were employed to remove additional ore. Overburden is generally removed by heavy equipment through the processes of ripping, loading and hauling. Conversely, drilling and blasting techniques may also be used to further expose the ore body. Removed material, such as topsoil and overburden would need to be stockpiled adjacent to the mine pit and by so doing enlarge the disturbance footprint. Potential groundwater infiltration to the open pit will require this water be pumped from the pit area to maintain access to the desired ore stratum.

Conventional open pit extraction often incorporates the need for conventional processing facilities to upgrade the raw ore into a concentrated form. A conventional mill will include all operations required to accomplish this concentration process including crushers, solution tanks, and concentration facilities. Sulfuric acid and an organic solvent are the typical reagents used to remove the uranium from the sand. Mill waste is delivered to a tailings pond located near the conventional mill. The heap leach process is a technology that is considered to be part of the conventional mining and milling industry (NRC, 2009).

Heap leaching includes placing ore in a heap and spraying the heap with an acid solution that separates the uranium from the ore. The uranium rich solution is then collected and transported to an IX or solvent extraction facility. Heap leaching requires some crushing and grading to build up the ore pile. Uranium recovery from heap leaching is expected to range from 50 to 80%, resulting in a final tailings material of around 0.01% U_3O_8 content. Once heap leaching is completed, the depleted materials are 11e.(2) byproduct material that must be placed in a tailings impoundment unless NRC grants an exemption for disposal in place. While impacts from heap leaching may be less than those from conventional milling, impacts from heap leaching are still greater than those associated with ISR processing. This type of alternative would increase potential environmental impacts and would increase the required effort needed to extract the ore content.

If uranium deposits exist at a depth too far below the surface for open pit extraction, underground mining techniques might be employed. These techniques would include a deep vertical shaft, cross cuts and drifts to provide access to remove the uranium ore. Typically a ventilation shaft or multiple ventilation shafts, manways and haulage ways would be required. The nature of the process and depth of mining would require dewatering and surface discharge of the dewatered groundwater. Although this process would produce less waste material compared to open pit, worker safety, cost and the environmental effects of dewatering must always be addressed.

From an environmental perspective, conventional underground and open pit production and the associated mills generate higher risks to employees, the public, and the environment. Radiological exposure to personnel in these processes is increased not only from the extraction process, but also from milling and the resultant mill tailings. Moreover, the personnel injury rate is traditionally much higher in open pit and underground extraction processes than has been the experience at ISR operations.

This ER compares the anticipated environmental impacts of the no-action alternative, the proposed action, and the alternative action as described above for all resource groups: land use, transportation, geology and soils, water resources, ecological resources, air quality, noise, historic and cultural resources, visual resources, socioeconomics, public and occupational health, and waste management. Section 4.0 presents the anticipated environmental impacts.

2.1.4 Reasonable Alternative Actions Considered but not Carried Forward for Detailed Analysis

2.1.4.1 Lixiviant Alternatives

A total of 24 years of operational experience at Smith Ranch and familiarity with several pilot programs prior to the commercial phase has shown that sodium carbonate/carbon dioxide lixiviant is very efficient at removing the uranium from the sandstone host rock with very little adverse environmental impact. At the North Butte Remote Satellite facility, the geology and mineralogy is similar to what is found at Smith Ranch. Initial laboratory testing at the Cameco Research Center in Port Hope, Ontario suggests that the cores tested can achieve recovery rates as high as 80% with a standard 1.0 g/L sodium carbonate lixiviant utilizing gaseous oxygen or liquid hydrogen peroxide as an oxidant. Alternatively, native groundwater can be fortified with a carbonate complexing agent of sodium bicarbonate and/or gaseous carbon dioxide to which the oxidant is added. Specific ratios of carbonate and oxidant concentrations are determined and modified as necessary during production.

Alternate recovery solutions include ammonium carbonate solutions and strong acidic solutions. Both of these solutions have been used in the past in ISR operations, but are now rarely used because of the difficulties in restoring and stabilizing the affected ore zone aquifers. As discussed in the final

Supplemental EIS for the Moore Ranch ISR Project (NRC, 2010a), acid-based lixiviants such as sulfuric acid dissolve heavy metals and other solids associated with uranium in the host rock creating chemical compounds that require additional remediation effort and have greater adverse environmental impacts. Strong acid lixiviants are now not considered to be viable options.

Ammonia-based lixiviants have been used in the past at ISR projects in Wyoming and other states. Operational experience has; however, shown that ammonia adsorbs onto clay minerals associated with the uranium host rock and then slowly desorbs from the clay fractions during aquifer restoration (NRC, 2010a). At the Irigaray ISR Project in Johnson County, Wyoming and ISR projects in other states traces of the ammonium bicarbonate lixiviant have been shown to remain in the aquifer even after extensive aquifer restoration attempts. Because of this and the great consumptive use of groundwater needed to restore an ammoniated mine unit, an ammonia-based lixiviant is now not considered to be a viable option.

2.1.4.2 Waste Management Alternatives

The primary liquid waste management methodology for Smith Ranch, North Butte, Gas Hills, and Ruth Remote Satellite locations is via UIC Class I disposal wells in conjunction with storage/surge pods and/or tanks to temporarily store the process liquid wastes prior to disposal. Geologic strata receiving these types of wastes are approximately 3,000 to 3,500 meters (9,000 to 10,000 feet) below the ground surface and are authorized by the State of Wyoming UIC Program and the US Environmental Protection Agency (EPA). An additional waste water disposal method at Smith Ranch consists of land application. Treated mine unit purge water is stored in a surface reservoir and land applied during the non-freezing months of the year. Deep well disposal is the only waste water disposal method proposed for the North Butte and Ruth Remote Satellite facilities. Evaporation ponds employing both conventional and enhanced evaporation are also proposed at the Gas Hills Remote Satellite. Cameco is exploring the option of installing disposal wells at the Gas Hills Remote Satellite to augment the evaporation disposal method. Should a receiver formation be identified, a UIC permit will be obtained and the wells will be installed prior to ISR operations.

All radioactive solid wastes are transported off site and disposed at an NRC-licensed disposal facility. Cameco currently has a contract with Denison Mines (USA), White Mesa Facility near Blanding, Utah for byproduct waste disposal.

2.2 Cumulative Impacts

The assessment of cumulative impacts in NEPA documents is required by regulations initially established by the Council on Environmental Quality (CEQ). Cumulative impacts; however, are not often fully addressed in NEPA documents due to the difficulty in understanding the complexities of these impacts, a lack of available information on their consequences, and the desire to limit the scope of environmental analysis. Completing an exhaustive analysis of all impacts to all resource groups is neither practical nor required by regulations. The CEQ indicates that an analysis of cumulative impacts should instead focus on 'meaningful impacts'.

Section 4.0 contains the anticipated environmental impacts associated with the alternatives described above for all resource groups: land use, transportation, geology and soils, water resources, ecological resources, air quality, noise, historical and cultural resources, visual resources, socioeconomics, public and occupational health, and waste management. In addition, this section evaluates the impacts of the proposed project on low-income and minority populations. The cumulative impacts analysis discusses in greater detail those impacts that are considered to be meaningful. Meaningful cumulative impacts are

discussed in relation to land use (Section 4.1), transportation (Section 4.2), water resources (Section 4.4), air quality (Section 4.6), noise (Section 4.7) and socioeconomics (Section 4.10). The following sections describe development and activities in the vicinity of SUA-1548 and presents predictive estimates of development in the area as made by state and federal agencies.

With the exception of the Gas Hills Remote Satellite, all SUA-1548 license areas are located in the southern portion of the Powder River Basin (**Figure 2.1, Powder and Wind River Basins**). The Powder River Basin is primarily rural in nature with abundant reserves of natural resources. Development of these natural resources, including coal, oil and gas, coal bed methane (CBM), wind energy, and uranium, drive the economic growth of the region now and presumably in the near future. Along with the energy industry, agriculture, manufacturing, and tourism also contribute to the economy of this part of Wyoming.

The Gas Hills Remote Satellite is located approximately 145 kilometers (90 miles) west-southwest of the Smith Ranch CPP and is located in the Wind River Basin. The Powder River Basin and Wind River Basin are separated by the Casper Arch, a large, northwest trending asymmetric anticlinal structure that connects the Bighorn Mountains with the Laramie Mountains (WSGS, 2011). This region is differentiated from the Powder River Basin in several respects. Energy development in the Wind River Basin is limited to uranium mining, and oil and gas production. Dominant vegetation type also shifts from herbaceous grasslands to brushland. Because of the distance and physiographic differences between the Gas Hills Remote Satellite and all other SUA-1548 sites, the cumulative impact analysis separately addresses the Powder River and Wind River Basins.

2.2.1 Powder River Basin

The Powder River Basin of Wyoming and Montana is a major energy development area with diverse environmental values. The Powder River Basin is the largest coal-producing region in the United States and coal mined in this basin is used to generate electricity both within and outside the region. The Powder River Basin also has produced, and continues to produce large quantities of oil and natural gas resources. Within the last decade, this region has also experienced nationally significant development of CBM. Smith Ranch, the North Butte and Ruth Remote Satellites are all in the Powder River Basin, and the cumulative impacts associated with these sites are addressed in the following sections.

2.2.1.1 Uranium Production

Wyoming has been the nation's leading producer of uranium since 1995, and also hosts the nation's largest uranium reserves (WSGS, 2011). Numerous uranium recovery sites, both potential and existing, are present in the Powder River Basin. Three additional uranium recovery operations are currently licensed in the Powder River Basin. The Willow Creek ISR facility, formerly known as the Christensen/Irigaray facility, is located in southeast Johnson County, approximately 145 kilometers (90 miles) north-northeast of Casper (**Figure 2.2, Regional Uranium Mining**). The Willow Creek facility is 16 kilometers (10 miles) northwest of the North Butte Remote Satellite. The NRC recently issued a license for the Moore Ranch ISR project, owned by Uranium One (dba Energy Minerals Corporation). The Moore Ranch Project is approximately 19 kilometers (12 miles) east of the Ruth Remote Satellite (SUA-1548). The Nichols Ranch ISR Project, operated by Uranerz, consists of the Nichols Ranch and Hank Unit properties, and is also licensed by NRC. The Nichols Ranch Project is approximately 8 kilometers (5 miles) south of the North Butte Remote Satellite and 18 kilometers (11 miles) north-northeast of the Ruth Remote Satellite.

Due to increased overall demand for energy in recent years, uranium spot prices increased from a low of $7 per pound in 2001 to over $138 per pound in 2007 and are currently (2011) around $52 per pound.

Long-term contract prices are typically higher. In response to the increased price of uranium, additional uranium development is anticipated within the Powder River Basin. NRC expects to receive additional applications for new uranium recovery facilities, as well as requests for restarts and expansions of existing facilities. The actual number of the proposed developments that will become operational will depend on several factors, including uranium prices and approval of permits and licenses. A list of all major uranium recovery license applications and their associated status can be found in **Table 2-1, Major Uranium Recovery Licensing Applications**. The information in **Table 2-1** was last updated on October 12, 2011.

Absent any site-specific features that could preclude development of these other sites (e.g., historical and cultural resources), ISR operations at additional sites likely will result in essentially the same potential impacts analyzed in this ER for the proposed action. Development of these sites may produce cumulative effects by increasing or prolonging the impacts analyzed for the proposed action, but the impacts will be distributed proportionately throughout the region of influence and therefore are not expected to significantly increase the severity of any impact. Such impacts will be appropriately addressed through license and permit amendments when any development plans are finalized.

2.2.1.2 Coal Production

BLM recently completed a regional technical study, titled the Powder River Basin Coal Review (Coal Review). The Coal Review assesses cumulative impacts associated with past, present, and reasonably foreseeable development in the Powder River Basin. For purposes of this study, the Wyoming portion of the Powder River Basin study area comprises all of Campbell County, all of Sheridan and Johnson Counties less the Bighorn National Forest lands to the west of the Powder River Basin, and the northern portion of Converse County. It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM High Plains District Office, and a portion of the Thunder Basin National Grasslands, which is administered by the US Forest Service (USFS). The goals of the Coal Review are to:

- Identify existing resource conditions in the Powder River Basin for the baseline year (2003) and, for applicable resources, update the BLM's 1996 status check for coal development in the Powder River Basin.
- Define past and present development activities in the Powder River Basin and their associated development levels as of 2003 and develop a forecast of reasonably foreseeable development in the Powder River Basin through 2020. The reasonably foreseeable activities fall into three broad categories: coal development; oil and gas development, including major transportation pipelines; and other development, which includes development that is not energy-related as well as other energy-related development.
- Predict cumulative impacts that could be expected to occur to air, water, socioeconomics, and other resources if the development occurs as projected in the forecast developed under the second task.

For the purposes of this cumulative impact analysis, the Coal Review will be the foundation for the discussion of cumulative impacts as they relate to coal, oil and gas, CBM, and wind energy development in the Powder River Basin.

Past, present, and reasonably foreseeable development in the Wyoming Powder River Basin were considered in the Task 1 and Task 2 reports for the Coal Review. The Task 1 report describes the existing situation as of the end of 2003, which reflects the past and present levels of development. The Task 2

report defines the past and present development activities in the Powder River Basin as of the end of 2003 and projects reasonably foreseeable development in the Powder River Basin through 2020. Task 2 was updated based on actual levels of development through 2007 and current development estimates available through year 2009 (BLM, 2009).

There are currently 13 operating coal mines in the Wyoming Powder River Basin. The Coal Review has grouped coal development by subregion. Subregions 2 and 3 are within 80 kilometers (50 miles) of SUA-1548 sites. The coal projects associated with Subregions 2 and 3 are listed below:

- Subregion 2 (South Gillette) – Belle Ayr, Caballo, Coal Creek, and Cordero-Rojo mines.
- Subregion 3 (Wright) – Antelope, North Rochelle/Black Thunder, Jacobs Ranch, and North Antelope/Rochelle mines.

The closest of these coal mines to the SUA-1548 license boundary is Coal Creek, which is located approximately 52 kilometers (31 miles) from the North Butte Remote Satellite. From 1989 to 2008, coal production in the Powder River Basin increased by an average of 6% per year. In 2009, production from the Wyoming Powder River Basin coal mines dropped by about 7% from the 2008 levels, the first drop since the early 1990s. This drop coincided with a national coal production decline due to reduced industrial electricity demand in 2009.

Due to the variables associated with future coal production, two coal production levels (an upper and a lower production level) were projected for the Coal Review to bracket the most likely foreseeable regional coal production level and to provide a basis for quantification of associated impact-causing parameters. The basis for the projected production ranges included: 1) an analysis of historic Powder River Basin production levels in comparison to the gross domestic product (GDP) and national coal demand; 2) an analysis of current Powder River Basin coal market forecasts that model the impact of GDP growth, potential regulatory changes affecting coal fired power plants, and mining and transportation costs on Powder River Basin coal demand; 3) the availability, projected production cost, and quality of future mine-specific coal reserves within the Powder River Basin region; and, 4) the availability of adequate infrastructure for coal transportation. The projected upper and lower production levels subsequently were allocated to coal mine subregions in the Powder River Basin and to individual mines based on past market shares. Individual mine production levels were reviewed relative to potential future production constraints (e.g., loadout capacities), permitted production levels, mining costs, and coal quality.

The projected upper and lower production levels were allocated to individual mines based on past market shares. Then the projected future production was aggregated on a subregion basis. **Figure 2.3, Projected Coal Development in the Powder River Basin – Lower Limit** and **Figure 2.4, Projected Coal Development in the Powder River Basin – Upper Limit** graphically show the expansion of Wyoming coal development at the lower and upper production levels. **Table 2-2, Wyoming Powder River Basin Coal Development by Subregion** lists not only production projections, but also anticipated land disturbance acreage, reclamation status, employment and water consumption, and production associated with coal development in Subregions 2 and 3 (those within 80 kilometers [50 miles]) of SUA-1548 sites.

There is no current or reasonably foreseeable coal development (conventional mining) near the SUA-1548 license areas, and therefore it is anticipated that these same uses will remain compatible with ISR uranium production.

2.2.1.3 Oil and Gas Production

According to the Coal Review, early oil exploration in the Powder River Basin was based on direct evidence of surface seeps or drilling anticlinal structures that were exposed on the surface. Oil was first produced from the Powder River Basin in 1887 from the Newcastle Formation on the east side of the Basin near Moorcroft (BLM, 2009). During the 1930s, low prices depressed exploration in the Basin. After World War II, a new round of exploration began with extensive use of seismic surveys to look for structural traps that could not be readily verified from surface mapping. In the 1960s and 1970s, drilling moved into deeper parts of the Basin as new and prolific oil fields were discovered in upper and lower Cretaceous rocks (BLM, 2009).

Within the Powder River Basin study area, conventional oil and gas activity has declined in the last 15 years with only 1,500 new wells over the period from 1990 to 2003. These wells include producing, injection, and wildcat (exploration) wells. The only significant discovery has been the African Swallow Field, discovered in 2000, which produced over a million barrels of oil and 14 billion feet^3) of gas from two wells by the end of 2003 (BLM, 2009). As of the end of 2003, there were approximately 3,500 productive conventional oil and gas wells in the Wyoming Powder River Basin study area plus 1,386 seasonally active wells (BLM, 2009). **Figure 2.5, Regional Coal, CBM, Oil and Gas** shows the location of all wells (producing, non-producing, and plugged and abandoned). Approximately 13 million barrels of oil and 1 billion meters^3 (41 billion feet$^{3)}$ of conventional gas (20.24 million barrels of oil equivalent [BOE]) were produced from these wells in 2003 based on Wyoming Oil and Gas Conservation Commission (WOGCC) (2004) data; Information Handling Services (2004) data report approximately 13 million barrels of oil and approximately 1 billion meters^3 (41 billion feet^3) of conventional gas. According to a 2002 estimate by the US Geological Survey (USGS), the mean undiscovered non-coal bed hydrocarbon resource in the Powder River Basin (including Montana) is 1.8 BOE (BLM, 2009).

By the end of 2007, there were approximately 3,857 productive conventional oil and gas wells in the Wyoming Powder River Basin study area plus an estimated 1,500 seasonally active wells (BLM, 2009). Approximately 11 million barrels of oil and 62 million meters^3 (22 billion feet^3) of conventional gas were produced from these wells in 2007 based on WOGCC 2008 data (BLM, 2009).

The probability for new oil and gas activities (including CO_2 enhanced oil recovery and associated pipelines) to occur in the future is a certainty; however, the level of activity is uncertain. **Table 2-3, Projection of Conventional Oil and Gas Activity** summarizes the projected production, number of wells, and long-term disturbance associated with conventional oil and gas development through 2020. From 1990 to 2004, a total of approximately 1,500 wells were drilled in the study area (BLM, 2009). Of those, 60% were development wells drilled in established producing areas. The other 40% of wells were classified as wildcat wells or wells drilled outside of producing areas or wells drilled to test non-producing prospective zones in producing areas.

Oil and gas development has always been compatible with the extensive amount of energy development in the Powder River Basin and it is anticipated that these same uses will remain compatible with ISR uranium production.

2.2.1.4 Coal Bed Methane Production

According to the Coal Review, CBM activity began in the 1980s and it took a number of years to become commercially viable. The first commercial gas production directly from coal seams occurred in 1989 at Rawhide Butte north of Gillette (BLM, 2009). Annual submission of Applications for a Permit to Drill (APD) did not exceed 100 until 1992. Commercially viable production was proven in the late 1990s and the number of APD submitted began to soar: 561 in 1996, 808 in 1997, 1,494 in 1998, and 5,101 in 1999

(BLM, 2009). In the 1-year period from June 2003 to May 2004, over 6,700 APDs were received statewide by the WOGCC.

Development moved from the Gillette area and spread to the west and northwest. At the end of 2003, there were 14,758 producing CBM wells in the study area and total production for 2003 was 9.8 billion meters^3 (346 billion feet^3), or 88% of the total gas production from the basin (BLM, 2009). From 1987 to 2003, the total cumulative gas production from Powder River Basin coals was over 34 billion meters^3 (1.2 trillion feet^3). The total water production for the same time period was approximately 2.3 billion barrels. Annual methane production has increased rapidly since 1999 and as of 2003 appeared to have started to level off or even decrease. Water production decreased slightly; however, it still was more than 500 million barrels during 2003. In 2003, the average CBM production was 30 million meters^3/day (900 million feet^3/day) (BLM, 2009). CBM production appeared to have peaked from a high of 28 million meters^3/day (977 million feet^3/day) in October 2003 to 25 million meters^3/day (899 million feet^3/day) in March 2004 (BLM, 2009). In 2007, the annual CBM production was 12 million meters^3 (432 million feet^3). CBM wells in the Wyoming Powder River Basin study area as of the end of 2007 are shown on **Figure 2.5, Regional Coal, CBM, Oil and Gas**.

The future of CBM development is highly sensitive to the price of gas. For a number of years, Wyoming natural gas production has been affected by the so-called price differential. The price differential represents a difference in market value resulting from inadequate pipeline capacity to move Rocky Mountain region gas to markets outside of the area. Historically, the differential has been as high as $2.40 per million British thermal units (BTU) (BLM, 2009). Three hundred meters (1,000 feet) is roughly equivalent to 1 million BTU. The differential was somewhat eased in 2003 with the opening of the Kern River Pipeline expansion that moves gas from southwestern Wyoming, northwestern Colorado, and northeastern Utah. At that time, the differential went from $1.86 per million BTU to $0.60 per million BTU (BLM, 2009). However, the addition of the Kern River system capacity did not completely solve the differential problem.

As described in the Coal Review, the impacts to the CBM resource associated with various water disposal methods were evaluated in 2002. The recoverable CBM resource would be in the range of 20 to 760-820 billion meters^3 (29 trillion feet^3) if the price differential drops and remains at $28.00 per 1,000 meters^3 ($0.80 per thousand feet^3) or less, and gas prices in general remain at reasonable long-term levels ($125.00 per 1,000 meters^3 [$3.56 per thousand feet^3 or equivalent to crude oil at $25 per barrel]). In spite of recent record highs for crude oil, the long-term forecast (10 years or more) for crude oil prices is expected to be around $25 per barrel (BLM, 2009). The size of the differential would be dependent upon the magnitude of production capacity in the Wyoming Powder River Basin and available pipeline capacity to deliver the gas to external markets. As a comparison to the ARI estimate, the USGS (2002) estimated that the undiscovered CBM resource in the Powder River Basin is 4.05 trillion meters^3 (14.3 trillion feet^3).

The amount of CBM activity appears to be at a lower rate than was forecast by earlier projections in the Final EIS and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project (BLM, 2009). New CBM well numbers fell from a high of slightly more than 4,600 in 2001 to approximately 2,000 in 2004. It is anticipated that the number of new wells would increase so that between 2010 and 2020 the number of new wells drilled per year basin-wide would range between 2,892 and 3,943. As shown in **Table 2-4, Projection of Coal Bed Methane Activity** there would be 31,943 CBM wells basin-wide by 2010, much lower than the over 40,000 wells predicted for the same time period in the Final EIS and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project (BLM, 2009). It is anticipated that production within the cumulative effects study area would increase from the 12 million meters^3

(432 million feet^3) per year observed in 2007 to approximately 29 million meters^3 (1,026 million feet^3) per year in 2020.

CBM has always been compatible with other energy development and agriculture and it is anticipated that this same use will remain compatible with ISR uranium production.

2.2.1.5 Wind Energy Production

At the time of the Coal Review in 2009, no wind energy generating projects were in existence in the Powder River Basin. However, due to increasing concerns over global climate change, there is strong interest from consumers, investor-owned utilities, and environmental and economic sustainability groups in the development of wind energy and other forms of renewable energy projects. The current development interest in wind energy generation is driven in part by mandates for many utilities to increase the use of renewables in their overall energy portfolio, decisions by environmentally conscious firms to use renewable energy sources, and also due to the development of wind energy manufacturing infrastructure in the region.

Wyoming ranks among the top locations in terms of wind energy potential. Although much of the current Wyoming development is in the southern portion of the state, areas in both Converse and Campbell Counties offer sufficient potential to support commercial-scale wind generation projects. One such project currently in operation is a three-phase project in Converse County owned and operated by PacifiCorp. The first two phases, known as the Glenrock Wind Energy Project and the Rolling Hills Wind Energy Project, initiated construction in 2008 and began operations in 2008 and 2009, respectively (BLM, 2009). These projects are immediately adjacent to Smith Ranch (**Figure 2.6, Regional Power Generation**). The third, currently unnamed phase is anticipated to be constructed between 2009 and 2011, depending on market demands and the performance of the first two phases. Each phase consists of 66 wind turbine generators (each rated at 1.5 MW [99-MW total]) mounted on 80-meter (260 feet) tall tubular towers, plus ancillary support facilities (BLM, 2009).

Wind energy production is currently compatible with licensed activities at Smith Ranch and it is anticipated that these same uses will remain compatible with ISR uranium production as defined by this LRA.

2.2.1.6 Other Land Uses

Other land uses in the Powder River Basin include agriculture and recreation. Federal actions regarding land uses in the general region of SUA-1548 have been analyzed for environmental effects in numerous programmatic and project-specific EISs as listed in Tables 5.2-3, 5.2-4 and 5.2-5 of the ISR Generic EIS. The majority of the lands within 8 kilometers (5 miles) of Smith Ranch, the North Butte Remote Satellite, and the Ruth Remote Satellite are privately owned and recreational activities such as hunting are closely controlled.

Grazing is the primary agricultural land use in and around each of the SUA-1548 license areas in the Powder River Basin. The U.S. Department of Agriculture, National Agricultural Statistics Service conducts a Census of Agriculture once every five years, most recently in 2007 (NASS, 2007). The Census of Agriculture collects information concerning all areas of farming and ranching operations including production expenses, market value of products and operator characteristics. **Table 2-5, Powder River Basin Livestock Grazing – 2007** presents data on cattle and calves, sheep and lambs as well as horses and ponies for Converse County (Smith Ranch), Campbell County (North Butte Remote Satellite), and Johnson County (Ruth Remote Satellite). Converse County ranks first among Wyoming's 23 counties for sheep and lamb production but significantly lower for cattle (12th) and horses (18th). Campbell County

ranks 6th for cattle and 5th in the state for both sheep and horse production. Johnson County ranks 16th in the state for cattle and 6th and 12th for sheep and horses, respectively (NASS, 2007).

These uses have always been compatible with the extensive amount of energy development and it is anticipated that these same uses will remain compatible with ISR uranium production.

2.2.2 Wind River Basin

The Wind River Basin is a semi-arid intermontane structural basin in central Wyoming. It is bounded by Laramide uplifts on all sides: Wind River Range on the west; Owl Creek Mountains on the North; the Casper Arch on the east; and the Sweetwater Uplift (Granite Range) to the south.

The thick interbasinal sedimentary formations are significant producers of petroleum and natural gas. The basin contains over 60 oil and gas fields mostly as structural traps within 17 different formations. The primary reservoirs include the Pennsylvanian Tensleep Sandstone, the Permian Phosphoria Formation and the Cretaceous Muddy Creek and Frontier Formations.

Unlike the Powder River Basin, there are no significant coal or wind energy projects in the Wind River Basin. The sections below describe current and projected future development in the Wind River Basin in the areas of uranium, oil and gas, and CBM.

The Gas Hills Remote Satellite is the only SUA-1548 satellite in the Wind River Basin (**Figure 2.1**). The discussion of cumulative impacts to follow is limited to impacts associated with the Gas Hills Remote Satellite.

2.2.2.1 Uranium Production

Uranium development within the Wind River Basin began in the early 1950s and continued until the decline in the market in the early 1980s. Nearly all of the historical production was conventional mining and included large surface mine pits, overburden and topsoil stockpiles, some underground mining, conventional milling and uranium heap leach facilities. The majority of these mines have either been reclaimed or are in various stages of reclamation or abandonment depending on federal or state reclamation obligations and enforcement actions. The WDEQ Abandoned Mine Land (AML) Division is responsible for reclamation of eligible non-coal (i.e., uranium disturbances) within the Wind River Basin.

Uranium recovery is not presently active in the Wind River Basin. There are several reasonably foreseeable projects including the Gas Hills Remote Satellite that reflect different stages of the license and permit application process in the region. Major uranium resources and the associated development potential within the Wind River Basin are located in the Gas Hills, Jeffrey City and the Green Mountain areas.

In addition to the Gas Hills Remote Satellite, Strathmore Minerals Corporation is in the process of permitting and licensing a Gas Hills Project within 10 kilometers (6 miles). A letter of intent for the Strathmore Gas Hills Project was submitted to the NRC on November 19, 2010 (**Table 2-1**). According to **Table 2-1**, Strathmore is intending to license a new conventional surface uranium mining and processing operation and anticipates submitting a license application to the NRC in September 2012. On February 10, 2011 Strathmore presented the concept for a uranium recovery facility using heap leach to the NRC at the site of the AML reclaimed Sagebrush Tablestakes Mining Area.

Titan Uranium, Inc. (Titan) is in the process of licensing and permitting a heap leach facility in the Green Mountain area called the Sheep Mountain Project, located within 80 kilometers (50 miles) of the Gas Hills Remote Satellite (**Figure 2.2**). This area was previously disturbed by conventional mining and Titan

is proposing both conventional surface and underground mining. The BLM Lander Field Office, announced their intent to prepare an EIS on August 23, 2011. This announcement marked the beginning of the scoping process to solicit public comments regarding issues and resource information for the proposed Sheep Mountain Uranium Project in Fremont County. The Sheep Mountain Project will reclaim not only the past effects of historic mining, but will reclaim their new disturbance. The heap will be reclaimed in-place after the ore has been fully leached, rinsed of leachate, and drained. Titan had a pre-submittal audit meeting with the NRC in October 2011.

2.2.2.2 Oil and Gas Production

Conventional oil and natural gas as well as liquid natural gas are the primary (non-uranium) energy materials extracted within the Wind River Basin. Oil and gas development across the state is expected to remain stable or increase over the next 20 years with the majority of activity currently occurring, or predicted to occur, in areas open to leasing having very high, high, and moderate potential for future development of oil or gas reserves (BLM, 2009).

The USGS assessed both undiscovered conventional oil and gas and undiscovered continuous (unconventional) oil and gas in the Wind River Basin. The assessment is based on the geologic elements of each total petroleum system (TPS) defined in the province, including hydrocarbon source rocks (source-rock maturation, hydrocarbon generation, and migration), reservoir rocks (sequence stratigraphy and petrophysical properties), and hydrocarbon traps (trap formation and timing). The USGS assessment estimated 68 million meters^3 (2.4 trillion feet^3) of gas, 41 million barrels of oil, and 20.5 million barrels of total natural gas liquids (for the three total petroleum systems in the Wind River Basin. The majority of the undiscovered gas resource, 81% or 54 billion meters^3 (1.9 trillion feet^3) of gas, is interpreted as continuous and is contained within the Cretaceous-Tertiary TPS. The continuous gas is contained within seven assessment units (AU) of the Cretaceous-Tertiary TPS including: Frontier-Muddy Continuous Gas AU 1.4 billion meters^3 (0.48 trillion feet^3 of gas), Cody Sandstone Continuous Gas AU 3.4 billion meters^3 (0.12 trillion feet^3 of gas), Mesaverde Meeteetse Sandstone Gas AU 1.2 trillion meters^3 (0.38 trillion feet^3 of gas), Lance-Fort Union Sandstone Gas AU 11 billion meters^3 (0.71 trillion feet^3 of gas), Mesaverde Coalbed Gas AU 3.1 billion meters^3 (0.11 trillion feet^3 of gas), Meeteetse Coalbed Gas AU 6.1 trillion meters^3 (0.02 trillion feet^3 of gas), and Fort Union Coalbed Gas AU 3.4 billion meters^3 (0.12 trillion feet^3 of gas) (USGS, 2005).

Conventional oil and gas production occurs within the Gas Hills Uranium Mining District and within 10 kilometers (6 miles) of the Gas Hills Remote Satellite. All of the oil and gas producing formations are present within the mining district (USGS, 2005). The Dutton Anticline arch is located 5 kilometers (3 miles) north of the Gas Hills Remote Satellite. These uses have always been compatible with the extensive amount of conventional uranium mining and it is anticipated that these same uses will remain compatible with ISR uranium production.

2.2.2.3 Coal Bed Methane Production

As discussed in Section 2.2.1.4, the future of CBM development is highly sensitive to the price of gas. For a number of years, Wyoming natural gas production has been affected by the so-called price differential. The price differential represents a difference in market value resulting from inadequate pipeline capacity to move Rocky Mountain region gas to markets outside of the area. Historically, the differential has been as high as $2.40 per million BTU (Holcomb, 2003) (28 meters^3 or 1,000 feet^3 is roughly equivalent to 1 million BTU). The differential was somewhat eased in 2003 with the opening of the Kern River Pipeline expansion that moves gas from southwestern Wyoming, northwestern Colorado, and northeastern Utah. At that time, the differential went from $1.86 per million BTU to $0.60 per million

BTU (BLM, 2009). However, the addition of the Kern River system capacity did not completely solve the differential problem.

As described in the Coal Review, the impacts to the CBM resource associated with various water disposal methods were evaluated in 2002. The recoverable CBM resource would be in the range of 6 to 8 trillion meters^3 (20 to 29 trillion feet^3) if the price differential drops and remains at $28 million meters^3 ($0.80 per million feet^3) or less, and gas prices in general remain at reasonable long-term levels $125 per million meters^3 ($3.56 per million feet or equivalent to crude oil at $25 per barrel). In spite of recent record highs for crude oil, the long-term forecast (10 years or more) for crude oil prices is expected to be around $25 per barrel (Winnecke, 2003). The size of the differential would be dependent upon the magnitude of production capacity in the Wyoming Powder River Basin and available pipeline capacity to deliver the gas to external markets. As a comparison to the ARI estimate, the USGS (2002) estimated that the undiscovered CBM resource in the Powder River Basin is 4.05 trillion meters^3 (14.3 trillion feet^3).

CBM development is currently taking place in the Wind River Basin (**Figure 2.7, CBM in the Wind River Basin**). There are three CBM fields approximately 56 to 72 kilometers (35 to 45 miles) due west of the Gas Hills Remote Satellite. The Beaver Creek field is 56 kilometers (35 miles) west of the Gas Hills Remote Satellite and is extracting CBM from the Mesa Verde Formation. The Riverton Dome and WC Fremont County -1 fields are 61 kilometers (38 miles) and 72 kilometers (45 miles) west of the Gas Hills Remote Satellite respectively. Similar to the Beaver Creek Field, these two fields extract CBM from the Mesa Verde Formation.

While CBM development is present in the Wind River Basin, the proven reserves are a fraction of the total U.S. reserves. Five small basins (Wind River, Illinois, Piceance, Gulf Coast and Forest City) combine to make up 0.3% of the total proven U.S. reserves. By contrast, the Powder River Basin contains 12.3% of the total proven U.S. reserves. The Potential Gas Committee released a report in 2006 entitled "Potential Supply of Natural Gas in the United States" (www.mines.edu/research/pga/index .html) containing recoverable resource estimates for CBM in the U.S. The recoverable resource estimates of CBM are those volumes which are potentially recoverable under existing and foreseen technological conditions. These resources have not yet been developed, and do not include proved reserves or cumulative production show in the projected recoverable reserves across the U.S. The four north Rocky Mountain Basins (Wind River, North Central, Big Horn, and Williston) together comprise 3% of the projected U.S. reserves. In contrast the Powder River Basin alone comprises 11% of the projected U.S. reserves. CBM development in the Wind River Basin is anticipated to be significantly less than that in the Powder River Basin.

There is no current or reasonably foreseeable CBM in the Gas Hills Uranium District or within 10 kilometers (6 miles) of the Gas Hills Remote Satellite (SUA-1548).

2.2.2.4 Other Land Uses

Other land uses in the Wind River Basin include agriculture and recreation. Since much of the land is federal surface, there is extensive grazing, hunting, and similar recreational uses. Grazing is the primary agricultural land use in and around the SUA-1548 sites in the Wind River Basin. The U.S. Department of Agriculture, National Agricultural Statistics Service conducts a Census of Agriculture once every 5 years, most recently in 2007 (NASS, 2007). The Census of Agriculture collects information concerning all areas of farming and ranching operations including production expenses, market value of products and operator characteristics. **Table 2-6, Wind River Basin Livestock Grazing – 2007** presents data on cattle and calves, sheep and lambs as well as horses and ponies for Freemont and Natrona Counties (Gas Hills

Remote Satellite). Freemont County ranks 1st in the state for horse production, 2nd for cattle production, and 8th for sheep production. Natrona County ranks 4th in the state for sheep production and 10th and 13th in cattle and horse production respectively (NASS, 2007).

No fishing takes place on federal land within the Gas Hills and generally hunting is confined to antelope and small game. These uses have always been compatible with the extensive amount of conventional uranium mining and it is anticipated that these same uses will remain compatible with ISR uranium production.

2.3 Comparison of the Predicted Environmental Impacts

Table 2-7, Predicted Environmental Impacts provides a summary of the environmental impacts for the no-action alternative (Section 2.1.2), the proposed action (Section 2.1.1), and the alternative action (Section 2.1.3.). Environmental impacts are discussed in greater detail in Section 4.0.

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3.0 Description of Affected Environment

3.1 Land Use

3.1.1 Project Location

SUA-1548 covers all ISR activities at Smith Ranch (Smith Ranch, Highland and the Reynolds Ranch Satellite), the North Butte Remote Satellite, the Gas Hills Remote Satellite and the Ruth Remote Satellite (**Figure 1.1**). The Smith Ranch CPP, Highland CPF and the associated satellites (Satellite 1, Satellite 2, Satellite 3, SR-1, SR-2 and Reynolds Ranch) are located in the southern portion of the Powder River Basin in Converse County. These properties are approximately 40 kilometers (25 miles) north of Douglas and 39 kilometers (24 miles) northeast of Glenrock.

The North Butte Remote Satellite, also in the southern Powder River Basin is in southwest Campbell County, approximately 80 kilometers (50 miles) north of Smith Ranch. The North Butte Remote Satellite is approximately 8 kilometers (5 miles) north of the Hank and Nichols Ranch uranium projects and approximately 16 kilometers (10 miles) southeast of the Irigaray and Christenson Ranch uranium projects.

The Gas Hills Remote Satellite is located in Fremont County, and is approximately 150 kilometers (94 miles) west of the CPP at Smith Ranch. The Gas Hills is a historic uranium mining district and was conventionally mined from the early 1950s through the late 1970s. The majority of uranium mine reclamation was completed. Additional AML reclamation will be active through at least 2015. Strathmore Minerals Corp. (Strathmore) has interests approximately 4 kilometers (2.5 miles) north of the Gas Hills Remote Satellite. Other proposed licensed facilities include the Titan Uranium USA, Inc. (Titan) Sheep Mountain proposed heap leach and conventional mine approximately 45 kilometers (28 miles) to the south-southwest.

The Ruth Remote Satellite is in Johnson County, and is located 23 kilometers (14 miles) south-southwest of the North Butte Remote Satellite, 11 kilometers (7 miles) south-southwest of the Hank and Nichols Ranch uranium projects, and 19 kilometers (12 miles) west of the Uranium One Moore Ranch uranium project.

3.1.2 Regional Land Use

NRC Regulatory Guide 3.8 suggests that the impacts associated with the proposed action be evaluated for all areas within 80 kilometers (50 miles) of the site, (NRC, 1982). To provide consistency with this analysis, this section evaluates regional existing land use conditions within 80 kilometers (50 miles) of all properties covered under SUA-1548.

With the exception of the Gas Hills Remote Satellite, all properties within SUA-1548 are located in the southern portion of the Powder River Basin. The Powder River Basin is primarily rural with abundant reserves of natural resources. Development of these natural resources, including uranium, coal, oil and gas, CBM, and wind energy drive the economic growth of the region now and presumably into the future. Along with the energy industry, agriculture, manufacturing and tourism also contribute to the economy of this part of Wyoming.

The Gas Hills Remote Satellite is located approximately 145 kilometers (90 miles) west-southwest of the other facilities, in the Wind River Basin. The Powder River Basin and the Wind River Basin are separated by the Casper Arch, a large, northwest trending asymmetric anticlinal structure that connects the Bighorn Mountains with the Laramie Mountains (WSGS, 2011b). This region is differentiated from the Powder River Basin in several respects. Energy development in the Gas Hills is limited to uranium mining

and oil and gas production. Vegetation type also shifts from being dominated by herbaceous grasslands to brushland.

Land ownership was assessed within an 80 kilometer (50 mile) radius around all operations within SUA-1548 (**Figure 3.1.1, Regional Ownership**). In the case of the properties located within the Powder River Basin (Smith Ranch, North Butte Remote Satellite and Ruth Remote Satellite) the majority of the surrounding lands are privately owned (**Table 3.1-1, Regional Ownership**). Seventy percent of the land within 80 kilometers (50 miles) of Smith Ranch is privately owned as is a comparable portion around the North Butte Remote Satellite (71%) and the Ruth Remote Satellite (67%). The BLM and State of Wyoming own the majority of the remaining surrounding lands around these properties (**Table 3.1-1**. The Department of Defense, Bankhead Jones, the USFS and the U.S. Bureau of Reclamation all hold less than 5% of the lands within 80 kilometers (50 miles) of the above mentioned properties. The majority of the lands within 80 kilometers (50 miles) of the Gas Hills Remote Satellite are public lands administered by the BLM (63%) followed by private (25%) and the State of Wyoming (9%). The USFWS and Bureau of Indian Affairs each own less than 5% of the lands within 80 kilometers (50 miles) of the Gas Hills Remote Satellite. Smith Ranch (Reynolds Ranch Satellite) has an approved BLM Plan of Operations. Approval of the Gas Hills Plan of Operations is pending completion of a BLM EIS for activities at the Gas Hills Remote Satellite.

3.1.3 Managed Lands

There are a series of managed and special use lands within 80 kilometers (50 miles) of properties within SUA-1548 (**Figure 3.1.2, Regional Managed Lands**). Glendo State Park is approximately 64 kilometers (40 miles) southeast of the Smith Ranch operations, and is a popular outdoor recreation destination. Boating, water skiing, fishing, and camping are among the most common activities at the park. The Medicine Bow National Forest (Medicine Bow) is approximately 50 kilometers (31 miles) south of the Smith Ranch operations and covers nearly 445,000 hectares (1.1 million acres). Only a portion of the Medicine Bow is shown on **Figure 3.1.2**. A series of designated Special Interest Areas (SIA) occur within the Medicine Bow. The Ashenfelder Basin SIA is the closest SIA in proximity to the Smith Ranch and straddles the Converse and Albany County borders. The Ashenfelder Basin SIA is 834 hectares (2,062 acres) in size and received this designation because of the importance of the area to local plant species.

The Thunder Basin National Grassland (Thunder Basin), located in northeastern Wyoming, is in the Powder River Basin, between the Big Horn Mountains and the Black Hills. The 231,000 hectare (572,000 acre) national grassland is approximately 6.4 kilometers (4 miles) northeast of the Smith Ranch operations and 24 kilometers (15 miles) east of the North Butte and Ruth Remote Satellites (**Figure 3.1.2**). Thunder Basin abounds with wildlife year-round, provides forage for livestock, and is underlain with vast mineral resources. Land patterns are very complex because federal, state, and private lands are intermingled. The Douglas Forest Service Ranger District administers Thunder Basin.

The Ed O. Taylor Wildlife Habitat Management Area (WHMA) is located 72 kilometers (45 miles) due west of the Ruth Remote Satellite. The Ed O. Taylor WHMA is a 4,111 hectare (10,158 acre) area purchased to ensure protection of winter range for elk, which summer in the Bighorn National Forest. In addition, this WHMA provides protection of year-round habitat for mule deer.

The Wind River Indian Reservation is 56 kilometers (35 miles) northwest of the Gas Hills Remote Satellite, spans 890,000 hectares (2.2 million acres), and is home to 2,500 Eastern Shoshone and more than 5,000 Northern Arapaho Indians. Although the two tribes own and govern the reservation jointly, most of the Shoshone live in the western half around Fort Washakie, while the Arapahos are centered near Ethete and Arapahoe.

The Sand Mesa WHMA and Boysen State Park are also approximately 56 kilometers (35 miles) northwest of the Gas Hills Remote Satellite. The Sand Mesa WHMA contains 142 hectares (350 acres) of wetlands that not only serve as habitat for waterfowl, but also filter runoff from surrounding lands. Boysen State Park is surrounded by the Wind River Indian Reservation and offers both day-use and overnight camping facilities. Boysen Reservoir is well-known as one of Wyoming's best walleye and trout fisheries.

The Pathfinder National Wildlife Refuge and Devil's Gate trail landmark are both approximately 43 kilometers (27 miles) southeast of the Gas Hills Remote Satellite. The Pathfinder National Wildlife Refuge consists of four small units totaling 6,801 hectares (16,807 acres) and is an important waterfowl migration stopover on the western edge of the Central Flyway. Devil's Gate is a major trail landmark along the Sweetwater River on both the Mormon and Oregon Trails.

3.1.4 Major Land Resource Area

Major Land Resource Areas (MLRA) are geographically associated land resource units delineated by the Natural Resources Conservation Service and characterized by a particular pattern that combines soils, water, climate, vegetation, land use, and type of farming. There are 204 MLRAs in the United States, ranging in size from less than 202,000 hectares (500,000 acres) to more than 24 million hectares (60 million acres). The majority of the lands within SUA-1548 are within MLRA 58B – the southern part of the Northern Rolling High Plains (**Figure 3.1.3, Regional MLRA**). This includes the Smith Ranch operations and the North Butte and Ruth Remote Satellites. The Gas Hills Remote Satellite is located within MLRA 34A – The Cool Central Desertic Basins and Plateaus.

MLRA 58B spans from Wyoming (95%) into Montana (5%), containing about 5 million hectare (19,300 square miles). Interstate 90 (I-90) crosses the northern third of this area from east to west, and Interstate 25 (I-25) crosses the western third from north to south. Most of the Powder River Basin is in this area. The Powder River Basin contains important coal, CBM, oil, and gas deposits.

Following are the various land use types, land ownership and percentage in MLRA 58B:

- Cropland—private, 4%
- Grassland—private, 76%; federal, 16%
- Forest—federal, 1%
- Urban development—private, 1%
- Other—private, 2%

More than 90% of MLRA 58B supports native grasses and shrubs grazed by cattle and sheep. Approximately 4% is dry-farmed in a wheat-summer fallow rotation. The dry-farmed areas occur mainly on gently sloping hills providing deep soils. Narrow strips of land along the Tongue, Powder, and Platte Rivers and some of their tributaries are irrigated. Alfalfa, other hay crops, and feed grains are the principal crops. Some land tracts are used as tame pasture. Open stands of ponderosa pine grow on the higher buttes and steep slopes that receive higher amounts of precipitation where local wildlife may inhabit.

The Gas Hills Remote Satellite is located within MLRA 34A. MLRA 34A is in Wyoming (85%), Colorado (13%), and Utah (2%) and contains approximately 8.55 million hectare (33,005 square miles). Interstate 80 (I-80) bisects the northern part of this MLRA.

Following are the various land use types, land ownership and percentage in MLRA 34A:

- Cropland—private, 2%
- Grassland—private, 27%; federal, 67%
- Forest—federal, 1%
- Urban development—private, 1%
- Other—private, 1%; federal, 1%

A little more than two-thirds of MLRA 34A consists of federal surface with the remaining being private or state-owned lands. Most of the land is used for grazing by sheep and cattle. Hunting also is an important land use. The rangeland consists of shrubs and cool-season grasses. About 2% of the area is cropland. Areas of irrigated hay and pasture occur mostly along the few large rivers or streams. Non-irrigated small grain crops are grown in small areas near Craig and Meeker, Colorado, where the annual precipitation is more than 0.33 meters (13 inches), the frost-free period is more than 75 days, the soils commonly are deep, and grain marketing facilities are nearby.

3.1.5 Regional Energy Development

With the exception of the Gas Hills Remote Satellite, all SUA-1548 lands are located in the southern portion of the Powder River Basin (**Figure 2.1**). The Powder River Basin is primarily rural in nature with abundant reserves of natural resources. Development of these natural resources, including coal, oil and gas, CBM, wind energy and uranium, drive the economic growth of the region now and presumably in the near future.

The Gas Hills Remote Satellite is located approximately 145 kilometers (90 miles) west-southwest of the other facilities, in the Wind River Basin. The Powder River Basin and Wind River Basin are separated by the Casper Arch, a large, northwest trending asymmetric anticlinal structure that connects the Bighorn Mountains with the Laramie Mountains (WSGS, 2011b). This region is differentiated from the Powder River Basin in several respects. Energy development in the Wind River Basin is limited to uranium mining and oil and gas production. Dominant vegetation type also shifts from herbaceous grasslands to brushland. Section 2.2 describes, in detail, existing and projected energy development in both the Powder River Basin and the Wind River Basin.

3.1.6 Smith Ranch

3.1.6.1 Local Land Use

The Smith Ranch operation consists of Smith Ranch, Highland and the Reynolds Ranch Satellite. Section 2.2 of NRC Regulatory Guide 3.4.6 suggests the evaluation of land use be within 8 kilometers (5 miles) from the center of the site. The majority of the lands within the license boundary of the Smith Ranch operations are private (84%). The remaining 10% and 6% are owned by the State of Wyoming and the BLM, respectively (**Figure 3.1.4, Smith Ranch Ownership**).

Historically, the area was homesteaded and dry-land farmed. Many of these dry farmed areas were ultimately abandoned and left to revegetate by natural processes or were seeded with crested wheatgrass or other grasses for grazing purposes.

Today the area remains remote and contains a low population density, primarily dominated by agricultural pursuits (Figure D1-1 and Plate D1-1 in Appendix D1 of the Smith Ranch WDEQ Permit). The majority of people living in the area reside on dispersed ranches. Sheep and cattle grazing comprise the major past and present land use in the area and at the project site. The Vollman Ranch is the only inhabited residence located within the current license area. According to the 2007 Census of Agriculture, agricultural uses of 960,000 hectares (2.37 million acres) account for 86.4% of the total surface area and

grazing is the dominant use. Per the Wyoming Department of State Lands records, grazing leases are limited to one animal unit month per 1.6 hectare (4 acre) of land surface.

The National Agricultural Statistics Service released a crop-specific land cover classification dataset encompassing the entire conterminous United States. The Cropland Data Layer (CDL) depicts type and location for crops planted during the summer 2009 growing season. The GIS-based dataset reports both agricultural and non-agricultural land use via a 56 meter resolution raster and merges non-agricultural land use types from the National Land Cover Dataset (NLCD) with a crop-specific raster analysis of agricultural production. **Figure 3.1.5, Smith Ranch CDL**, presents the CDL data for the Smith Ranch operations and a 5 kilometer (3 mile) radius around each. The majority of the site and surrounding areas contain shrublands, described in the NLCD as shrub/scrub and herbaceous grasslands. There are areas identified as fallow or idle cropland, hay and alfalfa production in isolated pockets in both the northeast and southern portion of the license area (**Figure 3.1.5**).

Due to the potential for harsh winter conditions at the site most livestock are moved off the area and closer to the Platte River for wintering. Although sheep and cattle are the primary domestic stock in the area, many varieties of native wildlife also utilize the area. Thus, the present use is periodic grazing by domestic livestock and concurrent use by wildlife. See Section 3.5.2 for a more detailed discussion of native wildlife.

Several oil and gas companies have begun enhanced oil recovery programs at existing oil fields in Converse County. After receiving environmental approval, Australia-based Linc Energy will start enhanced oil recovery at its Wyoming oil fields by injecting carbon dioxide into the South Glenrock B Unit 34 in the Powder River Basin.

Exploration for gas production from the Niobrara Shale is occurring near Smith Ranch. The target formation (Niobrara Shale) for drilling is significantly deeper than the uranium-bearing zone (Wasatch Formation) where the ISR operations are producing. The Cretaceous Age Niobrara is separated from the Tertiary Wasatch by the thick, marine Pierre Shale. Finally, although the Niobrara play has been successful in the Colorado Denver-Julesburg Basin, the oil and gas production potential from the Niobrara in the Powder River Basin is still debatable.

Surface disturbances at Smith Ranch are detailed in Section 3.3.4.1. Total surface disturbance as of 2010 is 571 hectares (1,410 acres) and is comprised of disturbance associated with buildings, roads, ponds and irrigation areas and mine units.

3.1.6.2 Past Development Activities

From the 1970s to the early 1980s, areas within and adjacent to Smith Ranch were extensively mined for uranium. Both surface and underground mining methods were employed in the area, with the majority of uranium ore being recovered by surface mining methods. From the early 1970s through the mid-1980s, companies suc-h as Bear Creek Uranium, Kerr McGee Nuclear, RAMC, The Tennessee Valley Authority (TVA), and Exxon Minerals produced uranium from the sandstone deposits within or near the license boundary. Most of these mines were shut down and/or reclaimed by 1985 because of poor uranium market conditions. Past mining disturbance areas are presented on Plate D1-3 in the Smith Ranch WDEQ Permit.

There were two open pit mines located north of Smith Ranch. These mines were in Sections 3, 28 and 33, T37N, R73W, and were mined under Permit to Mine 304-C. The mined areas were reclaimed and

revegetation was completed and verified. A release request for the reclaimed areas was included in the March 25, 1994 annual report/bond submittal for Permit 304-C.

Highland is located adjacent to portions of the reclaimed Exxon Highland Uranium Mine, which used conventional open pit and underground mining methods, and was in operation from 1971 to 1984. The underground mine was shut down and the shaft sealed by 1985. In 1985, Exxon sold their remaining uranium reserves to Everest Minerals Corp. (Everest) who developed the Highland ISR project, which began commercial ISR uranium production in 1988.

Also during this time period, Silver King Mines, Inc. operated an underground uranium mine for the TVA in the Section 14 area of the Highland property (North Morton Ranch mine) during the late 1970s and early 1980s. The mine was shut down and the shaft sealed in the mid-1980s. Everest acquired the reclaimed property from the TVA, which allowed expansion of the Highland operation to the west in 1989. Between 1989 and 2000, Highland produced approximately 450,000 kilograms (1 million pounds) of uranium per year. Cameco acquired PRI and Highland in 1997. Cameco subsequently acquired Smith Ranch in 2002 and received NRC authorization to combine the two licenses in 2003.

The Reynolds Ranch Satellite area was previously owned by Solution Mining Corporation (SMC). During 1980 to 1990, SMC installed wells, collected water quality data and performed two aquifer tests within the Reynolds Ranch Satellite. SMC never permitted the property which was subsequently purchased by RAMC and then PRI. The property was amended into SUA-1548 in 2007. The regional groundwater data collected by SMC is provided in Appendix D6, Addendum C of the WDEQ Permit. Recent well installation and groundwater quality information are also included in Appendix D6, Addendum C of the WDEQ Permit.

3.1.7 North Butte

3.1.7.1 Local Land Use

The area immediately surrounding the North Butte Remote Satellite includes predominantly private land, although there are parcels of state- and federal (BLM)-owned land. Lands within 8 kilometers (5 miles) of the project are 2% BLM, 6% State of Wyoming, and 92% private (**Figure 3.1.6, North Butte Ownership**). Even with federal ownership of land within the surrounding area, recreational use is limited. Private landowners control access to the federal and state parcels of land and therefore limit access for recreational purposes. Hunting of antelope and mule deer is permitted by landowner consent only. Sage grouse are also hunted to a limited extent. Fishing activity within the area is non-existent as there are no lakes, streams, or rivers that provide adequate habitat.

The National Agricultural Statistics Service CDL for this area depicts type and location for crops planted during the summer 2009 growing season. For a more detailed explanation of the CDL dataset, see Section 3.1.6.1. Similar to Smith Ranch, the majority of the lands in and around the North Butte Remote Satellite are shrublands, described in the NLCD as shrub/scrub and herbaceous grasslands. There are pockets of fallow or idle cropland and other hay lands to the east. Woodlands are located both northwest and southeast of the North Butte Remote Satellite (**Figure 3.1.7, North Butte CDL**).

Cattle and sheep ranching is the major land use in the region surrounding the North Butte Remote Satellite. Approximately 94% of the land in the Powder River Basin is classified as rangeland. Native rangeland vegetation provides the majority of the livestock forage in the region. Major native forage species are blue grama grass (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), needlegrasses (*Stipa* spp.), prairie junegrass (*Koeleria cristata*), and numerous forbs. North Butte WDEQ Permit Table D1-1.3 lists all ranches within 13 kilometers (8 miles) of the project area.

Livestock production was the leading industry of Campbell County prior to the mineral and mining development. Grazing of livestock is still a major industry as Campbell County is ranked fifth in the state for all cattle and for breeding sheep with a livestock inventory value of $99.9M in 2006 (Campbell County Natural Resource and Land Use Plan, 2007).

Proven methods of livestock grazing continue to maintain the health and productivity of grazing lands and provide improved wildlife habitat, healthy watersheds, and soil erosion control. A large part of Campbell County's present and future economic viability is strongly tied to the land and its productivity. There is no prime farmland located within the North Butte Remote Satellite.

Surface disturbances at the North Butte Remote Satellite are detailed in Section 3.3.4.2. Total surface disturbance as of 2010 is 12.3 hectares (30.5 acres) and is comprised of disturbance associated with an on-site single-wide trailer and several monitor wells.

In 2007, the Powder River Basin CBM field produced 12.5 billion cubic meters (442 billion cubic feet) of gas, making the field the third largest source of natural gas in the United States. In the vicinity of the North Butte Remote Satellite, CBM groundwater production generally began in 2008. The closest CBM wells to the project area are located within the Anadarko Petroleum Corporation's Dry Willow Phase I, II, and III Plan of Development areas. The North Butte Remote Satellite area includes portions of the Dry Willow Phase I and II developments. The future Dry Willow III development is located immediately south and west of the North Butte Remote Satellite permit boundary. The CBM industry does not discharge nor impound byproduct water to surface drainages that pass through the North Butte license area. A total of 119 existing and planned CBM wells were identified and included as part of an impact assessment prepared by Aqui-Ver, Inc. (2011). This assessment is presented in Section 4.4.

When the Atomic Energy Commission began looking in 1946 for domestic sources of uranium, it guaranteed a market and tempted prospectors with bonuses. Since uranium had been known in Wyoming since 1918, people bought Geiger counters and went hunting. The uranium they found varied from high-grade in eastern Fremont County to low-grade in the Pumpkin Buttes area of Campbell County and what they found was 35% of this nation's known uranium reserves. Several uranium projects are ongoing in the Powder River Basin and in the vicinity of the North Butte Remote Satellite. Nichols Ranch facility is located southwest of the project site and the Willow Creek Project (Christensen Ranch and Irigary) is located northwest of the site. The Moore Ranch ISR uranium project is southeast of the North Butte Remote Satellite.

3.1.8 Gas Hills

3.1.8.1 Local Land Use

The Gas Hills Remote Satellite and the surrounding area are composed of predominantly public lands administered by the BLM, although there are parcels of state- and private-owned land. Lands within 8 kilometers (5 miles) of this satellite are 85% BLM, 7% State of Wyoming, and 8% private (**Figure 3.1.8, Gas Hills Ownership**). The BLM currently authorizes grazing on public land for sheep and cattle. Other small parcels of privately and state-owned land are also located within the Gas Hills Remote Satellite license area.

In addition to agriculture, the area surrounding the Gas Hills Remote Satellite has been used for a number of purposes including conventional uranium mining, oil and gas, and recreational hunting. Mine reclamation activities (heavy construction) are ongoing within the Gas Hills District. The area has also seen production of oil and gas, although there is currently no production of oil and gas within 3

kilometers (2 miles) of the proposed satellite license boundary. The area is also used for recreational activities, including hunting, and is an important wildlife habitat for mule deer and pronghorn antelope.

The National Agricultural Statistics Service CDL for this area depicts type and location for crops planted during the summer 2009 growing season. For a more detailed explanation of the CDL dataset, see Section 3.1.6.1. The majority of the lands in and around the Gas Hills Remote Satellite are shrublands. There are pockets of herbaceous grasslands, evergreen forests and barren land intermixed. Woodlands are located along the southern boundary of the Gas Hills Remote Satellite property (**Figure 3.1.9, Gas Hills CDL**).

Surface disturbances at the Gas Hills Remote Satellite are detailed in Section 3.3.4.3. Total surface disturbance as of 2010 is 40 hectares (97.9 acres) and is comprised of disturbance associated with buildings, roads and monitor wells.

3.1.8.2 Past Development Activities

The Gas Hills Uranium District has been exploited for its uranium reserves by a number of companies, and has produced more than 50,000 tons of ore over the last 40 years. Most of the mines and processing facilities involved in these activities have been, or are being, decommissioned and reclaimed. In summary the District's current and previously exploited uranium reserves account for approximately 12% of the Nation's reserves. The District is remotely located, being near the geographical center of Wyoming in eastern Fremont and western Natrona Counties. The mineralized subsurface encompasses an area of approximately 260 square kilometers (100 square miles).

Of the approximately 3,458 hectares (8,538 acres) within the Gas Hills Satellite license boundary, approximately 15%, or 518 hectares (1,281 acres), have been previously disturbed by underground and/or surface mining activities. Additionally, exploration drilling (at least 14,000 exploration drillholes) and associated access road construction has previously disturbed an additional 105 hectares (260 acres) within the license boundary. In summary approximately 624 hectares (1,541 acres) (18%) within the license boundary has been previously disturbed by past mining and exploration efforts. Many of the historical drilling roads remain unreclaimed.

The 14 historical open pit and underground mining operations are further described within Appendix D1 and are illustrated on Plates D1-E and D1-W in the Gas Hills WDEQ Permit. Areas previously disturbed by mining are also discussed in Appendix D6, Table D6-1-1 and outlined on Plate D6-1 of the Gas Hills WDEQ Permit.

3.1.9 Ruth

The Ruth Remote Satellite is located 19 kilometers (12 miles) south-southwest of the North Butte Remote Satellite. The majority of the surrounding lands are privately owned. Lands within 8 kilometers (5 miles) of this satellite are 88% private, 6% State of Wyoming, and 6% BLM (**Figure 3.1.10, Ruth Ownership**).

The National Agricultural Statistics Service CDL for this area depicts type and location for crops planted during the summer 2009 growing season. For a more detailed explanation of the CDL dataset, see Section 3.1.6.1. The majority of the lands in and around the Ruth Remote Satellite are herbaceous grasslands. There are pockets of shrubland both within the license boundary and within an 8 kilometer (5 mile) radius. Scattered areas of woody wetlands run along a north-south line through the middle of the license boundary and extend out into the 8 kilometer (5 mile) radius to the southeast (**Figure 3.1.11,**

Ruth CDL). Hay production occurs in pockets in the southeast, southwest and northerly directions, but outside of the license boundary.

Surface disturbances at the Ruth Remote Satellite are detailed in Section 3.3.4.4. Total surface disturbance as of 2010 is 1.7 hectares (4.3 acres) and is comprised of disturbance associated with buildings, roads, ponds, and monitor wells.

Local land uses include cattle and sheep grazing, limited hunting, uranium ISR operations and CBM production. Since Ruth and North Butte Remote Satellites are close, please refer to the discussion presented above (Section 3.1.7) for more detail on both historical and current land use within the Ruth Remote Satellite area. Development of the Ruth Remote Satellite is anticipated to begin near the end of the next renewal period.

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3.2 Transportation

The previous SUA-1548 license renewal was approved in 2001 and does not address impacts to transportation resulting from operations at SUA-1548 facilities. The following sections describe the affected environment as it relates to individual site access and regional transportation corridors.

3.2.1 Smith Ranch

The main office complex, CPP and Highland CPF are at Smith Ranch, approximately 27 kilometers (17 miles) by air and 35 kilometers (22 miles) by road northeast of the town of Glenrock and 40 kilometers (25 miles) by road northwest of Douglas. From the intersection of Highway 93 and Highway 95 access can be achieved via Converse County Road 31 (Ross Road). **Figure 1.1** shows the general project location in addition to the existing transportation route into Smith Ranch. The two processing facilities are approximately 14 kilometers (9 miles) away

Shipments of uranium-laden resin or yellowcake slurry will be transported from each of the three remote satellites (North Butte, Gas Hills and Ruth) to the CPP or CPF, where it will be processed into dried yellowcake. The existing traffic conditions associated with each transportation route to the CPP or CPF are discussed below under the individual satellite location.

According to the DOT Monthly Automatic Traffic Recorder Report for 2010, Highway 59 north of Douglas (east of the Smith Ranch Project) sees 1,900 cars per day. Highway 18/20 east of Orin Junction (southeast of the Smith Ranch Project) sees 2,200 cars per day, and I-25 west of Glenrock (west of the Smith Ranch Project) sees 8,049 cars per day (WYDOT, 2010). All daily traffic estimates are based on monthly averages.

Yellowcake product shipments will travel from the processing facility to a conversion facility at Port Hope, Ontario, Canada by common carrier. Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and DOT hazardous material transportation regulations at 49 CFR Parts 171–189. From the CPP or CPF, the distance travelled is approximately 2,736 kilometers (1,700 miles). The preferred route will be determined by the common carrier but most likely would be the Ross Road or the Highland Loop Road to Highway 93; thence Highway 93 to Douglas; thence I-25 to Cheyenne; thence Interstate 80

(I-80)/Highway 94 to Marshall, Michigan; thence I-69 to Lansing, Michigan; thence Highway 402 to London, Ontario; thence Highway 401 to Port Hope, Ontario. Resin and yellowcake slurry shipments are made in accordance with DOT and NRC regulations. Dried yellowcake shipments are made in accordance with DOT, NRC and Transport Canada regulations. All shipments are classified as Low Specific Activity (LSA) material. Mitigation measures designed to reduce transportation risk to a minimum are detailed in Section 5.2.

Operations and support at Smith Ranch are expected to require approximately 170 people to operate the mine through the next 15 years of production activity. Currently they employ approximately 150 people. The staffing requirements will start to taper off after 15 years as the activities shift to predominantly groundwater restoration and surface reclamation and less uranium processing activities. The staff lives in predominantly three communities, Douglas, Glenrock, and Casper. The percentage split among the three communities is approximately 40% each for Douglas and Glenrock with the remaining 20% residing in Casper.

Vehicle transport to the facility will continue to be employee-owned vehicles. Based on site information one can assume that cars averaging two persons per trip represent 60% of the site trips and pickups averaging one person per site trip represents 40% of the site trips.

The transportation route from Douglas will be as follows (see **Figure 3.2.1, Regional Transportation**):

- Highway 93 North to Ross Road (paved road) — 28 kilometers (18 miles)
- Left on Ross Road (County Road #31) (paved road) — 11 kilometers (7 miles)
- Right turn to 762 Ross Road

The transportation route from Glenrock will be as follows:

- Glenrock to the junction of Highway 95 and 93 (paved road) — 27 kilometers (17 miles)
- Left on Highway 93 (paved road) — 0.3 kilometer (0.2 mile)
- Left on Ross Road (County Road #32) (paved road) — 11 kilometers (7 miles)
- Right turn to 762 Ross Road (paved road)

The transportation route from Casper will be as follows:

- Casper to Glenrock I-25 South, Exit 165 (paved road) — 34 kilometers (21 miles)
- Glenrock to the junction of Highway 95 (paved road) — 27 kilometers (17 miles)
- Left on Highway 93 (Paved Road) — 0.3 kilometer (0.2 mile)
- Left on Ross Road (County Road #32) (paved road) — 11 kilometers (7 miles)
- Right turn to 762 Ross Road (paved road)

3.2.2 North Butte Remote Satellite

Primary access to the North Butte Remote Satellite will be via Highway 387 (east of Pine Tree Junction), to Highway 50 near Savageton, then west on Van Buggenum Road to Christensen Road. After approximately 10 kilometers (6 miles) on Christensen Road, primary access to North Butte will be via an existing oil field road owned by T-Chair Ranch (**Figure 1.1**). The Van Buggenum Road is a county maintained gravel road that provides access to several ranches located in the project region. There will be two main access routes to the North Butte Remote Satellite that will utilize the T-Chair Road. To access the site from the northeast side of the license boundary, travel along the T-Chair Road for approximately 2 kilometers (1.3 miles). At that point turn north onto a graveled CBM road and travel

approximately 1.2 kilometers (0.75 miles) and turn west onto the project access road. This road begins at a point located in the NE1/4 NE1/4 of Section 19, T44N, R76W. This access road will be a combination of existing and new roadway that will cover a distance of approximately 2.9 kilometers (1.8 miles) to the proposed satellite IX facility.

The site can also be accessed from the south on the T-Chair Road. One travels past the CBM road turn-off, continues in a westerly direction past the Pfister Ranch and travels north across Willow Creek. This existing gravel road will be used by Cameco to reach the project access road which starts at a point located in the NE1/4 NW1/4 of Section 25, T44N, R76W. This access road is an existing road built by Cleveland-Cliffs Iron Company (Cleveland-Cliffs) during the initial development of the orebody. Cameco plans to upgrade this road, which is entirely within the permit boundary, for a distance of approximately 1.4 kilometers (0.9 mile) to the proposed satellite IX facility.

The Van Buggenum Road consists of a 7.4 meter (24 foot) wide crowned-and-ditched road that is wide enough to handle two tractor trailers passing one another. The speed limit is posted at 72 kilometers/hour (45 miles/hour). Ranch roads occurring on the T-Chair Livestock Company property are also gravel crowned-and-ditched roads. These roads range from 4.6 to 6.0 meters (15 to 20 feet) wide and are constructed and maintained by the landowner and nearby mining interests. These roads will allow for safe passage of both passenger cars and tractor trailers when travelling to and from the North Butte Remote Satellite. The speed limit for these roads is 40 to 48 kilometers/hour (25 to 30 miles/hour).

The uranium-laden resin will be transported from the North Butte Remote Satellite to the CPP or CPF for processing. Resin and yellowcake slurry shipments are made in accordance with DOT and NRC regulations. All shipments will be handled as LSA material including eluted resin. Trucks will travel west on Highway 387, south on Highway 259 which merges with I-25 north of Casper. East of Casper (near Evansville) trucks will leave I-25 and travel east on Highways 20/26 almost into Glenrock and turn northeast on Highway 95 then northwest on Highway 93 to Ross Road then west on Ross Road towards the Smith Ranch CPP or continue on Highway 93 to Highland Loop Road then east on Highland Loop Road to the Highland CPF.

According to the 2010 DOT Automatic Traffic Recorder Report, Highway 387 east of Pine Tree Junction (south of the North Butte Remote Satellite) sees approximately 800 cars per day and I-25 south of Buffalo (west of the North Butte Remote Satellite) sees approximately 2,800 cars per day (WYDOT, 2010). All daily traffic estimates are based on monthly averages.

North Butte management, operations, decommissioning and technical personnel will be required. It is anticipated that 75% of the operations staff for the facility will be traveling from the Gillette area, 20% from the Wright area, and the remaining 5% from the Casper area. The North Butte Remote Satellite facility will utilize an average of 40 personnel throughout the lifecycle of the ISR operation.

3.2.3 Gas Hills Remote Satellite

The uranium-laden resin or yellowcake slurry will be transported from the Gas Hills Remote Satellite to the CPP or CPF at Smith Ranch for processing. All shipments will be made in accordance with DOT and NRC regulations. Shipments will be handled as LSA material, including the eluted resin. From the Gas Hills, the primary route for shipments of resin or slurry will be (see **Figure 1.1**):

- Northwest on the Gas Hills Road (Waltman Road);
- Thence east on Highway 20/26 to Glenrock;

- Thence northeast on Highway 95 to the junction of Highway 93;
- Thence north on Highway 93 to Ross Road;
- Thence northwest on Ross Road to Smith Ranch CPP; or
- Highway 93 to Highland Loop Road;
- Thence Highland Loop Road to Highland CPF.

An alternate transportation route will be:

- West on Dry Creek Road to Gas Hills Road (Highway 136) ;
- Highway 136 into Riverton;
- Thence north on Highway 26/County Road 789 to Shoshoni,
- Thence east on Highway 20/26 to Glenrock;
- Thence northeast on Highway 95 to the junction of Highway 93;
- Thence north on Highway 93 to Ross Road;
- Thence northwest on Ross Road to Smith Ranch CPP; or
- Highway 93 to Highland Loop Road;
- Thence Highland Loop Road to Highland CPF.

The primary traffic impacts from the Gas Hills Satellite will be along the transportation route between the Gas Hills Remote Satellite and the CPP at Smith Ranch. According to the 2010 DOT Automatic Traffic Recorder Report, Highway 20/26 east of Shoshoni sees approximately 2,500 cars per day. The old Glenrock Highway (I-25) east of Casper sees approximately 2,800 cars per day (WYDOT, 2010). All daily traffic estimates are based on monthly averages.

The Gas Hills Remote Satellite facility is estimated to require an average of 46 personnel daily throughout the life of operations. The staff will live in predominantly two communities, Riverton and Casper. The percentage split among the two communities is approximately 80% in Riverton with the remaining 20% residing in Casper.

Vehicle transport to the facility will be employee-owned vehicles. Based on site information, one can assume that cars averaging two persons per trip represent 60% of the site trips and pickups averaging one person per site trip represent 40% of the site trips.

The transportation route from Riverton will be as follows:

- Riverton to Highway 136 (paved road) — 74 kilometers (46 miles)
- Gas Hills Road to Gas Hills Facility (unpaved road) — 14 kilometers (9 miles)

The transportation route from Casper will be as follows:

- Casper to US 20/26 (paved road) — 76 kilometers (47 miles)
- US 20/26 to Gas Hills Road (Waltman) (unpaved road) — 40 kilometers (25 miles)
- Gas Hills Road to Gas Hills Facility (unpaved road) — 11 kilometers (7 miles)

3.2.4 Ruth

Access to the Ruth Remote Satellite is via Highway 387 to a turnoff 27 kilometers (17 miles) east of Edgerton (mile post 117). There are 6 kilometers (4 miles) of gravel road between the Highway 387 turnoff and the Ruth Remote Satellite. From the Ruth Remote Satellite uranium-laden resin will be transported by truck down the 6 kilometer (4 mile) gravel road to Highway 387. From here, trucks will travel:

- East on Highway 387 to Wright;
- South on Highway 59 to Douglas;
- Then northeast on Highway 93 to Ross Road;
- Then northwest on Ross Road to Smith Ranch CPP; or
- Highway 93 past Ross Road to Highland Loop Road;
- Thence Highland Loop Road to Highland CPF.

The Ruth Remote Satellite is anticipated to employ personnel from Gillette and Casper. Personnel traveling from Casper will predominately travel north on I-25 to Exit 210 and travel northeast on Highway 259 to Highway 387. Personnel will travel 17 miles east of Edgerton, and an additional 6 kilometers (4 miles) on gravel road to the project site.

Personnel traveling from Gillette to the Ruth Remote Satellite will predominately travel southwest along Highway 50 to Highway 387. Staff will travel approximately 23 kilometers (15 miles) along Highway 387 to the gravel road site entrance.

3.2.5 References

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3.3 Geology and Soils

3.3.1 Regional Geology

3.3.1.1 Powder River Basin

Smith Ranch, and the North Butte and Ruth Remote Satellites are located in the Powder River Basin. The Powder River Basin is a late Cretaceous to early Tertiary structural asymmetrical syncline, with its axis oriented in a general northwest-southeast direction along the western margin of the basin. East of the axis, the sedimentary rock strata exposed at the surface gently dip at approximately 1 to 2 degrees to the west. West of the axis, the strata dip more steeply (as much as 20 degrees) to the east.

The basin incorporates a sedimentary rock sequence that has a maximum thickness of approximately 4,600 meters (15,000 feet) along the synclinal axis. The sediments range in age from Recent (Holocene) to early Paleozoic (Cambrian) (500 million to 600 million years ago) and overlie a basement complex of Precambrian-age (more than a billion years old) igneous and metamorphic rocks. Of particular interest are the Tertiary Formations outcropping within the Powder River Basin including; the Oligocene-age White River Formation (25 to 40 million years ago), the Eocene-age Wasatch Formation, and the Paleocene-age Fort Union Formation (60 to 70 million years ago).

The uranium-bearing sandstones lie within the upper Fort Union and lower Wasatch Formations. These mineralized deposits are in C-shaped rolls, narrow in width and elongated approximately parallel to the

axis of the channel. Actually they rarely exhibit a theoretical C shape but are distorted in response to the variable lithology and permeability of the host rock. Both the Wasatch and Fort Union Formations are non-marine fluvial floodplain deposits. The Wasatch Formation consists of approximately 300 meters (1,000 feet) of claystone and siltstone containing widespread discontinuous lenses of coarse cross-bedded arkosic sandstones. The coarsest of these occur in the southwestern portion of the basin and are the host rock for the uranium deposits. Sediments gradually diminish in thickness and aerial extent northward. North of the Pumpkin Buttes, the Wasatch Formation sediments become significantly finer-grained and similar in appearance to the Fort Union Formation sediments. The regional geology addressing the Powder River Basin including Smith Ranch and the North Butte and Ruth Remote Satellite project areas is thoroughly discussed in NUREG-1910 (NRC, 2009) and Appendix D5 of the Smith Ranch and North Butte WDEQ Permits.

3.3.1.2 Wind River Basin

The Gas Hills Remote Satellite is located within the Gas Hills Uranium District of the Wind River Basin. The Wind River Basin is a 21,000 kilometer^2 (8,000 mile^2), trapezoidal shaped foreland basin. The basin is asymmetric with its synclinal axis located along its northern flank. It is bounded by the Casper Arch (east), Owl Creek Mountains (north), Wind River Mountains (west), and the Granite Mountains (south) and contains up to 9,000 meters (30,000 feet) of sediment across its axis. The sediments range in age from Recent (Holocene) to early Paleozoic (Cambrian) (500 million to 600 million years ago) and overlie a basement complex of Precambrian-age (more than a billion years old) granitic rocks. The uranium-bearing sandstone is hosted in the Eocene-age Wind River Formation. Regionally the Wind River Formation is comprised of dark gray to greenish-gray medium to granulated arkosic channel sandstone with interbedded granitic pebble to boulder conglomerates, claystones, and siltstones. The sandstone and conglomerates were deposited along the axes of alluvial fans and form massive coarse-grained units. These alluvial fan deposits are the host for the Gas Hills uranium deposits. The ore deposits occur as roll fronts along these margins and are typically 5 meters (15 feet) thick and can be traced for hundreds of meters. Along the boundary of the fans are alternating sand and shale sequences. Sandstones and conglomerates are typically confined vertically by siltstones and claystones. Detailed regional geology of the Gas Hills Remote Satellite is discussed in the 2004 Gas Hills EA and Appendix D5 of the Gas Hills WDEQ Permit.

3.3.2 Site Geology

3.3.2.1 Smith Ranch Geology

The *Safety Evaluation Report for Renewal of Rio Algom Mining Corp. Smith Ranch In-Situ Leaching Facility Converse County, Wyoming (2001)* states that the NRC has reviewed and accepted the geologic and seismic site characterization contained in the Environmental Assessment for Renewal of Source Material License No. SUA-1548 Rio Algom Mining Corporation Smith Ranch Uranium Project Converse, County (2001). The approved site characterization for Smith Ranch is summarized in the following sections. Cameco has been operating under SUA-1548 since 2002 and has expanded the geologic knowledge of the ore body. An updated site conceptual model of the ore zone is also included in this report.

The site-specific geology for each site within the entire SUA-1548 license area has been previously reviewed and evaluated by NRC Staff during the 1999 LRA and is presented in detail in the appropriate sections of Appendix D5 of the WDEQ Permits. Summaries of the site-specific geology for Smith Ranch and the remote satellites are provided below. Since the last renewal, additional delineation drilling at Smith Ranch and the remote satellites has not identified any information that would change the geological conclusions made in past NRC reviews.

3.3.2.1.1 Smith Ranch Surficial Geology

A variety of surficial materials mantle the Wasatch Formation at Smith Ranch. They include residual soils, slopewash formed by the downslope movement of soil and weathered rock fragments, playa deposits, and stream-deposited alluvium. The residual soils and slope wash range in thickness from a few centimeters on the steep slopes to 3 meters (10 feet) or more on the upland areas and lower valley slopes. The boundary between the surficial material and the bedrock typically occurs 1 meter (3 feet) or more beneath the ground surface. The surficial materials commonly are sandy to clayey silt, but a range of textures is found from silty clay in the upland areas to clayey sand on the lower slopes.

Playa deposits are similar compositionally to the alluvium but more alkaline. These deposits occur in closed depressions in the upland areas. These depressions appear to have formed where loosely cemented sandstone has been eroded, probably by wind, and are underlain by more resistant shales or mudstones.

The alluvial deposits that form the floor of Sage Creek and the Dry Fork of the Cheyenne River and their tributaries typically include clays, silts, and sands with local gravel lenses. The material is poorly stratified, unconsolidated, and commonly 2 to 5 meters (5 to 15 feet) thick. As much as 12 meters (40 feet) of alluvium is estimated to occur locally.

3.3.2.1.2 Smith Ranch Ore Zone Geology

The Wasatch Formation is the youngest unit present within Smith Ranch including Highland and the Reynolds Ranch Satellite. The Wasatch Formation consists of interbedded and highly lenticular silty claystones, sandy siltstone, and relatively clean sandstones. The Wasatch Formation is generally less than 150 meters (500 feet) thick in the central and eastern portions of Smith Ranch, and less than 90 meters (300 feet) in the northern portion. It is absent in the western and southwestern portions of Smith Ranch. The contact between the Wasatch and the underlying Fort Union Formation passes through the southern portion of Smith Ranch. The School Coal Seam delineates the contact between the two formations.

The Fort Union Formation is lithologically similar to the Wasatch Formation and includes interbedded silty claystones, sandy siltstones, relatively clean sandstones, arkosic sandstone, and claystones with a few thin limestone and coal beds occurring locally. The sandstone units within the upper Fort Union and lower Wasatch Formations can be correlated across Smith Ranch. As many as 10 separate potentially uranium-bearing sandstone units have been identified within the Smith Ranch property. Within individual mine units, sandstone units may be discontinuous in some areas or merge with over or underlying sandstone units. Historically, the sandstone units within the Highland area have been identified from bottom to top as the 0, 10, 20, 30 through 120 Sand. Within the western and northern portions (Smith Ranch and Reynolds Ranch) of the site, the same sandstone units are identified from bottom to top as the K, M, O, Q through W Sand. Above the School Coal Seam, the sandstone units are identified from bottom to top as the E and G Sands. The O Sand package at Smith Ranch and Reynolds Ranch correlates directly to the 20 through the 80 Sand packages at Highland. The sandstones range from fine grained to very coarse grained, are sub-angular, and exhibit fair to poor sorting. A schematic cross section of Smith Ranch from the proposed Reynolds Ranch area to the Highland area is presented on **Figure 3.3.1, Smith Ranch Schematic Cross Section**.

3.3.2.1.3 Smith Ranch Update to the Site Conceptual Geologic Model

Cameco has reviewed the drill logs and geologic data obtained from the hydrologic data packages developed at Smith Ranch since the last renewal and has refined the site conceptual geologic model. The K Sand is the deepest uranium ore zone sand member at Smith Ranch. Commercial uranium

deposits in the K Sand occur in the southwest portion of Smith Ranch and consist of stacked, braided, fluvial sandstone units. The K Sand is irregular as indicated by variable sand thickness, grain size, and shale content. The K Sand is composed of an upper and lower unit in the southwest and ranges in thickness from 23 to 41 meters (75 to 135 feet). The K Sand is bounded by confining layers above and below. The J Shale is the underlying confining unit that separates the K Sand from the underlying I Sand and ranges in thickness from 2 meters (8 feet) to upwards of 46 meters (150 feet). The L Shale confining unit separates the K Sand from the overlying M Sand. Where the M Sand is present, the L Shale thins to less than 3 meters (10 feet). The L Shale is up to 27.4 meters (90 feet) thick locally.

The O Sand is the principal uranium ore zone sand member at Smith Ranch and ranges in thickness locally from 12 meters (40 feet) to more than 91 meters (300 feet). The O Sand is divided into four separate segments, mostly due to interbedded shale lenses. The O Sand is bounded above and below by confining layers. The N Shale is the underlying confining layer for the O Sand. The N Shale thickness ranges from less than 1.5 meters (5 feet) to as much as 34 meters (110 feet).

The P Shale is the overlying confining layer for the O Sand. It is composed of highly bentonitic claystones and siltstones with some discontinuous sandstone lenses and minor lignitic stringers. This shale often merges with the R Shale where the Q Sand is absent. Locally, the P/R Shale thins to less than 3 meters (10 feet) but may be as much as 67 meters (220 feet) thick.

Overlying the P Shale is the Q Sand which contains little in the way of economic mineralization. Some mineralization is encountered where the overlying S Sand was deposited in channels scoured into the Q Sand resulting in preferential, oxidized, mineralized groundwater flow. The Q Sand is discontinuous across Smith Ranch, occurring mainly in isolated sand channels. Where present the Q Sand thickness ranges from 0 to nearly 24 meters (80 feet).

The R Shale is the upper confining layer for the Q Sand, where present, and is the lower confining layer for the overlying S Sand. It is similar in composition to the P Shale. Where the Q and S Sands are present, the R Shale can be as thick as 30 meters (100 feet). In other areas the S Sand is also "shaled out" completely and does not exist. The resulting shale is then continuous from the top of the Q Sand to the base of the U Sand. This is referred to as the P/R/T Shale.

In the northern portion of Smith Ranch, the S and U Sands are continuous where significant channel sand deposition has occurred. Individually, these sand units range in thickness from 0 to 21 meters (70 feet) but when combined can be as thick as 46 meters (150 feet). Over much of Smith Ranch, these two sands are referred to jointly as the U/S Sand. Where the S and U Sands are separated, the T Shale is present. The T Shale ranges in thickness from nearly non-existent to as much as 46 meters (150 feet). The upper confining layer for the U/S Sand is the V Shale which is composed of siltstones and claystones which are highly bentonitic. It ranges in thickness from 6 to 21 meters (20 to 70 feet).

The W Sand is stratigraphically the highest continuous sand unit of the Fort Union Formation within Smith Ranch. It varies in thickness from non-existent to 26 meters (85 feet), pinches out in the northwestern portion and is completely eroded away in the east.

Separating the Fort Union Formation from the overlying lower Wasatch Formation is the School Coal Seam, which varies in thickness from non-existent to 6 meters (20 feet) pinching out to the north and east. The shallowest mineralized sand units of interest in the northern portion of Smith Ranch near the Reynolds Ranch Satellite occur in the lowermost section of the Wasatch Formation. These sands are designated the "E" and "G" Sands (stratigraphically moving upward). These sands are relatively shallow,

with the base of the "E" at an average depth of 107 meters (350 feet) below the ground surface. Much of the uranium mineralization in this sand occurs near, or above, the water table and is therefore not recoverable with current ISR technology. Uranium deposits within these unsaturated sandstones located north of Smith Ranch have been previously mined by conventional open pit methods.

Below the surficial material, clay rich shale and sandstones are present. Measured permeability of the claystone-shale interbeds has been found to be less than 1E-11 centimeters^2 (2E-12 inches^2) which is in sharp contrast to the permeability of the sandstone units which typically average between 5E-6 and 2E-6 centimeters^2 (8E-7 to 3E-7 inches^2). Depending on the specific location within Smith Ranch, sandstone or claystone will be present beneath the surficial material. The sandstone units are typically separated by at least 6 to 14 meters (20 to 45 feet) of low permeability claystone and shale except where channel scour has removed the interbeds bringing two sandstone units into communication. The geologic cross sections provided in Addendum D-5 A2 and Addendum D-5 B2 of the Smith Ranch WDEQ Permit show the relationship between the different sand packages and interbedded confining units across Smith Ranch. Copies of the geophysical logs used to construct the cross sections are included in the above referenced Addenda.

3.3.2.1.4 Smith Ranch Structural Geology

Smith Ranch lies across the northwest-southeast-trending synclinal axis of the Powder River Basin. Within the central portion of Smith Ranch, the Wasatch and Fort Union Formations dip gently northwestward, reflecting the general axial plunge in that direction. At the western and eastern boundaries of Smith Ranch, the strata dip generally toward the axis some 2 to 5 degrees to the west and east, respectively.

No major faults or folds in the bedrock within Smith Ranch have been detected by exploration programs conducted by Cameco and their predecessors. However, a series of subparallel anticlines and synclines relief ranging from 3 to 6 meters (10 to 20 feet) were identified in the Highland area.

3.3.2.2 North Butte Geology

3.3.2.2.1 North Butte Surficial Geology

The overall surface of the North Butte Remote Satellite is that of flat to gently sloping terrain with two moderate to large drainages in the western portion and three moderate to small drainages in the east. All the drainages generally trend from the north to the south, eventually forming tributaries to Willow Creek which runs from east to west, crossing the southern tip of the North Butte site. In the western portion of the site the terrain is more steeply sloped with the drainages more incised. The surface consists of alternating sands and sandy shales in a repeating Wasatch facies environment. Colluvial wash is minor except in the northwest portion where there is extensive slide material present from the erosion of North Butte. This material consists of upper Wasatch Formation and lower White River Formation materials which form the walls and cap rock of North Butte, respectively.

Cameco has drilled and defined the alluvial deposits of Willow Creek. These deposits consist of clays, silts, and fine sands with local gravel lenses. The gravel is poorly stratified, unconsolidated, and approximately 0 to 2 meters (6 feet) thick within Willow Creek.

3.3.2.2.2 North Butte Ore Zone Geology

To characterize the ore zone geology of the North Butte Remote Satellite, isopach maps were generated for the geologic units of interest. The target sands are units of the Eocene Wasatch Formation. Beginning with the uppermost sand unit, the units of interest are the F Sand, F-C Shale, CB and BA interbedded shales within the C-B-A Sands, A-1 Shale, and the 1 Sand. Individual isopachs were also

generated for each of the C, B, and A Sands. The isopach maps are presented as Plates D5-1.2 through D5-1.10 in Appendix D-5 of the North Butte WDEQ Permit. A stratigraphic column of the North Butte Remote Satellite is also included as Figure D5-3 in the North Butte WDEQ Permit.

A subsurface geologic investigation was conducted in November 2011 to determine the presence or absence of saturated alluvium within Willow Creek and the potential for saturated sand units between the surface and the uppermost F Sand. Two boreholes (WC #1 and WC #2) were drilled inside the floodplain of Willow Creek. The locations of the boreholes are included on **Figure 3.3.2, Shallow Aquifer Investigation Well Location Map**. Borehole WC #1 was drilled to a depth of 32 meters (105 feet) below ground surface (bgs) and encountered interbedded silty clay with thin lenses of fine grained sand. No alluvium was encountered in WC #1. Borehole WC #2 was drilled to a depth of 24 meters (80 feet) bgs and encountered mostly interbedded silty clay with lenses of fine grained sand. Approximately 1 meter (4 feet) of dry sandy alluvial gravel was encountered in WC #2. Other than the thin lenses of fine grained sand encountered in WC #1 and WC #2, no other sand units were present between the surface and the F Sand.

The F Sand is the uppermost non-mineralized, saturated sand unit within the North Butte Remote Satellite. The F Sand is stratigraphically continuous in the west but ranges in thickness from 0 to approximately 31 meters (100 feet) over the entire North Butte area. Where present the F Sand ranges in thickness from 7 to 31 meters (22 to 99 feet). Detailed evaluation of geophysical logs from the area, indicate that the F Sand does shale out in the north central portion of the North Butte area.

The FC Shale is stratigraphically continuous over the North Butte Remote Satellite area. The FC Shale separates the F Sand from the underlying C Sand. The thickness of the FC Shale ranges from approximately 15 to 55 meters (50 to 180 feet). The unit thickness is fairly uniform across the entire project. There are two locations where the FC Shale thins to approximately 15 meters (50 feet); one is located in the far north and the other is located along the south end of the site

The C, B, and A Sands are the primary mineralized members and comprise the North Butte mining sand. The C Sand is the uppermost unit of the C-B-A Sand package. The C Sand ranges in thickness from 0 to 40 meters (130 feet). The unit is stratigraphically continuous over most of the North Butte Remote Satellite, except for the east end of the project where the C Sand shales-out. The C Sand isopach and cross sections included in Appendix D5 of the North Butte WDEQ Permit illustrate the C Sand shale-out. The C Sand overlies the B Sand. In portions of the site these sands are distinct members separated by inter-bedded shale identified as the CB Shale. Locally due to deposition or erosion, the CB Shale is not present. In these areas the C and B Sands are in vertical contact resulting in a vertically continuous thick sand package.

The CB Shale ranges in thickness from approximately 0 to 18 meters (60 feet). The shale is discontinuous across large areas of the project, but especially in the central portion of the North Butte Remote Satellite. The absence of the CB Shale is most likely due to the paleo-depositional setting and not a result of erosion. The thickest occurrence of the CB Shale is on the east end of the North Butte Remote Satellite which results in the greatest amount of separation between the C and B Sands.

The B Sand is the middle unit and primary ore-bearing member of the C-B-A ore Sand. The B Sand ranges in thickness from approximately 15 to 49 meters (50 to 160 feet). The thickness of the unit is variable but stratigraphically continuous across the project. Where the CB Shale is absent, the top of the B Sand is in contact with the base of the C Sand. The B Sand is separated from the A Sand by the underlying BA Shale.

The BA Shale ranges in thickness from approximately 3 to 31 meters (10 to 100 feet). The unit is continuous across the North Butte Remote Satellite, but does demonstrate some variability in thickness. On the east and south ends of the project, the BA Shale thins to approximately 3 meters (10 feet).

The A Sand is the lower most unit of the C-B-A Sand package. The A Sand ranges in thickness from approximately 6 to 46 meters (20 to 150 feet). The thickness of the unit is fairly uniform; however on the northwest and south ends of the project locally the unit does thicken. Locally the A Sand splits into an upper and lower unit. The A Sand is separated from the underlying 1 Sand by the A-1 Shale.

Data presented in Appendix D5 of the North Butte WDEQ Permit indicate that the A-1 Shale is approximately 21 to 43 meters (70 to 140 feet) thick and is a continuous unit across the project. The 1 Sand is 0 to 12 meters (0 to 40 feet) thick and shales-out on the southeast side of the project. Across large portions of the North Butte Remote Satellite the 1 Sand is estimated to be less than 5 meters (15 feet) thick.

During future development at North Butte, delineation drill holes will be completed to penetrate the A-1 Shale and 1 Sands to better characterize the stratigraphy of these units. It is anticipated that future drilling will confirm that the A-1 Shale is laterally continuous across the North Butte Remote Satellite with a minimum thickness of approximately 21 meters (70 feet). It is also anticipated that additional drilling will show that the 1 Sand is even more discontinuous than currently modeled and will confirm the modeled thickness of 0 to 12 meters (40 feet).

3.3.2.2.3 North Butte Structural Geology

The structural attitude of the beds beneath the North Butte Site is nearly horizontal with only a slight dip of 0.5 to 1.5 degrees to the northwest. Evidence of structural instability at the North Butte site such as faulting has not been observed either by field observations or through drill hole correlation. The closest known faulting and/or significant folding are present approximately 26 kilometers (16 miles) to the west of the site along Pine Ridge.

3.3.2.3 Gas Hills Geology

3.3.2.3.1 Gas Hills Remote Satellite Site Geology

The *Safety Evaluation Report for Operation of the Gas Hills Project In Situ Leach Uranium Recovery Facility in Fremont and Natrona Counties, Wyoming (2004)* states that the NRC has reviewed and accepted the hydrologic site characterization contained in the Environmental Assessment for the Operation of the Gas Hills Project Satellite In Situ Leach Uranium Recovery Facility (2004). The approved geologic and seismic site characterization for the Gas Hills is summarized in the following sections.

3.3.2.3.2 Gas Hills Surficial Geology

The surface of the Gas Hills Remote Satellite is that of relatively steep slopes originating from the Beaver Divide which trends along the southern boundary of the site. West Canyon Creek, Fraser Draw and their tributaries generally flow to the north and dissect previous surface and underground mining activities. These disturbances include total blockage of channels by spoils piles, stream capture by mine pits, and surface disturbances by exploration activities. Gully erosion and headcutting are actively occurring throughout the area. Natural channel development (watershed elaboration) processes are enhanced by badland topography near the Beaver Rim. Disturbance-enhanced erosion and sedimentation has occurred to the past effects of historic mining practices.

Formations that crop out within the Gas Hills Remote Satellite include the Quaternary Alluvium and Colluvium, Miocene Split Rock Formation, Oligocene White River, Eocene Wagon Bed and the uranium-

bearing members of the Eocene-Age Wind River Formations. Quaternary alluvium occurs along not only the tributaries but the mainstem of Fraser Draw and West Canyon Creek and consists of unconsolidated sand, silt and clay. The Miocene Split Rock Formation crops out along the south and caps the Beaver Divide. The Split Rock Formation is both stratigraphically and topographically higher than the White River and Wind River Formations and consists of arkosic sands and conglomerates. The White River Formation consists of tuffaceous bentonitic mudstone with local lenses of arkosic sandstone and conglomerate. The Eocene Age Wagon Bed Formation consists of variegated mudstone, tuffaceous sandstone, and several ledge forming rhyodacite breccias flows and conglomerates. The underlying Wind River Formation can be locally broken into the Upper Wind River and Lower Wind River Formations and consists of interbedded fluvial derived sandstone, siltstones, mudstones and conglomerates. In the vicinity of the Gas Hills license area, the localized environments of deposition consist of coalesced alluvial fans.

3.3.2.3.3 Gas Hills Ore Zone Geology

To characterize the site geology, cross sections A-A' through O-O' in Appendix D5 of the Gas Hills WDEQ Permit were developed and show detailed stratigraphy and structure for mine units at the Gas Hills Remote Satellite. Addendum D5-2 of the Gas Hills WDEQ Permit contains copies of the geophysical logs used to develop the cross sections. The target sands are units of the Eocene Wind River Formation and have been subdivided into a series of sand and shale units. The sand units are numbered by even increments of ten starting with the lowest defined sand, the 30 Sand, which is overlain by the 40 Sand, and so on. The sand units represent zones of coarser clastic sediments and are dominantly comprised of dark gray to greenish-gray, medium to coarse grained arkosic sandstone with interbedded granitic pebble to boulder conglomerates. The sand units are moderately to poorly sorted sandstone, which locally contain clay and silt fractions as well as clay and siltstone interbeds. The sand units are the zones that contain the ore deposit. The shale units represent zones of finer clastic sediments and consist of dark gray to brownish gray claystone, mudstone, siltstone and minor amounts of fine grained sandstone. The contact between sand and shale units may be sharp or gradational.

Sandstones and conglomerates typically coalesce along the axes of the alluvial fan systems present in the Gas Hills area. Along the margins of the fans, alternating series of coarse channel sands and conglomerates with fine grained overbank deposits are typical. Table D5-2-1 of the Gas Hills WDEQ Permit describes the general stratigraphy of the Gas Hills area. Stratigraphic interpretation within the Gas Hills Remote Satellite is complicated by extensive intertonguing of various strata, members and beds, and by post-depositional faulting. Exploration drilling has focused interpretation of the site geology on a mine unit-by-mine unit basis. The most detailed information has been collected in Mine Units 1 and 2. Additional geologic data will be acquired during delineation drilling and mine unit testing. This information will be provided to NRC for review as reports are finalized. See Plates D5-1, D5-2, and D5-3 of the Gas Hills WDEQ Permit for mine unit locations.

Mine Unit No. 1 (Muskrat Deposit)

Mine Unit No. 1 is located in the west central part of the Gas Hills Remote Satellite. The production zone is the 70 Sand and consists of medium to very coarse grained arkosic sandstone. The sand is a well-defined single sandstone bed that ranges in thickness from 6 to 24 meters (20 to 80 feet) and is generally underlain and overlain by continuous shale beds.

The confining units consist of shales, claystones, and siltstones. The upper unit overlies the 70 Sand throughout the area and ranges from 17 to 46 meters (55 to 150 feet) in thickness and separates the 70 Sand from several thin discontinuous undifferentiated sandstones. The lower confining unit ranges from 6 to 15 meters (20 to 50 feet) in thickness and separates the 70 Sand from the underlying 50 Sand.

Mine Unit No. 2 (Bountiful Deposit)

Mine Unit No. 2 is located in the east central portion of the Gas Hills Remote Satellite. The production zone is located within the 40-50-60-70-80 Sand horizons. These sands consist of medium to very coarse grained arkosic sandstone with cobble and boulder conglomerate interbeds. The individual sandstones range in thickness from pinch-out to 30 meters (100 feet). The production sands typically are separated vertically by confining units which can range in thickness up to 6 meters (20 feet). These interbedded shale units tend to be continuous within the mine unit but commonly disappear to the east.

The production zone is overlain and underlain by confining beds. The upper confining unit consists of siltstone and claystone and ranges from 23 to 122 meters (75 to 400 feet) in thickness. The lower confining unit is the Triassic Chugwater Formation. The Chugwater Formation is dominantly shale and siltstone and is not considered an aquifer. The total thickness of the Chugwater Formation is approximately 300 meters (1,000 feet) in the region. Within Mine Unit No. 2 interbedded shales typically range from 2 to 6 meters (5 to 20 feet) in thickness.

Mine Unit No. 3 (Peach Deposit)

Mine Unit No. 3 is located in the western portion of the Gas Hills Remote Satellite. The production zone is located within the 30-40-50 Sands. These units consist of medium to very coarse grained arkosic sandstones. The individual sands range in thickness from pinchout to 15 meters (50 feet). The production sands are separated by confining claystones and siltstones which can range up to 9 meters (30 feet) in thickness.

The production zone is overlain and underlain by confining beds. The upper confining unit is a claystone which is contiguous throughout the mine unit and ranges from 2 to 12 meters (5 to 40 feet) in thickness. The confining units immediately underlying Mine Unit No. 3 are claystones and mudstones of the Wind River Formation or shales of the Pre-Tertiary Formations.

Mine Unit No. 4 (Buss Deposit)

Mine Unit No. 4 is located in the eastern part of the Gas Hills Remote Satellite. The production zone is located within the 50-60-70-80-90 Sands. These sand units consist of medium to very coarse grained arkosic sandstones with cobble and boulder conglomerate interbeds. The individual sandstones within this area range in thickness from 9 to 30 meters (30 to 100 feet). The sands can be separated vertically by mudstone or siltstone interbeds which range from pinchout to 5 meters (15 feet) in thickness. These confining units are not always continuous and frequently pinchout allowing coalescence of sand units within Mine Unit No. 4

The production zone is overlain and underlain by confining units. An upper confining unit overlies the uppermost 90 Sand throughout the mine unit south of the Buss Fault and ranges from 3 to 30 meters (10 to 100 feet) in thickness. A thinner, 3 to 12 meters (10 to 40 feet), locally continuous confining bed overlies the 80 Sand, south of the Buss Fault. The confining unit north of the Buss Fault overlies the 60 Sand since the 70-80 Sands are generally unconfined at this locale. The shale overlying the 60 Sand ranges in thickness from 3 to 6 meters (10 to 20 feet). The confining unit below the 50 Sand ranges from 2 to 9 meters (5 to 30 feet) thick. This confining unit separates the 50 Sand from the underlying East Canyon Conglomerate.

Mine Unit No. 5 (Pix Deposit)

Mine Unit No. 5 is located in the northeastern part of the Gas Hills Remote Satellite. The production zone is located within the 50 Sand and consists of medium to very coarse grained arkosic sandstone with cobble and boulder conglomerate interbeds. The 50 Sand ranges in thickness from 15 to 21 meters (50

to 70 feet). The 60 Sand may interfinger with the 50 Sand in Mine Unit No. 5 and will represent a single sand unit where it does.

The production zone is overlain and underlain by confining units. The upper confining unit overlies the 50 Sand throughout the mine unit and ranges from 6 to 12 meters (15 to 40 feet) thick. The confining unit below the 50 Sand ranges from 6 to 12 meters (20 to 40 feet) thick. This unit separates the 50 Sand from the underlying East Canyon Conglomerate.

3.3.2.3.4 Gas Hills Structural Geology

Normal faulting that occurred during the late Miocene and early Pliocene is present within the Gas Hills Remote Satellite. Cameco delineation drilling and hydrologic testing is defining the location, characteristics and hydrologic properties of these faults. Plate D5-2 of the Gas Hills WDEQ Permit shows the mapped faults within the site and distinguishes between subsidiary and traceable faults. Subsidiary faults are those which have limited displacement and/or are discontinuous laterally and/or vertically, and would not offset sand units enough to interrupt hydrologic continuity. Traceable faults are defined as continuous, mapable faults which have a significant enough displacement to offset sand units. The impacts of traceable faults are discussed specifically for each mine unit below.

Mine Unit No. 1 (Muskrat Deposit)

The Jasper Fault and the HBow Fault lie south of Mine Unit No. 1. There are no known traceable faults within Mine Unit 1. Delineation drilling will further define local structure, if any within Mine Unit No. 1.

Mine Unit No. 2 (Bountiful Deposit)

Two traceable faults pass through Mine Unit No. 2 and include the Bountiful and UPZ Faults. The Bountiful Fault has 12 to 15 meters (40 to 50 feet) of displacement. The UPZ Fault has up to 15 meters (50 feet) of displacement and is known to be transmissive along part of its length. Hydrologic testing will further define its characteristics.

Mine Unit No. 3 (Peach Deposit)

Three faults pass through or near Mine Unit No. 3. They include the PCH Fault, the Jasper Fault and the Lucky Mc Fault. Additional information regarding the faults in Mine Unit No. 3 will be acquired as delineation drilling and mine unit testing is completed.

Mine Unit No. 4 (Buss Deposit)

Mine Unit No. 4 will intersect one known traceable fault known as the Buss Fault. The Buss Fault has approximately 15 meters (50 feet) of displacement. Delineation drilling will further define local structure, if any within Mine Unit No. 4.

Mine Unit No. 5 (Pix Deposit)

One traceable fault intersects Mine Unit No. 5, marking the southern side of the Thunderbird Graben. The Thunderbird Graben is characterized by two parallel striking faults. The stratigraphic section between these two faults is downthrown by approximately 46 meters (150 feet). Delineation drilling will further define local structure, if any within Mine Unit No. 5.

3.3.2.4 Ruth Geology

3.3.2.4.1 Ruth Surficial Geology

The land surface at the Ruth Remote Satellite is flat to gently sloping terrain with one major drainage (Dry Fork of the Powder River) and two dissecting minor drainages. The Dry Fork flows from southeast to northwest. Crawford Draw is the more important of the two minor drainages and generally flows from

southwest to northeast. The local geology consists of Eocene Age sandstones, sandy shales and shales in a repeating facies type environment. Weathered detritus is present on the land surface and includes manganese nodules found on the knolls and high areas. These nodules are less present in the lowland areas.

3.3.2.4.2 Ruth Ore Zone Geology

The target sands at Ruth are units of the Eocene Wasatch Formation and are similar to those present at North Butte Remote Satellite, which is approximately 22 kilometers (14 miles) away. Beginning with the uppermost sand unit, the units of interest are the B Sand, B-A Shale, A Sand, A-1 Shale, and the 1 Sand. The production sand is the A Sand and is a laterally continuous depositional unit. Mineralization occurs throughout the A Sand but variations exist vertically and laterally. The production zone is typically 15 meters (50 feet) thick at an average depth of 163 meters (535 feet) below the surface. The A Sand is primarily arkosic in composition, very friable, and contains moderate to substantial organic debris and carbonaceous stringers. There are some small localized sandy shale intervals but most of the A Sand is relatively free of shale. The production zone is bounded above and below by impermeable shale intervals averaging about 9 meters (30 feet) thick. The upper and lower confining beds are composed of shales, silty shales and shaley lignite interbeds. Cross sections through the ore zone showing the A Sand and its confining layers are presented as Figures 15.2 through 15.10 in Volume II of the Ruth Supplemental Report.

In the confining unit above the A Sand there are zones where sand lenses divide the shale into two or three thinner intervals. Although the confining unit thickness is variable, the shale sequence still provides a continuous, low permeability cap on the production sand. The interbedded sand lenses are discontinuous and are not laterally traceable for any significant distance. In a majority of the production area, the upper confining shale is vertically continuous and not compromised by sand lenses.

The underlying confining unit of the A Sand consists of a shale layer divided by a thin coal seam. A stratigraphic column of the Ruth Remote Satellite is presented on Figure 9.5 (Volume II of the Ruth Supplemental Report).

3.3.2.4.3 Ruth Structural Geology

Evidence of geological structure, such as faulting or folding at the Ruth Remote Satellite has not observed either by field observations or through drill hole correlation. The closest known faulting and/or significant folding of Wasatch rocks occur approximately 7 kilometers (4 miles) to the west of the site along Pine Ridge.

3.3.3 Seismic Activity

3.3.3.1 Smith Ranch, North Butte Remote Satellite, Ruth Remote Satellite

Historic seismic events for Converse, Campbell, Natrona, and Johnson Counties surrounding the license area including Smith Ranch, North Butte and Ruth Remote Satellites have been documented by the US Geological Survey (USGS) (Case and others, 2002, 2003) and are summarized chronologically below.

Converse County

Twelve magnitude 3.0 and greater earthquakes have been recorded in Converse County. The first earthquake recorded in Converse County occurred on April 14, 1947. The earthquake had an intensity of V, and was felt near LaPrele Creek southwest of Douglas.

On August 21, 1952, an intensity IV earthquake occurred approximately 13 kilometers (8 miles) north-northeast of Esterbrook, in Converse County. It was felt by several people in the area, and was

reportedly felt 64 kilometers (40 miles) to the southwest of Esterbrook. Three additional earthquakes have occurred in the same location as the August 21, 1952 event. The first, a small magnitude event with no associated magnitude or intensity, occurred on September 2, 1952. The second, an intensity III event, occurred on January 5, 1957. The most recent, an intensity IV event occurred on March 31, 1964. No damage was reported for any of the events.

Only one earthquake was documented in Converse County in the 1970s. On January 15, 1978, a magnitude 3.0, intensity III earthquake occurred approximately 5 kilometers (3 miles) northeast of Esterbrook, in Converse County. No damage was reported.

Two earthquakes occurred in Converse County in the 1980s. On November 15, 1984, a magnitude 3.0, intensity III earthquake occurred approximately 24 kilometers (15 miles) northeast of Casper in western Converse County. No damage was reported. On December 5, 1984, a non-damaging magnitude 2.9 earthquake occurred in the Laramie Range in southern Converse County.

Four earthquakes occurred in Converse County in the 1990s. On June 30, 1993, a magnitude 3.0 earthquake was located approximately 24 kilometers (15 miles) north of Douglas. No damage was reported. On July 23, 1993, a magnitude 3.7, intensity IV earthquake occurred in southern Converse County, approximately 21 kilometers (13 miles) north-northwest of Toltec. This event was felt as far away as Laramie. On December 13, 1993, another earthquake occurred approximately 13 kilometers (8 miles) east of Toltec. This non-damaging event had a magnitude of 3.5. Most recently, on October 19, 1995, a magnitude 4.2 earthquake was recorded approximately 24 kilometers (15 miles) northeast of Casper in western Converse County. No damage was reported, although the event was felt by many Casper residents.

Campbell County

Five magnitude 2.5 and greater earthquakes have been recorded in Campbell County. The first earthquake recorded in the county occurred on May 11, 1967. This magnitude 4.8 earthquake was centered in southwestern Campbell County approximately 11 kilometers (7 miles) west-northwest of Pine Tree Junction. The second event took place on February 18, 1972, when a magnitude 4.3 earthquake occurred approximately 29 kilometers (18 miles) east of Gillette. No damage was reported for either event.

Two earthquakes were recorded in Campbell County during the 1980s. On May 29, 1984, a magnitude 5.0, intensity V earthquake occurred approximately 39 kilometers (24 miles) west-southwest of Gillette. The earthquake was felt in Gillette, Sheridan, Buffalo, Casper, Douglas, Thermopolis, and Sundance. On October 29, 1984, a magnitude 2.5 earthquake occurred approximately 40 kilometers (25 miles) west-northwest of Gillette. No damage was reported.

Most recently, on February 24, 1993, a magnitude 3.6 earthquake occurred in southeastern Campbell County approximately 16 kilometers (10 miles) east-southeast of Reno Junction. No damage was reported.

Natrona County

Twelve magnitude 2.5 or intensity III and greater earthquakes have been recorded in Natrona County. The first earthquake that occurred in Natrona County took place on December 10, 1973, approximately 3 kilometers (2 miles) south of Powder River. People in the area reported feeling the earthquake as an intensity III event. Two of the earliest recorded earthquakes in Wyoming occurred near Casper. On June 25, 1894, an estimated intensity V earthquake was reported approximately 5 kilometers (3 miles)

southwest of Evansville. Residents on Casper Mountain reported that dishes rattled to the floor and people were thrown from their beds. Water in the Platte River changed from fairly clear to reddish, and became thick with mud due to the riverbanks slumping into the river during the earthquake. An even larger earthquake was felt in the same area on November 14, 1897. This intensity VI-VII earthquake, one of the largest recorded in central and eastern Wyoming caused considerable damage to a few buildings. On October 25, 1992, an intensity IV-V earthquake was detected approximately 10 kilometers (6 miles) north-northeast of Bar Nunn. The event was felt in Casper; at Salt Creek 80 kilometers (50 miles) north of Casper; and at Bucknum, 35 kilometers (22 miles) west of Casper. No significant damage was reported in Casper.

One of the first earthquakes recorded near Midwest occurred on December 11, 1942. The intensity IV-V event occurred approximately 23 kilometers (14 miles) south of Midwest. Although no damage was reported, the event was felt in Casper, Salt Creek, and Glenrock. On August 27, 1948, another intensity IV earthquake was detected approximately 10 kilometers (6 miles) north-northeast of Bar Nunn. No damage was reported.

In the 1950s, two earthquakes caused some concern among Casper residents. On January 23, 1954, an intensity IV earthquake occurred approximately 11 kilometers (7 miles) northeast of Alcova. No damage was reported. On August 19, 1959, an intensity IV earthquake was recorded north of Casper, approximately 10 kilometers (6 miles) north-northeast of Bar Nunn. People in Casper reported feeling this event; however, it is uncertain if this earthquake actually occurred in the Casper area, as it coincides with the Hebgen Lake, Montana earthquakes that initiated on August 17, 1959.

Only one earthquake was reported in Natrona County in the 1960s. On January 8, 1968, a magnitude 3.8 earthquake occurred approximately 16 kilometers (10 miles) north-northwest of Alcova. No damage was reported.

An earthquake of no specific magnitude or intensity occurred approximately 21 kilometers (13 miles) southeast of Ervay on June 16, 1973. No one felt this earthquake and no damage was reported.

No other earthquakes occurred in Natrona County until March 9, 1993, when a magnitude 3.2 earthquake was recorded 27 kilometers (17 miles) west of Midwest. No damage was reported. A magnitude 3.1 earthquake also occurred in the far northwestern corner of the county on November 9, 1999. No one reported feeling this earthquake that was centered approximately 51 kilometers (32 miles) northwest of Waltman.

Most recently, on February 1, 2003, a magnitude 3.7 earthquake occurred approximately 26 kilometers (16 miles) north-northeast of Casper. Numerous Casper residents felt this event.

Johnson County

Eight magnitude 2.5 and greater earthquakes have been recorded in Johnson County. The first earthquake recorded in the county occurred on October 24, 1922. The location was originally determined to be near Buffalo, and the event was classified as an intensity II earthquake. Based upon a description of the earthquake in the October 27, 1922 edition of the Sheridan Post, however, the location and assigned intensity may be in error. The Sheridan Post reported that at Cat Creek, 13 kilometers (8 miles) east of Sheridan, houses were shaken and dishes were rattled. In addition, the October 26, 1922 edition of the Sheridan Post reports that only a slight earthquake shock was felt in Sheridan. Based upon this information, it seems reasonable to locate the earthquake 13 kilometers (8 miles) east of Sheridan, and to assign an intensity of IV-V to the event.

On September 6, 1943, an intensity IV earthquake was felt in the Sheridan area, although the epicenter was determined to be approximately 5 to 6 kilometers (3 to 4 miles) south-southwest of Buffalo. Beds and chairs were reported "to sway" in the Sheridan area.

Two earthquakes were recorded in Johnson County in the 1960s. A magnitude 4.7 earthquake occurred on June 3, 1965. This event was centered approximately 19 kilometers (12 miles) south of Kaycee. On April 12, 1966, an earthquake of no specified magnitude or intensity was detected approximately 40 kilometers (25 miles) southwest of Buffalo. No one reported feeling these events.

On September 2, 1976, a magnitude 4.8, intensity IV-V earthquake was felt in Kaycee. The event was located approximately 53 kilometers (33 miles) northeast of Kaycee. No damage was reported.

A magnitude 5.1, intensity V earthquake occurred on September 7, 1984, approximately 53 kilometers (33 miles) east-southeast of Buffalo. The earthquake was felt throughout northeastern Wyoming, including Buffalo, Casper, Kaycee, Linch, and Midwest, and in parts of southeastern Montana. No significant damage was reported.

Two earthquakes were detected in Johnson County in 1992. The first occurred on February 22, 1992. This magnitude 2.9 event was recorded approximately 29 kilometers (18 miles) east of Buffalo. As expected with such a small earthquake, no damage was reported. Most recently, a magnitude 3.6, intensity IV earthquake occurred on August 30, 1992. The earthquake was centered near Maynworth, approximately 35 kilometers (22 miles) west-northwest of Kaycee. It was felt in Barnum and Kaycee, but no damage was reported.

There are no known exposed active faults with a surficial expression in the vicinity of Smith Ranch, North Butte, or Ruth. As a result, no fault-specific analysis can be generated for these locations.

3.3.3.2 Gas Hills

The Gas Hills Remote Satellite is located in the south central portion of the Wind River Basin. Historically, central Wyoming has had a moderate level of seismic activity compared to the rest of the state. A discussion on historical earthquakes in the surrounding areas (Atlantic City, Lander, and Sand Draw/Gas Hills Areas,) is presented below. Historic earthquakes that have occurred in Natrona County located east of the Gas Hills Satellite were discussed in Section 3.3.3.1.

Atlantic City Area

The Atlantic City area is located about 100 kilometers (62 miles) southwest of the Gas Hills Satellite. One of the first recorded earthquakes in central Wyoming occurred on December 10, 1873, near Atlantic City in southern Fremont County. It was felt as an intensity III event in nearby Camp Stambaugh (Case, 1996a). An intensity V earthquake was reported from Atlantic City on December 12, 1923; no significant damage was reported (Humphreys, 1924). Non-damaging earthquakes were also reported in the area on October 30, 1925 (intensity III) and on August 22, 1959 (intensity IV). On February 23, 1963, a magnitude 4.3 (Modified Mercalli), intensity V earthquake occurred about 48 kilometers (30 miles) west, northwest of Atlantic City. No damage was reported. On November 3, 1984, a magnitude 5.0, intensity VI earthquake was recorded approximately 16 kilometers (10 miles) northwest of Atlantic City. This earthquake was one of the strongest recorded in this quarter of the state.

Lander Area

The Lander area is located approximately 100 kilometers (62 miles) west of the Gas Hills Satellite. A number of earthquakes have occurred in the Lander area. The first reported earthquake occurred on

January 22, 1889, and had an intensity of III-IV (Case, 1993). This event was followed by an intensity IV earthquake on November 21, 1895, which resulted in houses being jarred and dishes being rattled. On November 23, 1934, an intensity V earthquake was centered about 32 kilometers (20 miles) northwest of Lander. Cracks were found in buildings in two business blocks and the brick chimney on the outside of the Fremont County Courthouse was moved 5 centimeters (2 inches) away from the building. There were a series of earthquakes in the Lander area in the 1950s that produced little damage. On August 17, 1950, there was an intensity IV earthquake that caused loose objects to rattle and buildings to creak. On January 12, 1954, there was an intensity II event, and on December 13, 1955, there was an intensity IV event near Lander (Murphy and Cloud, 1957), with no report of damage.

On June 14, 1973, a small earthquake was reported about 13 kilometers (8 miles) east-northeast of Lander. This event has since been interpreted as a probable explosion. On January 31, 1992, a non-damaging magnitude 2.8 earthquake occurred approximately 32 kilometers (20 miles) northwest of Lander (Case, 1994). This event was followed by a magnitude 4.0, intensity III earthquake on October 10, 1992. Its center was approximately 35 kilometers (22 miles) east of Lander (Case, 1994).

Sand Draw/Gas Hills Area

The first earthquake reported in the Gas Hills Area occurred on August 11, 1916, about 10 kilometers (6 miles) south of Jeffrey City (Reagor et al., 1985). No damage was associated with this intensity III event. On April 22, 1973, a magnitude 4.8, intensity IV earthquake was recorded approximately 19 kilometers (12 miles) north of Jeffrey City. On March 25, 1975, there was a magnitude 4.8, intensity III earthquake recorded about 29 kilometers (18 miles) northwest of Jeffrey City. A mobile home 56 kilometers (35 miles) southeast of Riverton was moved 3 centimeters (1 inch) off its foundation. On December 19, 1975, a non-damaging magnitude 3.5 earthquake was recorded approximately 40 kilometers (25 miles) northeast of Jeffrey City (Reagor et al., 1985).

On August 16, 1985, a magnitude 4.3, intensity IV event was recorded about 40 kilometers (25 miles) northwest of Jeffrey City; no damage was reported. On June 1, 1993, a non-damaging magnitude 3.8, intensity III earthquake occurred near Bairoil, about 32 kilometers (20 miles) southeast of Jeffrey City (Case, 1994).

There are three exposed active faults in the vicinity of the Wind River Basin and the Gas Hills Remote Satellite. Of these faults, the Green Mountain segment of the South Granite Mountain Fault System was analyzed deterministically to estimate the ground motion at the Gas Hills Remote Satellite. This fault was the only one analyzed because it is closer to the site than the other faults, its recurrence interval is shorter, and it can produce a maximum credible earthquake for the area. For the site, which is located about 45 kilometers (28 miles) from the nearest segment of the Green Mountain Fault, the expected horizontal ground acceleration at the site would be about 6% g for a magnitude 6.75 earthquake (Campbell, 1987).

3.3.3.3 Earthquake Design Considerations

The Uniform Building Code (UBC) is a document that was prepared by the International Conference of Building Officials. Its stated objective is to provide minimum standards to safeguard life or limb, health, property, and the public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within its jurisdiction. The entire SUA-1548 license area is in Seismic Zone 1 as defined by the UBC. Because effective peak accelerations (90% chance of non-exceedance in 50 years) range from 5 to 10% g in Zone 1, an average peak acceleration of 7.5% g can be applied in designing a non-critical facility near the center of the zone (Case, 1996b).

Within a tectonic province, earthquakes associated with buried faults are assumed to occur randomly. These earthquakes are designated as "floating earthquakes." In a report by Algermissen et al. (1982), the entire area occupied by SUA-1548 was assigned a floating earthquake with a magnitude of 6.1. This value was updated to 6.25 by Bernreuter et al. (1994). In addition, federal or state regulations usually specify if a floating earthquake analysis is required for a facility. For uranium mill tailings sites, the NRC requires analyzing the impacts of a floating earthquake with an epicenter 14 kilometers (9 miles) from the site. A magnitude 6.25 earthquake placed 14 kilometers (9 miles) from the Smith Ranch, North Butte, Gas Hills and Ruth Project sites would generate horizontal accelerations of about 15% (Case, 1996b).

For short-term probabilistic seismic hazard analyses, USGS acceleration maps are frequently used. These maps are for return periods of 500, 1,000, and 2,500 years. Although the maps are subject to change as earthquakes occur, the current 500-year map provides accelerations that are comparable to those derived from the UBC and in the case of the Gas Hills Remote Satellite, from the deterministic analysis for the Green Mountain Segment of the South Granite Mountain Fault System. The estimated acceleration in central Wyoming is 7% g for the 500-year map, and 20% g on the 2,500-year map. For structure design within the SUA-1548 license area, an acceleration of 7.5% g would be adequate for design purposes (Case, 1996b).

Earthquake probability maps that are used in the most current building codes (2,500-year maps) predict a scenario that would result in moderate damage to buildings and their contents, with expected damage increasing from the northeast to the southwest in Converse, Campbell, Natrona, and Johnson Counties. Fremont County experiences more variability in probabilistic earthquake acceleration due to higher acceleration rates predicted in the northwestern and southern portions of the county. The probability-based worst-case scenario however, estimates earthquakes that could result in similar levels of damage at all locations throughout the license area. Smith Ranch and the North Butte, Gas Hills, and Ruth Remote Satellites are all located in intensity VII earthquake areas. In intensity VII earthquakes, predicted damage is negligible in buildings of good design and construction, slight-to-moderate in well-built ordinary structures, considerable in poorly built or badly designed structures such as unreinforced masonry buildings. Some chimneys will be broken.

3.3.4 Soils

3.3.4.1 Smith Ranch Soil Survey and Existing Surface Disturbance Summary

Baseline soil studies were performed at Smith Ranch, Highland and Reynolds Ranch Satellite as part of the licensing process for each property. The results of these studies are provided in Appendix D7 of the Smith Ranch WDEQ Permit.

The soils at Smith Ranch are typical of the semi-arid grasslands of the western United States. Due to prevailing climate and vegetation conditions, organic matter is accumulated slowly and is confined primarily to the surface horizon resulting in light coloration. Subsoil color is usually light brown.

Most of the upland soils are residual and are formed from weathered sedimentary bedrock, mostly sandstone and shale. Most developed soils reflect the character of the bedrock. Areas of sandy and medium textured friable soils are underlain by sandstone and sandy shale. Typical toposequences under such conditions range from Taluce (shallow end) to Bowbac (moderately deep) to Hiland (deep). Heavy clay soils are underlain by clayey shale. A typical toposequence under such conditions ranges from Shingle (shallow) to Cushman (moderately deep) to Forkwood (deep). These soils vary widely in both depth and suitability and reflect the parent material from which the soils have formed.

Major stream channels are characterized by alluvial soils such as the Kishona (formerly Kim) series, Clarkelen series, and Draknab series. These soils are developed from a variety of material washed from the uplands and redeposited along the stream courses. The alluvial soils reflect the character of the weathered, transported material and generally have a dark friable surface that contains a larger amount of organic matter than upland soils.

According to the 2011-2012 surety bond estimate, Smith Ranch (including Highland and Reynolds Ranch Satellite) soils have been affected by past surface disturbances related to existing buildings, existing access roads, settling basin and storage pond construction, irrigation areas, purge storage reservoirs, and surface disturbances from individual mine units. The surety bond estimate indicates there are 36 buildings currently on site that take up a total of 2 hectares (6 acres). There are 13 access roads totaling approximately 27 hectares (66 acres). The total area taken up by storage ponds and settling basins is 3 hectares (8 acres). Irrigation areas and purge storage reservoirs total 85 hectares (210 acres) of surface disturbance. Individual mine unit disturbances consist of production wells, injection wells, monitoring wells, associated header houses, access roads, and wellfield patterns. The total area of disturbed surface related to mine unit development is approximately 453 hectares (1,120 acres). The total existing surface disturbance at Smith Ranch is 570 hectares (1,410 acres). The majority of this surface disturbance (roughly 70 to 75%) consists of well field areas that have been revegetated.

From 1996 through 2010, approximately 7 hectares (17 acres) at Smith Ranch have been impacted by spills from pipeline leaks and leaks from header houses. Cameco keeps detailed records of all spills. Soils impacted by spilled materials will be cleaned up during site decommissioning.

3.3.4.2 North Butte Remote Satellite Soil Survey and Existing Surface Disturbance Summary

For the North Butte Remote Satellite, a soil study was performed by Uranerz in the late 1980s. This survey was supplemented by a confirmatory study in 2010. The results of these studies are provided in Appendix D7 of the North Butte WDEQ Permit, and a summary is provided below.

The soils at North Butte are typical of the semi-arid grasslands of the western United States. Due to prevailing climate and vegetation conditions, organic matter is accumulated slowly, and soils have developed with light-colored surfaces. Subsoil color is usually light brown or yellowish brown.

Most of the upland soils of the survey area are residual (developed in place) and are formed from weathered sedimentary bedrock, mostly sandstone and shale. Most developed soils reflect the character of the bedrock. Areas of sandy and medium-textured friable soils are underlain by sandstone and sandy shale. Heavy clay soils are underlain by clayey shale. These soils vary widely in both depth and suitability of the material for topsoiling depending primarily on the parent material from which the soils have formed.

Stream channels of the survey area are characterized by alluvial soils of the Kishona (Kim) series. These soils are developed from a variety of material washed from the uplands and redeposited along the stream courses. The alluvial soils reflect the character of the weathered, transported material and generally have a dark friable surface that contains a larger amount of organic matter than upland soils.

According to the 2011-2012 surety bond estimate the North Butte Remote Satellite soils have been affected by past surface disturbances related to construction of existing buildings and monitor well drilling. There is one building (trailer) currently on site. The trailer takes up a total of 0.02 hectares (0.04 acres). According to Table 2 (Abandoned Borehole and Monitor Well Surface Reclamation 2010) of the

2010 North Butte Annual Report, there are 61 abandoned borehole or monitor well sites that have yet to see final grading and reseeding. It is estimated that each monitor well, between the pad and access road to the well disturbs approximately 0.2 hectares (0.5 acres) for a total of 12 hectares (31 acres). Therefore the total existing surface disturbance at the North Butte Remote Satellite is approximately 12 hectares (31 acres).

3.3.4.3 Gas Hills Remote Satellite Soil Survey and Existing Surface Disturbance Summary

For the Gas Hills Remote Satellite, a soil study was performed in December 1996 and revised in February 1998. The results of this study are provided in Appendix D7 of the Gas Hills WDEQ Permit.

The soils at the Gas Hills Remote Satellite are typical of the semi-arid areas of the western United States. Most of the upland soils are residual and are formed from weathered sedimentary bedrock. Most developed soils reflect the character of the bedrock. The areas of sandy and medium-textured friable soils are underlain by sandstone and loamstone, while the heavy clay soils are underlain by shale. These soils vary widely in both depth and the suitability of the material for topsoil, which depends primarily on the parent material from which the soils have formed. The ephemeral stream channels are characterized by alluvial soils. These soils are developed from a variety of material washed from the uplands and then redeposited along the stream courses. The soils formed in alluvium reflect the character of the weathered, transported material.

The soils are generally shallow near the Beaver Rim and deepen as one moves north within the license area. Generally, the depth of suitable material can be estimated from the landscape position, e.g., ridge vs. alluvial drainage or pediment. However, sometimes extensive suitable topsoil appears on an atypical landscape position. A more highly dissected landscape was evident in the southwestern portion of the Gas Hills area. The percent of finer material, clay or silt, was generally greater within this area of the site, as is the potential for runoff and subsequent erosion.

According to the 2011-2012 surety bond estimate the Gas Hills Remote Satellite soils have been affected by past surface disturbances. The disturbances are related to existing buildings, access roads, and monitor well installation. The Carol Shop is the only building on site and the associated disturbance area is approximately 9 hectares (21 acres). In addition there are approximately 26 hectares (64 acres) associated with access roads and 5 hectares (13 acres) related to monitoring well installation. The total amount of existing surface disturbances at the Gas Hills Remote Satellite is 40 hectares (98 acres).

3.3.4.4 Ruth Remote Satellite Soil Survey and Existing Surface Disturbance Summary

For the Ruth Remote Satellite, a soil study was performed by Uranerz in the late 1980s. No supplemental study has been conducted since then. The soil survey results for Ruth are provided in the Ruth Supplemental Report and a summary is provided below.

The soil survey was confined to the defined ore body plus a 150 meters (500 feet) buffer. The soils occurring on the Ruth Remote Satellite are typical of the semi-arid grasslands found throughout the SUA-1548 license area. Due to prevailing climate and vegetation conditions, organic matter is accumulated slowly, and soils have developed with light colored surfaces. Subsoil color is usually light brown or reddish brown.

Most of the upland soils of the survey area are residual and are formed from weathered sedimentary bedrock, mostly sandstone and shale. Most developed soils reflect the character of bedrock. Areas of sandy and medium textured friable soils are underlain by sandstone and sandy shale. Heavy clay soils

are underlain by clayey shale. Depending on the parent material from which the soils have formed, these soils vary widely in both depth and suitability of the material for topsoil stockpiling.

The major stream channels within the survey area are characterized by alluvial soils including Glenburg, Bankard, and Haverson. These soils are developed from a variety of material washed from the uplands and redeposited along the stream channels. These soils have a generally dark friable surface that contains a fair amount of organic matter.

According to the 2011-2012 surety bond estimate the Ruth Remote Satellite soils have been affected by past surface disturbances related to existing buildings, access roads, evaporation ponds and monitor well access. Currently there are three buildings on site that occupy a total of 0.04 hectares (0.11 acres). In addition there is approximately 0.4 hectares (0.88 acres) of area associated with haul roads and parking areas. There are two evaporation ponds on site that total approximately 0.4 hectares (1.01 acres) in size and the existing well field disturbance (including three monitor wells and associated access roads) is 0.9 hectares (2.3 acres). The total amount of existing surface disturbances at the Ruth Remote Satellite is 1.7 hectares (4.3 acres).

3.3.5 References

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USNRC. 2004. "Environmental Assessment for the Operation of the Gas Hills Project Satellite In Situ Leach Uranium Recovery Facility." January, 2004.

3.4 Water Resources

3.4.1 Regional Water Resources

The Smith Ranch, North Butte and Ruth Remote Satellite areas are located in the Powder River Structural Basin in east central Wyoming. The Gas Hills Remote Satellite is located in the Wind River Structural Basin. The geology of these basins has played a key role in the uranium deposition, drainage development, and aquifer characteristics of the SUA-1548 license area including the remote satellites.

3.4.1.1 Powder River Basin

The Powder River Basin covers a large portion of Converse, Campbell, and Johnson Counties and contains the most extensive uranium deposits in Wyoming. The Powder River Basin is bounded on the west by the Bighorn Mountains and the Casper Arch and on the south by the Laramie Range-Hartville Uplift. The northern and eastern margins of the basin are less distinct. The broad Black Hills Uplift forms the eastern demarcation, and the Miles City Arch forms the northern boundary. Principal watersheds within the Powder River Basin are Glendo Reservoir (on the North Platte River), Middle North Platte-Casper, Lightning Creek, Dry Fork of the Cheyenne River, Antelope Creek, Salt Creek, Upper Cheyenne River, Upper Belle Fourche River, and Upper Powder River. Watersheds containing only intermittent

and/or ephemeral streams that flow to the Cheyenne River include Lightning Creek, Antelope Creek, Dry Fork of the Cheyenne River, and Upper Cheyenne River. Besides uranium, these watersheds also contain areas of coal, oil and gas, and CBM development. Surface water conditions and streamflow are summarized in Appendix D6 of the WDEQ Permit.

Descriptions of the geologic formations of the Powder River Basin and their hydrologic properties have been discussed in numerous publications (Hodson et al., 1973; Hodson, 1971; Whitcomb et al., 1958; Huntoon, 1976; Davis, 1976) and in Section 3.3. The hydrologic units beneath the Smith Ranch and the North Butte and Ruth Remote Satellites include the following: Holocene-age alluvial deposits, the Eocene-age Wasatch Formation, the Paleocene-age Fort Union Formation, and the Cretaceous-age Lance and Fox Hills Formations. Individual sandstones within these units may be classified as aquifers depending on their hydrologic characteristics and potential yield to wells and/or springs.

3.4.1.2 Wind River Basin

The Gas Hills Remote Satellite lies primarily along the south-central flank of the Wind River Basin. The Beaver Divide, which trends along the southeastern side of the site, forms a prominent drainage divide between the Wind River and Sweetwater River Basins. Major drainages within the project area are tributary to the Wind River.

Descriptions of the geologic formations of the Wind River Basin and their hydrologic properties have been summarized in Appendix D5 of the Gas Hills WDEQ Permit and in Section 3.3. The hydrologic units beneath the Gas Hills Remote Satellite and in the general vicinity include the following: Quaternary alluvium, the Miocene-age Split Rock Formation, Oligocene-age White River Formation, the Eocene-age Wind River Formation. Underlying these Tertiary units lie the Late Cretaceous-age Frontier Formation, the Early Cretaceous-age Muddy Sandstone and Cloverly Formations, the Late Jurassic-age Sundance Formation, the Jurassic/Triassic-age Nugget Formation, the Triassic-age Chugwater and Dinwoody Formation, the Permian-age Phosphoria Formation, the Middle Pennsylvanian-age Tensleep Sandstone, the Early Pennsylvanian-age Amsden Formation, and the Early Mississippian-age Madison Limestone. Individual sandstones within these units may be classified as aquifers depending on their hydrologic characteristics and potential yield to wells and/or springs.

3.4.2 Smith Ranch, Highland, and Reynolds Ranch Satellite

The *Safety Evaluation Report for Renewal of Rio Algom Mining Corp. Smith Ranch In-Situ Leaching Facility Converse County, Wyoming (2001)* states that the NRC has reviewed and accepted the hydrologic site characterization contained in the Environmental Assessment for Renewal of Source Material License No. SUA-1548 Rio Algom Mining Corporation Smith Ranch Uranium Project Converse, County (2001). The approved hydrologic site characterization for Smith Ranch is summarized in the following sections. Updated water rights and water quality data and updated potentiometric surface maps are included in this report. There has been no new hydrologic evidence that would alter the findings of the 2001 Safety Evaluation Report.

3.4.2.1 Surface Water

3.4.2.1.1 Hydrology and Stream Flow

Smith Ranch (including Highland and the Reynolds Ranch Satellite) occupies approximately 16,200 hectares (40,000 acres) and is located in the southern portion of the Powder River Basin.

Smith Ranch lies within the Sage Creek drainage of the North Platte River drainage system and includes Box Creek, Duck Creek, Willow Creek, and Brown Springs Creek- all tributary to the Cheyenne River. All streams are ephemeral and flow only in response to snowmelt and heavy thunderstorms. There are no

gauging stations within the drainages; therefore flow quantities are not measured. A considerable area encompassed by the project site is internally drained to playas. Smith Ranch receives approximately 31 centimeters (12 inches) of precipitation annually (detailed climatic data are presented in Section 3.6 and Appendix D4 of the WDEQ Permit. Stock ponds constructed in many of the ephemeral streams draining the area collect some runoff for watering livestock; however, these ponds are dry much of the time. There are numerous playas present which hold runoff water during times of abundant precipitation. Tables D6-1 and D6-2 in Addendum D-6 B1 of the WDEQ Permit contain USGS stream flow records for Box Creek, downstream of Smith Ranch. These tables show the lack of runoff and stream flow in the area and the ephemeral nature of the stream system.

Sage Creek runs through the southwest portion of Smith Ranch. The USGS maintained a stream gage near Orpha, approximately 3 kilometers (2 miles) southeast of Smith Ranch (USGS Gage No. 06648780). Peak stream flow values were recorded from 1965 to 1984. The data indicate that Sage Creek is highly variable as annual peak flow rates range from 0 to 6.5 meters^3/second (229 feet^3/second). Sage Creek is also ephemeral, as 5 out of 19 years were dry.

Average annual runoff from Smith Ranch is approximately 0.8 to 1.3 centimeters/year (0.3 to 0.5 inches) with the majority of runoff occurring in response to thunderstorm events. Snowmelt conditions occasionally contribute to surface water flow- but typically in an intermittent fashion.

3.4.2.1.2 Water Use and Quality

Surface water use at Smith Ranch is for livestock and wildlife watering. The drainages are ephemeral and flow only in response to snowmelt or major precipitation events. Stock ponds and playas impound the water on a seasonal basis. Surface water samples from selected points in the Box Creek drainage were sampled by previous developers during the period of surface mining activities. The data, which historically have been considered to be representative of surface water quality for Smith Ranch, Highland, and Reynolds Ranch Satellite, are included in Table D6-3 in Addendum D-6 B1 of the WDEQ Permit. Sampling locations are shown on Figure D6-1 in Addendum D-6 B2 of the WDEQ Permit. The data indicate that water quality in these surface waters does not meet Wyoming domestic water use suitability standards (Class I) or EPA public health standards for chloride, sulfate, and TDS. These waters do however meet Wyoming livestock use suitability standards (Class III) and are suitable for stock and wildlife consumption.

Sampling for radiological constituents has been conducted at select surface water points within Smith Ranch since 2003 and since 1987 from the Highland area. Figure D6-2 of Appendix D6 of the WDEQ Permit show the radiological surface water sampling locations. The results are summarized in Table D6-2 of Appendix D6 of the WDEQ Permit. Surface water samples were collected at Reynolds Ranch between August 17 and 18, 2011. The results are presented in **Table 3.4-1, Reynolds Ranch Surface Water Quality Data**. The sample locations are presented on **Figure 5.7** of the TR.

Sediment samples were collected along ephemeral drainages and impoundments within Reynolds Ranch between August 17 and 18, 2011. **Table 3.4-2, Reynolds Ranch Sediment Quality Data** presents the results of radionuclide analysis completed on all sediment samples. In general, concentrations of radium 226 and lead-210 averaged 2.7 pCi/gram, uranium concentrations averaged 1.3 pCi/gram, and thorium 230 concentrations averaged 0.9 pCi/gram. Sediment sample locations are presented on **Figure 5.7** of the TR.

3.4.2.1.3 Water Rights

A list of all surface water rights within Smith Ranch (including Highland and Reynolds Ranch Satellite) and on adjacent lands, as of November 2011 is included in **Table 3.4-3, Smith Ranch Surface Water rights**. The locations of the surface water rights are shown on **Figure 3.4.1, Smith Ranch Surface Water and Groundwater Rights**. The majority of surface water rights are limited to small stock ponds and associated ditches.

3.4.2.2 Groundwater

The geologic units within Smith Ranch (including Highland and Reynolds Ranch Satellite) were mentioned previously in the regional setting and are summarized in more detail in Section 3.3. The hydrogeologic units are discussed in the following sections and site-specific groundwater hydrology are presented in detail in Appendix D6 of the WDEQ Permit. Baseline aquifer characteristics and water quality were developed for Smith Ranch and Highland beginning in the 1970s and have been updated as additional data have been acquired during hydrologic unit testing of the various ISR mine units. The uranium producing sands are hosted within the Eocene-age Fort Union Formation. A local geology map is presented on Figure D5-3.1 of Appendix D-5 of the WDEQ Permit.

3.4.2.2.1 Hydrogeologic Stratigraphy

Alluvium – Alluvial deposits in the Smith Ranch area consist of thin, unconsolidated, poorly stratified clays, silts, sands, and gravels. The total thickness of these deposits is estimated to range from less than 0.3 to 9 meters (1 to 30 feet). Small amounts of precipitation infiltrate the alluvium during part of the year and intermittent flows across the alluvium may provide some recharge. The water table is typically more than 31 meters (100 feet) below the land surface throughout most of Smith Ranch. Therefore, most of the recharge flows through the lower portion of the alluvium. The potential for future development of alluvial groundwater supplies is considered very poor.

Wasatch Formation - The Wasatch Formation typically is composed of lenticular, fine- to coarse-grained sandstones with interbedded claystones and siltstones. This formation underlies all except the southwestern and extreme western portions of Smith Ranch and ranges in thickness from 0 to approximately 150 meters (500 feet). The Wasatch Formation is one of the more important shallow aquifers in the Powder River Basin.

Properly constructed wells penetrating the Wasatch Formation in the vicinity of the Smith Ranch CPP generally yield from 19 to 57 liters/minute (5 to 15 gallons/minute). A water supply well (WW-103) completed in the Wasatch Formation near the former Bill Smith mine initially produced 530 liters/minute (140 gallons/minute); however, production was from a composite thickness of approximately 37 meters (120 feet) of sandstone including four separate sandstone units commingled within the well. This 145 meter (474 foot) deep well taps the Wasatch Formation in one of its thicker zones. The permit for this well has been cancelled for years; since the Bill Smith mine shaft was sealed.

For the most part, groundwater as utilized by stock wells from the Wasatch Formation exists under water table (unconfined conditions) and such wells are generally low-yielding. Artesian (confined) zones near the base of the formation are separated from near-surface deposits and from each other by impermeable shale layers. The Wasatch Formation is considered to have good potential for water supply development for livestock.

Fort Union Formation - The Fort Union Formation underlies the Wasatch Formation. The top of the Fort Union Formation is exposed at the surface in the southwestern and western portions of Smith Ranch,

but occurs at depths of 150 meters (500 feet) or more in the eastern and northeastern part of Smith Ranch. The formation is as much as 900 meters (3,000 feet) thick beneath the surface.

The Fort Union Formation is an important aquifer in the Powder River Basin. Nearly all of the Smith Ranch wells are completed in this formation. While most of the wells are designated for limited yields of 19 to 114 liters/minute (5 to 30 gallons/minute), wells completed in the Fort Union Aquifer associated with the former Bill Smith mine dewatering program produced as much as 2,120 liters/minute (560 gallons/minute). Substantial volumes of groundwater can be produced from the Fort Union Formation over extended periods, as demonstrated by the various historical and current ISR operations in the Southern Powder River Basin.

Lance and Fox Hills Formations - The Lance and Fox Hills Formations underlie the Fort Union Formation at depths of approximately 1,067 and 1,676 meters (3,500 and 5,500 feet), respectively beneath the site. The formations are comprised of fine- to medium-grained sandstones, interbedded sandy shales and claystones. Well yields from these formations are not expected to exceed 380 liters/minute (100 gallons/minute), and the associated groundwater reserves may be limited. Little is known of the hydrologic characteristics of the Lance and Fox Hills Formations as no water wells tap these aquifers in the vicinity of Smith Ranch.

3.4.2.2.2 Producing Sands

Previous reports for the individual sandstone units within Smith Ranch and Highland have used different nomenclature for the different delineated sandstone units. This historic nomenclature is maintained throughout this document in an effort to preserve the sampling, testing and ISR history. For the purposes of correlation, the M Sands, which are present at Smith Ranch, are equivalent to the 10 Sands at Highland; the O1, O2, O3 and O4 Sands at Smith Ranch are equivalent to the 20/30, 40/50, 60/70 and 80 Sands, respectively at Highland. The Q and S Sands at Smith Ranch are equivalent to the 90 and 100 Sands, respectively at Highland. A schematic sandstone correlation chart for Highland, Smith Ranch, and Reynolds Ranch Satellite is presented on **Figure 3.3.1**.

Wells drilled for aquifer tests and/or collecting baseline data for Smith Ranch, including the two Smith Ranch pilot projects, are listed in Table D-6.4 of Addendum D-6 A1, and are located as shown on Figures D-6.4, D-6.5, and D-6.6 of Addendum D-6 A2 of the Smith Ranch WDEQ Permit.

3.4.2.2.3 Confining Unit Characteristics

Before ISR commenced, characterization of the confining layers was completed for the eastern portion of Smith Ranch and is documented in Appendix D6 of the WDEQ Permit. This characterization is considered representative of baseline conditions for the entire Smith Ranch area. Low permeability confining units (aquitards) are present between the various sandstone aquifers. These units are typically 6 to 14 meters (20 to 45 feet) in thickness, but may be thicker in areas where the sandstone pinches out. These siltstone and claystone units are usually continuous over relatively large areas. Where individual sandstone units converge (facies change), the previous overlying claystone is non-existent. Geologic cross-sections which show the thickness and extent of confining units are included in Appendix D-5 of the WDEQ Permit.

Vertical permeability of confining units was determined in the laboratory from actual cored material and from pump test results utilizing the Neuman-Witherspoon Method. Table D6-5 of Addendum D-6 B1 of the WDEQ permit contains estimates of the vertical permeability of the confining units. These vertical permeabilities are considered representative of conditions found throughout Smith Ranch in similar units.

3.4.2.2.4 Aquifer Pump Tests and Analysis

Five baseline pump tests were conducted in the Smith Ranch area to evaluate the baseline hydrologic characteristics of the mineralized zones. The first pump test was conducted in 1974 to evaluate anticipated groundwater inflow associated with the development of the Bill Smith underground mine (Harshbarger and Associates, 1974). It is discussed in Attachment A of Addendum D-6 A3 of the Smith Ranch WDEQ Permit. The second pump test was conducted in 1981 at the Q Sand ISR pilot site to document the suitability of the site for solution mining and is discussed in Attachment B of Addendum D-6 A3 of the WDEQ Permit. The third pump test was conducted in 1983 at the O Sand ISR pilot site and is discussed in Attachment C of Addendum D-6 A3 of the WDEQ Permit. To provide additional aquifer characteristic data, pump tests were also conducted in two additional areas, Sections 25 and 35. A 1988 report including the results and analysis of these pump tests is included as Attachment D of Addendum D-6 A3 of the WDEQ Permit.

Five baseline pump tests were also conducted at Highland. These five pump tests evaluated the aquifer characteristics of the 20, 30, 40 and 50 Sands. A summary of the results are presented in Table D-6.4 of Addendum D-6 B1 of the WDEQ Permit.

Two pump tests were conducted in the Reynolds Ranch Satellite area. The tests were conducted in January 1989 in areas of future potential production. The sand zones that were tested include the U/S Sand and the O Sand. The pump tests conducted at the Reynolds Ranch Satellite are discussed in Addendum D6 C3 of the WDEQ Permit.

Since 1987, more than 17 pump tests have been performed across Smith Ranch as part of the hydrologic testing program for new mine units. All pump tests conducted to date have demonstrated that the mineralized formations have acceptable permeability and transmissivity characteristics suitable for ISR activities at Smith Ranch. Monitoring wells have been completed in hydrologic connection with the mine units, and all confining units tested have proven to be effective aquitards for controlling the vertical movement of leach solutions.

Since the 2001 renewal, hydrologic testing of eight additional mine units has been completed. Mine unit testing has been conducted in Mine Units 2, 9, 15, 15A, I, J, K, and the Southwest Area. Figures OP-1-1 through OP1-6 of the WDEQ Smith Ranch Permit show mine unit locations. Mine Units 2, 15, 15A, I, and K targeted the well-established O Sand. The Southwest Area, which includes Mine Units 9 through 12 targeted the mineralized K Sand, and Mine Unit J targeted the mineralized Q Sand. Examples of pump test data and mine unit aquifer characteristics determined since 2001 are presented below.

Mine Unit K was pumped in 2006 at a rate of 266 liters/minute (70 gallons/minute) for 73.5 hours. The Lower O Sand was monitored using 55 wells. Drawdown in the monitoring wells ranged between 0.5 and 7 meters (2 and 24 feet). Negligible changes were observed in the overlying and underlying sands. Transmissivity results from the Theis analysis range from 15 to 49 meters^2/day (157 to 523 feet^2/day), with an average transmissivity value of 28 meters^2/day (300 feet^2/day). Based on an average thickness of 37 meters (120 feet), the average hydraulic conductivity is 0.81 meters/day (2.67 feet/day). Storage coefficients range from 7.9 E-5 to 3.1 E-4. The O Sand multi-well pump tests at OP-2 and Section 25-584 yielded average permeabilities of 1 and 3 meters/day (4 and 10 feet/day) respectively. An average permeability of 2 meters/day (7 feet/day), an average gradient of 0.0015 and an effective porosity of 0.1 indicate that the average velocity in the O Sand is 12 meters/year (38 feet/year).

The Southwest Area which includes Mine Units 9 through 12 was pumped in 2006 at an average rate of 101.8 liters/minute (27 gallons/minute) for 196 hours. The K Sand was monitored using 11 wells.

Drawdown in the monitoring wells ranged between -0.5 and 1.5 meters (-0.2 and 5 feet). Negligible changes were observed in the overlying and underlying sands. Transmissivity results from the Theis analysis range from 5 to 17 meters^2/day (59 to 185 feet^2/day), with an average transmissivity value of 12 meters^2/day (125 feet^2/day). Based on an average thickness of 27 meters (90 feet), the average hydraulic conductivity is 0.4 meters/day (1.4 feet/day). Storativity values range from 5.4 E-5 to 1.3 E-4.

Mine Unit J was pumped in 2005 at an average rate of 85.2 liters/minute (23 gallons/minute) for 65.8 hours. The Q Sand was monitored using 36 wells. Drawdown in the monitoring wells ranged between 0.1 and 4.7 meters (0.41 and 15.5 feet). Negligible changes were observed in the overlying and underlying sands. Transmissivity results from the Theis analysis range from 1.3 to 8.1 meters^2/day (13.7 to 86.6 feet^2/day), with an average transmissivity value of 5.4 meters^2/day (58 feet^2/day). Based on an average thickness of 12.2 meters (40 feet), the average hydraulic conductivity is 0.4 meters/day (1.45 feet/day). Storativity values range from 1.4 E-5 to 6.8 E-5.

Review of available data indicate that the pump tests for all mine units (post 2001) established hydraulic communication within the production sands and that adequate confinement by the overlying and underlying aquitards exist. Confining unit vertical hydraulic conductivity has been well established in the eastern portion of Smith Ranch and it is possible to correlate many confining units between the eastern and western portions of Smith Ranch. Vertical conductivities calculated from core and pump test results range from 7.9 E-8 to 4.3 E-4 m/day (2.6 E-7 to 1.4 E-3 ft/day).

3.4.2.2.5 Aquifer Potentiometric Surfaces

Potentiometric surface contours were constructed for aquifers which could potentially be affected by ISR activities as part of the baseline data collection. These aquifers are the M Sand, O Sand, Q Sand and S Sand (deepest to shallowest) in the western portion of Smith Ranch and the 40, 50, and 60 Sands in the Highland area. A schematic sandstone correlation chart for Smith Ranch, Highland, and the Reynolds Ranch Satellite is presented on **Figure 3.3.1**.

The baseline potentiometric contour map for Smith Ranch was constructed by Hydro-Engineering using available wells and water levels collected during February 1991. In the Highland area maps were constructed with water level data collected on, or near August 15, 1990. Figure D-6.7 of Addendum D-6 A2 of the WDEQ Permit presents the baseline potentiometric surfaces for the M, O, Q and S aquifers at Smith Ranch. The circle, square, triangle and star symbols show locations for the M, O, Q and S wells respectively. Wells TW¬1, TW-2, OWD-1, and OWD-4 are completed in both the M and O Sands. Therefore, their symbol is a combination of a square and circle. Some of these wells are completed over only a portion of these sands, and where the sand is very thick, a significant head difference can exist from the top to the bottom of the sand. The contours on the potentiometric surface maps are Hydro-Engineering's interpretation of average head conditions in each of these sands and, therefore, some points are not given as much weight as others. Table D-6.37 of Addendum D-6 A1 of the Smith Ranch WDEQ Permit provides the basic well information used for construction of the potentiometric contours. It should be noted that the shaft, located at the Bill Smith mine site under the present CPP office building, was being pumped at a rate of approximately 757 liters/minute (200 gallons/minute) at the time the baseline water levels were measured. The shaft has since been filled and sealed. Updated potentiometric surface maps based on more recent data from the Hydrologic Unit Testing packages for the M, O, Q, and S Sands are provided on Plates D6-1A through D6-1D of Appendix D6 of the WDEQ Permit.

Water levels from wells M-136, M-421, M-422, M-310, M-295, M¬296, M-528, M-736, M-741, M-744, and OMM-1 were used to develop the baseline potentiometric surface contours for the M Sand aquifer

in the Smith Ranch area. At the time that map was prepared, groundwater in the M Sand was flowing to the east-northeast and most of it converged to the mine shaft due to pumping at the time of measurement. The average groundwater velocity was estimated to be 0.4 meters/year (1.3 feet/year) based on a permeability of 0.1 meters/day (0.3 feet/day), an average gradient of 0.0012 and an effective porosity of 0.1. The permeability was obtained from the Section 35-739 multi-well pump test and is thought to be low due to the overall flat gradient in this aquifer. An updated potentiometric surface of the M Sand is provided on Plate D6-1A in Appendix D6 of the WDEQ Permit. The potentiometric surface provided on this map blends data collected in 2001 from Mine Unit 2, 2004 from Mine Unit 15, 2006 from Mine Unit 15A with the 1998 and 1999 data collected from Mine Units 4 and 4A.

An updated "concept level" potentiometric surface of the O Sand is provided on Plate D6-1B of Appendix D6 of the WDEQ Permit. This map was developed at the request of WDEQ by blending data collected between 1991 and 2006 from Mine Units 1, 2, 3, 4, 4A, 15, and 15A at Smith Ranch, Mine Unit 27 at Reynolds Ranch, and Mine Units A, C, E, F, H, and I at Highland.

The hydrologic conditions of the Q Sand were originally defined only in Section 36. The small dashed lines on Figure D-6.7 in Addendum D-6 A2 of the WDEQ Permit represent the baseline potentiometric surface of the Q Sand. The contours yield an average gradient of 0.0036. The Section 35-739 multi-well test produced an average permeability of 1.4 meters/day (4.5 feet/day). These properties indicated that groundwater was moving to the north-northwest at 18 meters/year (59 feet/year) in the Q Sand. Additional testing in Mine Units, 1, 2, 3, 15, 15A, J, and K has characterized the Q Sand in other areas of Smith Ranch. An updated potentiometric surface of the Q Sand is provided on Plate D6-1C in Appendix D6 of the Smith Ranch WDEQ Permit.

The baseline S Sand potentiometric contours are represented with the small solid lines on Figure D-6.7 in Addendum D-6 A2 of the WDEQ Permit. These contours indicated a steep gradient of 0.05. The groundwater was estimated to be moving to the north at 54.9 meters/year (180 feet/year) based on that gradient. The estimated permeability of the S Sand is 0.3 meter/day (1 foot/day). An updated potentiometric surface of the S Sand is provided on Plate D6-1D in Appendix D6 of the Smith Ranch WDEQ Permit based on data collected in Mine Units 1, 2, 15, and 15A at Smith Ranch and Mine Unit 27 at Reynolds Ranch.

Individual baseline potentiometric surface maps for the 40, 50, and 60 Sands at Highland are included as Plates D6-1, D6-2 and D6-3 in Addendum D-6 B2 of the WDEQ Permit, respectively. These maps were constructed with water level data collected on, or near August 15, 1990. An updated potentiometric surface for the 30/40/50 sands is correlated with the O Sands on Plate D6-1B in the Smith Ranch WDEQ Permit. The potentiometric surface maps show that in areas unaffected by existing Smith Ranch activities or past underground mine dewatering, the general direction of groundwater flow is from the southwest to the northeast. Unaffected water level gradients are approximately 0.008 for the 40 Sand, 0.003 for the 50 Sand and 0.002 for the 60 Sand.

The baseline potentiometric surfaces for the U/S and O aquifers in the Reynolds Ranch Satellite area are presented as Figures D6-2 and D6-3 in Addendum D-6 C of the Smith Ranch WDEQ Permit. Table D6-4 in Addendum D-6 C of the Smith Ranch WDEQ Permit lists the wells and associated water level monitoring results used to prepare the maps. The water levels were measured on November 6, 2004. Direction of flow is oriented in a more northerly direction.

3.4.2.2.6 Groundwater Quality

Extensive groundwater quality data have been collected from each of the two Smith Ranch pilot projects in the western portion of Smith Ranch. These data were previously submitted to NRC and WDEQ in the NRC License Applications and WDEQ Land Quality Division (LQD) quarterly reports. Baseline water quality data for the production zones in the pilot projects are summarized in Addendum D-6 A1, Tables D6-5 and D6-6 of the WDEQ Permit for the Q Sand and O Sand pilots, respectively.

In addition to sampling at the pilot projects, baseline water quality data was collected from about 30 other wells. These data are representative of the baseline water quality throughout the western portion of Smith Ranch before ISR operations commenced. Typically five samples were collected from each well over a period of 6 to 9 months and analyzed for the full list of WDEQ approved parameters. These data are included in Tables D-6.7 through D-6.36 of Addendum D-6 A1 to the Smith Ranch WDEQ Permit. In general, the water quality of the Smith Ranch area is similar to that seen at the pilot sites. There are some variations in water quality constituents on a sand-by-sand basis. Water quality data representative of specific sands are collected and analyzed during the Hydrologic Unit Testing program for each new wellfield.

Baseline groundwater quality data reflective of the Highland area were submitted with the original WDEQ permit application and include:

- four Exxon water supply wells completed in the Highland ore sand aquifer, outside of the ore zones;
- the Numrick livestock well;
- the Fowler Ranch water well; and
- the Vollman Ranch water well.

The latter three wells are completed in the intermediate sand zone which lies stratigraphically above the local ore sand aquifer. The locations of these wells are shown on Figure D6-1 of Addendum D-6 B2 to the WDEQ Permit. A summary of the water quality data are included in Tables D6-6 and D6-7 of Addendum D-6 B1 to the WDEQ Permit. This aquifer has not, nor is it anticipated to be affected by ISR activities.

A vast amount of baseline groundwater quality data have been collected since ISR activities starting at Highland. Baseline groundwater quality data have been collected from the A, B, C, D, E, F, H, I, and J-wellfield areas as part of required wellfield development activities. Numerous water quality samples have been collected from the 10, 20, 30, 40, 50 and 60 Sands to document baseline conditions within these wellfields. These data are on file with both the WDEQ and NRC.

In general, the baseline groundwater quality in the Highland area sandstone aquifers meets Class I-Domestic use suitability standards (WDEQ WQD R&R Chapter 8) except in proximity to the ore zones where radium concentrations can greatly exceed the domestic, agriculture and livestock standard of 5 pCi/liter. Total dissolved solids concentrations sometimes exceed the domestic standard of 500 milligrams/liter. Tables D6-8 and D6-9 of Addendum D-6 B1 to the WDEQ Permit provide a summary of the baseline water quality data for the 20 and 30 Sands, respectively, in the A and B mine unit areas. This data summary is representative of baseline groundwater quality conditions throughout the Smith Ranch project site.

Extensive groundwater quality data were previously collected by SMC to characterize the Reynolds Ranch Satellite area. The water quality data were collected from the planned production zones and potential potable or existing stock water sources. These baseline water quality data are presented in

Attachment D6-2 to Addendum D-6 C3 to the WDEQ Permit. A well location map is also presented in Addendum D-6 C2 to the WDEQ Permit as Figure D6-1. Additional water quality data collected in 2004 from Mine Unit 27 are presented in Tables D-6-5, D6-6, D6-7, and D6-8 of Appendix D6 of the WDEQ Permit.

A baseline water quality comparison was conducted using Smith Ranch, Highland and Reynolds Ranch Satellite historical water quality data. Average concentrations of constituents from Smith Ranch and Highland (Tables D6-5 and D6-6 of Addendum D-6 A1; Tables D6-8 and D6-9 of Addendum D-6 B1 of the Smith Ranch WDEQ Permit) were combined with averages from Reynolds Ranch Satellite Mine Unit 27 to produce Table D6-9 (Appendix D6 of the WDEQ Permit). An average baseline range of parameters were created using Smith Ranch, Highland, and Reynolds Ranch Satellite data and compared to the approved mine unit baseline data. Averages for approved mine unit baseline data were developed from MP wells (i.e., interior production zone wells). A summary of the water quality data mentioned above is presented in Table D6-9 of Appendix D6 of the Smith Ranch WDEQ Permit.

Comparing the approved mine unit data to the baseline average range of parameters, 98 outliers were identified from the hundreds of analyses that were performed. The majority of outliers were just outside the minimum or maximum average. Of note are uranium values for Mine Units C and D which exceed the average range of concentrations with values of 2.1 and 1.1 milligrams/liter, respectively.

The average water quality results for the approved mine units are similar to the baseline water quality determined for the Smith Ranch, Highland, and Reynolds Ranch Satellite areas. Overall, Smith Ranch water quality is dominated by calcium-sodium-bicarbonate-sulfate water.

3.4.2.2.7 Groundwater Rights

A list of all groundwater rights within Smith Ranch and adjacent lands, as of November 2011 is included in **Table 3.4-4, Smith Ranch Groundwater Rights**. The locations of the groundwater rights are shown on **Figure 3.4.1.**

There are more than 1,400 groundwater rights on file with the Wyoming State Engineer's Office (WSEO) within Smith Ranch and within a 5 kilometer (3 mile) area of the site boundary. The vast majority of these groundwater rights are for wells installed for hydrologic monitoring, dewatering purposes at the decommissioned conventional uranium mining operations, and ISR activities at Smith Ranch. There are 131 wells permitted for miscellaneous use. The majority of these wells are permitted for industrial/miscellaneous dual use associated with ISR activities. There are 162 groundwater rights associated with wells installed for livestock water. There are three wells used for irrigation purposes. There are 32 groundwater rights within 5 kilometers (3 miles) of Smith Ranch permitted for domestic supply. Half of these wells are dual use domestic water rights combined with livestock, industrial, or irrigation purposes. The remaining 16 water rights are permitted strictly for domestic use according to the WSEO.

There are five groundwater rights permitted for domestic supply within the Smith Ranch boundary. Two are permitted for domestic/industrial dual use and one is permitted for domestic/stock dual use. Two groundwater rights are permitted strictly for domestic supply wells. The first well, Mason #1 is located in the northwest area of the Reynolds Ranch Satellite. The well is 36 meters (118 feet) in depth. The second domestic well is associated with the Vollman Ranch house, which is located near the center of Smith Ranch. This well is 55 meters (180 feet) in depth.

There are three public water systems (PWS) in the vicinity of Smith Ranch. They include PRI Smith Ranch (PWS # 5601500), Fort Fetterman State Historical Site (PWS # 56080174), and the Town of Douglas (PWS # 5600137). The first is located on site, the remaining two are 27 kilometers (17 miles) south, and 38 kilometers (23 miles) southeast of the Smith Ranch site, respectively.

3.4.3 North Butte Remote Satellite

3.4.3.1 Surface Water

3.4.3.1.1 Hydrology and Stream Flow

The North Butte Remote Satellite is located in the Willow Creek drainage which is a tributary to the Powder River and ultimately to the Yellowstone and the Missouri Rivers. The Willow Creek drainage system is shown on Plate D6-1 of Appendix D6 of the North Butte WDEQ Permit. Willow Creek and its tributaries are classified as ephemeral streams and flow generally in response to heavy snow melt and large convective rainstorms. Willow Creek may flow intermittently in the spring and early summer, yet remains dry the remainder of the year except during major thunderstorms in the area. Its drainage basin above the Dry Willow Creek confluence is approximately 35.4 kilometers^2 (13.6 miles^2), and its gradient through the North Butte Remote Satellite is about 0.03 meters/kilometer (99 feet/mile). Active stream channel width averages 4 meters (14 feet) and its length is approximately 660 meters (2,165 feet).

Cameco compared hydrologic model data to empirically derived data calculated from the USGS Water-Supply Paper (WSP, 2056) entitled "*Analysis of Runoff from Small Drainage Basins in Wyoming*" by Craig and Rankl (1978) to establish peak discharge calculations for Willow Creek at the North Butte Remote Satellite. Willow Creek peak discharge calculations can be found in Table D6-1.5 of Addendum D6 to the North Butte WDEQ Permit.

Beginning in 2010, Cameco completed additional hydrologic data collection to characterize peak discharges in the ephemeral tributaries to Willow Creek. The locations of the ephemeral tributaries are presented on Figure D6-1.5 of Addendum D6 to the WDEQ Permit. The majority of the ephemeral tributaries originate at the North Butte itself and flow to the south and southeast. Eventually all of these drainages enter Willow Creek near the south end of the North Butte Remote Satellite boundary. Channel gradients in the tributaries range from 0.012 to 0.068.

Thirteen channel cross sections were surveyed on the ephemeral drainages and Willow Creek. The locations and detailed channel cross sections are presented in Attachment D6-1.3 to Addendum D6 to the WDEQ Permit. In general, the tributary drainage bottoms are grass lined channels, narrower than Willow Creek. The typical tributary draw (drainage) surveyed had side slopes that ranged from 1.5 to 5.0:1 (H:V).

Ephemeral drainage basin hydrology was evaluated with the HydroCAD computer model. The model generates hydrographs for individual basin areas and hydrographs are routed downstream through channels and/or reservoirs. Multiple sub-areas can also be modeled within a given watershed model. The HydroCAD model was used to calculate flood flows throughout the North Butte Remote Satellite area.

The HydroCAD model incorporates the Soil Conservation Service curve number calculations into the flood flow predictions. The runoff curve number is an empirical parameter used in hydrologic calculations for predicting direct or infiltration-excess runoff. The runoff curve number is determined, based on hydrologic soil group, land use, surface treatment and hydrologic condition. Two different curve numbers were utilized in the HydroCAD modeling for Willow Creek and its tributaries. Sub-basins that occupy areas of visible outcropping or shallow soils on aerial imagery will accordingly exhibit lower

infiltration rates. A curve number of 76 was used for the upper reaches of several of the basins, in particular those that abut the North Butte. An average curve number of 70 was used in the lower, downstream sub-basin areas where outcropping was not visible and/or well drained soils are indicated.

The calculated discharges do not account for potential flood volume storage within the several stock ponds in the basin. For conservatism, the presence of the stock ponds is not incorporated into the analysis even though, under average conditions, a large amount of abstraction of the runoff would occur as a result of these stock ponds. The peak discharges and critical drainage basin parameters used for the North Butte Remote Satellite Project's culvert designs are presented in **Table 3.4-5, Peak Discharges for Design Recurrent Interval Storm Events**.

3.4.3.1.2 Surface Water Use and Quality

Cameco established 27 new surface water quality sampling sites in addition to maintaining the three original points established by Uranerz (SWS1, SWS2, and SWS3), making a total of 30 surface water monitoring sites at the North Butte Remote Satellite. The drainages in and around the permit area are ephemeral in nature, which complicates Cameco's ability to collect live flowing and representative surface water samples. Of the 27 surface water quality sampling sites established by Cameco, 18 are at impoundment locations where a berm or dam structure is trapping water creating a holding pond. The remaining nine sites are located upstream and downstream of drainages sufficiently close to the operation to be subject to surface drainage from potentially contaminated areas or wellfield leaks or spills. The location of all 30 sites (18 impoundment, 9 stream channel sites, and original sites SWS1, SWS2, and SWS3) are shown on Figure D6-1.6 of the North Butte WDEQ Permit.

All 30 surface water quality sampling sites were visited during field data collection in August 2010, early June 2011, and September 2011. During the August 2010 sampling campaign, the majority of the historic and contemporary water quality sampling sites were dry thereby preventing the collection of water samples for analysis. Three impoundment sites (NBI5, NBI12, and NBI16) contained ponded water and were sampled. In June 2011, all 30 surface water quality sites were visited again. Eleven impoundment sites (NBI3, NBI5, NBI6, NBI8, NBI10, NBI11, NBI12, NBI14, NBI15, NBI16, and NBI17) and one downstream sampling location (NBSD1) had enough water to sample. The sites were also visited in September 2011; two of the sites (NBI15 and NBI16) contained water and were sampled. The 2010 and 2011 surface water quality results are presented in **Table 3.4-6, North Butte Surface Water Quality Data Within 2 Kilometers**.

Most of the surface water quality samples collected to date have been from impoundments and therefore represent stagnant, non-flowing conditions. As a result, total dissolved solids (TDS), conductivity, nutrient and cation/anion values are likely higher than would be expected during an active rainfall/runoff event. Even in wet years, Willow Creek in the vicinity of the North Butte Remote Satellite only flows for a couple of months. In dry years, there is essentially no flow during the entire 12 month period. Stock reservoirs in the area provide sources of water for livestock and wildlife.

Sediment samples were collected from Willow Creek, impoundments, and ephemeral drainages in and near the North Butte Remote Satellite on three different occasions (August 12-14, 2010; May 31-June 2, 2011 and September 20-21, 2011). **Table 3.4-7, North Butte Remote Satellite Sediment Quality Data** presents the results of radionuclide analysis completed on all sediment samples. In general, concentrations of radium-226 and lead-210 averaged 1.4 pCi/gram, uranium concentrations average 2.2 milligrams/kilogram, and thorium-230 concentrations averaged 0.9 pCi/gram. See **Figure 5.8** of the TR for sediment sampling locations.

3.4.3.1.3 Surface Water Rights

Surface water rights within 5 kilometers (3 miles) of the North Butte Remote Satellite are identified in Table D6-1.6 of Addendum D6 to the North Butte WDEQ Permit. There are 16 adjudicated surface water rights located within a 5 kilometer (3 mile) radius of the North Butte Remote Satellite boundary according to the WSEO records. All 16 surface water rights are for either reservoirs or stock reservoirs. There are no surface water rights for diversion of direct flows from Willow Creek or its tributaries within 5 kilometers (3 miles) of the site boundary. A map showing the approximate locations of the surface water rights to the nearest quarter section is presented on Figure D6-1.6 of Addendum D6 to the North Butte WDEQ Permit.

3.4.3.2 Groundwater

3.4.3.2.1 Hydrogeologic Stratigraphy

The North Butte Remote Satellite is located within the southern portion of the Powder River Basin slightly west of the axis of the Powder River Basin syncline. The aquifers of interest are sand members within the Eocene Age Wasatch Formation, a fluvial deposit containing alternating layers of sands and shales. Recharge to the sands of the Wasatch Formation occurs mainly on their outcrops, with some influx of groundwater from vertical movement through adjacent aquitards. Flow in the aquifers generally moves to the north along paleodrainage trends, with a small portion of the groundwater regionally discharging to streams. Aquifer properties are highly variable due to large variations in local lithologies. Reported transmissivities within the Wasatch Aquifer range anywhere from 0.01 to 62 meters^2/day (0.1 to 667 feet^2/day).

The hydrogeologic units that occur within the North Butte Remote Satellite area are described regionally in Section 3.4.1.1 and are summarized more specifically below.

Alluvium – Alluvial deposits in the North Butte Remote Satellite area consist of thin, unconsolidated, poorly stratified clays, silts, sands, and gravels along Willow Creek. The total thickness of these deposits is estimated to range from less than 0.3 to 9.1 meters (1 to 30 feet). Cameco conducted a field investigation of the alluvial deposits along Willow Creek during August 2011. Results of the 2011 alluvial/shallow aquifer investigation indicate the sand and gravel deposits are discontinuous and range between 0 and 2 meters (6 feet) thick within the channel of Willow Creek. Small amounts of precipitation infiltrate the alluvium during part of the year and intermittent flows across the alluvium may provide some recharge locally.

Wasatch Aquifer - The Wasatch Aquifer typically is comprised of lenticular, fine- to coarse-grained sandstones with interbedded claystones and siltstones. The Wasatch Aquifer is considered to have good potential for possible development as a future water supply; however, Hodson et al, (1973) could not adequately quantify its hydrologic characteristics to estimate the maximum amount of groundwater that could potentially be available.

Fort Union Aquifer - The Fort Union Aquifer underlies the Wasatch Aquifer. Typically, the Fort Union is comprised of lenticular fine to coarse-grained sandstones with interbedded claystones, siltstones, and coal. The formation is as much as 900 meters (3,000 feet) thick. The Fort Union Aquifer is an important water supply source in the Powder River Basin. While most of the Fort Union wells are completed for limited yields of 19 to 114 liters/minute (5 to 30 gallons/minute), some wells completed in the Fort Union Aquifer can produce substantial volumes of groundwater over extended periods.

Lance and Fox Hills Aquifers - The Lance and Fox Hills Aquifers underlie the Fort Union Aquifer. The formations are comprised of fine- to medium-grained sandstones, interbedded sandy shales and

claystones. Well yields from these aquifers are not expected to exceed 380 liters/minute (100 gallons/minute), and the groundwater reserves may be limited. Little is known of the hydrologic characteristics of the Lance and Fox Hills Aquifers as no water wells tap these aquifers in the vicinity of the North Butte Remote Satellite. The depth and low yield of these potential aquifers makes it unlikely that these formations will be tapped for water supplies in the future.

3.4.3.2.2 Summary of Aquifer Properties

Potential Alluvial Aquifer

Between November 1 and 2, 2011, a hydrogeologic investigation was conducted to determine if an alluvial aquifer exists within Willow Creek and if a shallow aquifer exists between the surface and the F Sand, considered the uppermost aquifer at the North Butte Remote Satellite. Two sites were selected within the channel of Willow Creek, and exploratory drilling was conducted. The locations of the exploratory boreholes are shown on **Figure 3.3.2**.

Borehole WC #1 was drilled to a depth of 32 meters (105 feet). No alluvium or water producing sands were encountered between the surface and the underlying F Sand (**Figure 3.4.2, WC#1 Borehole Log**). Borehole WC #2 was drilled to a depth of 24 meters (80 feet). Alluvium consisting of dry gravelly sand was encountered between 4 and 5 meters (14 and 18 feet) below ground surface at this location. In summary, the alluvium, which underlies Willow Creek is laterally discontinuous and is not water-bearing. Although no water was encountered in the alluvium, it was determined that the alluvium could become saturated during spring runoff. Therefore a monitoring well was drilled and completed on November 2, 2011. WCA #1 was offset approximately 2 meters (7 feet) east of WC #2 and completed to a depth of approximately 5.5 meters (22 feet) below ground surface. Well completion details are presented on **Figure 3.4.3, WCA #1 Well Completion Log**. If water is present in the spring of 2012 the well will be developed and a water sample will be collected for analysis.

This same drilling program investigated the stratigraphic column below the Holocene sediments and above the F Sand Aquifer. No potential water producing sands were encountered between the alluvium and the uppermost F Sand (**Figure 3.4.4, WC#2 Borehole Log**).

Production Zone Aquifers

Baseline aquifer tests on the production sands were performed by Cleveland Cliffs in 1988. Two North Butte sites (SS2 and SSE) were tested to define the aquifer and aquitard baseline properties. The detailed hydrologic analyses and supporting data are presented in a report as Attachment D6-1 of Appendix D6 of the North Butte WDEQ Permit. One multi-well test was conducted at the SS2 site and is referred to as HYDRO Test NB1. Two multi-well tests were performed at the SSE site. These tests are referred to as HYDRO Tests NB2 and NB3. Table A-1 of the above referenced attachment, presents the basic well data for wells used to define the aquifer properties. The aquifer pump test plans for both sites were approved by the NRC and the WDEQ LQD in letters dated March 22, 1988 and April 24, 1988 respectively, prior to running the tests.

The production zone at the North Butte Remote Satellite occurs in three sand members (A, B and C) with the A Sand being the lowest stratigraphically. These three sand members are directly connected at some locations in the North Butte Remote Satellite area, and when in combination are considered the production sand at those locations. Generally, where the B and C Sands are separately delineated, they are approximately 31 and 15 meters (100 and 50 feet) thick, respectively. At the SS2 site (NB1 test), the B and C Sands are connected hydrologically, are 49 meters (160 feet) thick, and are tested as one unit. Figure D6-1 of Appendix D6 of the North Butte WDEQ Permit presents a schematic diagram of the geologic setting of the HYDRO Test No. NB1 (SS2) site. This figure also shows the relative position of the

next overlying aquifer, the F Sand and the intervening aquitard, FBC, which is approximately 31 meters (100 feet) thick at this location.

A schematic of the geologic setting of the SSE site, which is the location of the HYDRO Tests NB2 and NB3 is presented as Figure D6-2 of Appendix D6 of the North Butte WDEQ Permit. This schematic shows that the tested ore sand, A, is 22 meters (71 feet) thick at this location, and is underlain by an approximately 14 meter (45 foot) thick lower aquitard (A1). The lower aquitard (A1) isolates the production zone, and separates the A Sand and the underlying 1 Sand. The 1 Sand is a marginal sand at the SSE site and is approximately 9 meters (30 feet) thick. Figures D6-3 and D6-4 of the referenced attachment present the locations of the cluster of wells at the SS2 (NB1 test) and SSE (tests NB2 and NB3) sites, respectively.

3.4.3.2.3 BC Sand Aquifer

The aquifer characteristics of B and C Sands are discussed as a single unit in this section due to the fact that they are combined as a single unit at the SS2 location. The BC Sand aquifer was tested by pumping fully penetrating BC well SSM2M. Proximal BC Sand aquifer wells SS2BC1, SS2BC2 and SS2MP were monitored for drawdown. In addition, outlying B and C wells 11-2, 7-1 and 7-2 were also monitored.

A summary of the results from HYDRO Test NB1, are presented in Table D6-1 of Appendix D6 of the North Butte WDEQ permit. This table presents the range of aquifer properties obtained from the Jacob straight line analysis, the Hantush type curve match, and the recovery results.

The transmissivities for the observation wells obtained from the straight line analyses varied from 7 to 11 meters^2/day (75 to 118 feet^2/day). A very similar range of values was calculated from the Hantush type curve matches, 7 to 10 meters^2/day (75 to 108 feet^2/day). The recovery straight line solution also yielded similar transmissivity values ranging from 8 to 9 meters^2/day (86 to 97 feet^2/day). An average transmissivity obtained from the Hantush log-log analysis of 8 meters^2/day (86 feet^2/day) is thought to best represent the BC Sand aquifer in this area because this method accounts for a leaky aquitard.

The hydraulic conductivity (permeability) of the BC Sand was obtained by dividing the transmissivity of the aquifer by the aquifer thickness at the pumped well. Permeabilities of 0.14 to 0.17 meters/day (0.45 to 0.56 feet/day) were obtained from the Hantush analysis. An average horizontal permeability of 0.2 meters/day (0.5 feet/day) is thought to best represent the BC Sand aquifer at the SS2 site.

The BC Sand is a confined aquifer at the SS2 site. The calculated storage coefficient varied from 2.1E-4 to 2.6E-4 using the Hantush methodology. A storage coefficient of 2.4E-4 is thought to best represent the BC Sand aquifer at the SS2 site.

Two wells completed only in the B Sand aquifer and two wells completed only in the C Sand aquifer were tested by Cleveland Cliffs. One of the B Sand wells is located at the SS1 North Butte site and is labeled SS1M. The transmisivity values determined for the B Sand aquifer at the SS1M location ranged from 13 to 14 meters^2/day (140 to 1151 feet^2/day). A permeability of between 0.8 and 0.9 meters/day (2.6 and 2.8 feet/day) was determined for the B Sand aquifer at that location.

The B Sand aquifer well SSEM tested at the SSE site yielded a transmissivity value of approximately 13 meters^2/day (140 feet^2/day). The B Sand aquifer at this site has a permeability of 0.4 meters/day (1.3 feet/day).

The C Sand aquifer was tested at the SS1 site by three pump tests using wells SS1U and SS1UP. The tests yielded transmissivity values of between 8 to 14 m^2/day (86 to 151 ft^2/day) and permeabilities of

between 0.4 to 0.7 m/day (1.4 to 2.4 ft/day). A storage coefficient of 4.5E-5 was determined from these tests.

3.4.3.2.4 A Sand Aquifer

Two aquifer tests were performed on the A Sand aquifer at the SSE site. These tests are referred to as HYDRO Tests NB2 and NB3. The Jacob straight line and Theis log-log analyses yielded values very similar to each other for the SSE wells. The transmissivity values ranged from 3.8 to 5.5 meters^2/day (41 to 59 feet^2/day) with permeabilities between 0.2 to 0.3 meters/day (0.6 to 0.8 feet/day). Storage coefficients of between 4.7E-5 to 1.8E-4 were determined from the test with an average value of 7.0E-5.

Two other single-well tests were conducted in the A Sand aquifer by Cleveland Cliffs. A short test on well SSEL yielded a lower transmissivity than those determined in HYDRO tests NB2 and NB3. Well SS1L, completed in the A Sand aquifer, was also tested. The transmissivity of the aquifer at this location was determined to be 13 and 10 m2/day (140 and 108 ft2/day) from the Jacob straight line and Theis recovery analysis, respectively. Permeability ranged from 0.27 to 0.34 m/day (0.88 to 1.13 ft/day).

An average horizontal permeability of 0.3 m/day (0.9 ft/day) is considered representative of the A Sand aquifer. A storage coefficient of 8.5E-5 is considered representative of the A Sand aquifer.

3.4.3.2.5 Summary of Aquitard Properties

In addition to determining the aquifer properties at each site, HYDRO Test NB1 was designed to evaluate the Upper aquitard and HYDRO Test NB2 was designed to evaluate the Lower aquitard. The "Upper" and "Lower" aquitards refer to the overlying aquitard between the C and F Sands and the underlying aquitard between the A and 1 Sands, respectively. Several pump tests previously conducted by Cleveland-Cliffs were analyzed and used for additional background aquifer characterization.

The Neuman-Witherspoon's method was used to analyze drawdown data from the aquitard wells. Table D6-2 of Appendix D6 of the North Butte WDEQ Permit presents the summary of aquitard properties determined by the Neuman-Witherspoon method, and also presents comparative vertical permeability results determined from the Hantush leaky aquifer methods and the laboratory analysis of core samples. The Neuman-Witherspoon analysis calculated vertical permeabilities of 0.01 meter/year (0.04 feet/year) for the Upper aquitard, and 0.01 meter/year (0.04 ft/year) for the Lower aquitard. Specific storage values of 1.94E-5 and 1.67E-5 were determined for the Upper and Lower aquitards, respectively.

The modified Hantush leaky aquifer analysis calculated vertical permeabilities ranging from 2.1E-3 to 2.2E-2 meters/year (6.9E-3 to 7.3E-2 feet/year). The upper range of these values is approximately twice as high as the Upper aquitard vertical permeability calculated from the Neuman-Witherspoon method. It was assumed that all leakage came from the Upper aquitard in the Hantush calculation. If some leakage was attributed to the aquitard below the BC Sand, then the Hantush results would be lower.

Cores from the Upper and Lower aquitard intervals were loaded in a triaxial machine to simulate the field conditions and measure laboratory vertical permeabilities. The coefficient of compressibility and porosity (void ratio) were also measured on these cores. The laboratory vertical permeabilities were 2.0E-3 for the Upper aquitard and 4.3E-3 meters/year (6.6E-3 and 1.4E-2 feet/year) for the Lower aquitard core samples.

Wells completed in the adjacent aquifers in HYDRO Tests NB1, NB2, and NB3 were monitored for drawdown. In test NB1, the overlying sand to the BC Sand, the F Sand, was monitored during the test by using well SS2U. Approximately 0.1 meter (0.2 feet) of drawdown was observed in this well during the

test. The underlying aquifer (AL Sand) at the SS2 site showed no signs of drawdown during the test or recovery phases of the test in wells SS2L or 11-1.

The lower 1 Sand and upper B and F Sands at the SSE site were measured during both HYDRO Tests NB2 and NB3. In addition, two B and one C Sand aquifer wells, located a radius of 900 to 1,130 meters (3,000 to 3,700 feet) from the pumping well, were measured during test NB2. The lower 1 Sand showed 0.1 meter (0.4 feet) of drawdown during the pump test. No drawdown was observed as a result of pumping the A Sand aquifer well SSEA1 in any other adjacent aquifer wells during the NB2 and the NB3 tests.

3.4.3.2.6 Aquifer Potentiometric Surfaces

Static water levels were measured in monitoring wells at the North Butte Remote Satellite in June, September and November 2010. Completion information and static water levels for the wells that were sampled in 2010 are summarized in Table D6-1.1 of the North Butte WDEQ Permit. Using static water levels measured in 2010, potentiometric maps of two hydrostratigraphic units in the Wasatch Aquifer beneath the North Butte Remote Satellite have been prepared: 1) the F Sand which is the first overlying unmineralized aquifer (Figure D6-1.1 of the North Butte WDEQ Permit), and 2) the CB Sands Production Zone Aquifer (Figure D6-1.2 of the North Butte WDEQ Permit).

In November 2010, F Sand static water levels were measured in wells UM-1 through UM-8, SS1-F, SSE-U, and SS2-U to determine the potentiometric surface of the F Sand. The F Sand potentiometric contours indicate that this aquifer is confined, and groundwater flow is generally towards the south/southwest beneath the site. This flow orientation is distinctly different than the Production Zone Aquifer groundwater flow direction but correlates well with the 1996 potentiometric surface determined by PMC. The gradient of the F Sand potentiometric surface was 0.02 in 2010. In 1988 the average groundwater gradient was 0.008. A comparison of water levels in wells between 1988 and 2010 indicates an average decline of 0.6 meters (2 feet).

Water levels were measured in September 2010 to determine the potentiometric surface of the Production Zone Aquifer. The C, B, and A Sands all were identified as the Production Zone Aquifer in the original permit. Wells completed in the C and B Sands exhibit similar heads across the site. The Production Zone Aquifer groundwater elevations indicate that groundwater in the ore zone is confined, and flow is generally towards the northwest. The gradient of the Production Zone Aquifer is 0.006 which is unchanged when compared to the 1988 data. A comparison of water levels measured in 1988 and 2010 indicate an average decline of 0.9 meters (3 feet) in static water levels.

The A Sand water levels indicate that this sand is also confined and groundwater flow is generally towards the northwest beneath the site. Water levels in four A Sand wells were measured in September 2010 and are included on Figure D6-1.2 of the North Butte WDEQ Permit (Wells SSE-L, SS2-L, NBHW-16, and SS1-L). The average gradient of the A Sand potentiometric surface in 2010 was 0.02. In 1988 the groundwater gradient was also approximately 0.02.

3.4.3.2.7 Groundwater Quality

Original mine site owner Cleveland Cliffs conducted a groundwater assessment program at the North Butte Remote Satellite from October 1978 through July 1981. In April 1988, subsequent mine site owner, Uranerz collected additional groundwater samples from three monitor wells completed in the A Sand, two monitor wells completed in the B Sand, one well completed in the C Sand, one well completed in the BC Sand, and three wells completed in the F Sand. In 1992 PMC drilled 40 monitoring wells in the Mine Unit 1 and 2 areas for acquisition of baseline data, including 20 perimeter ore zone wells, nine upper sand wells, two upper-upper sand wells, and nine ore zone/baseline restoration wells. Mechanical

integrity testing was completed in 1993. In 1996, PMC collected four quarters of baseline water quality samples from the monitoring wells and completed aquifer pump testing to determine the hydraulic communication with the monitoring wells within the ore zone. PMC installed 20 additional hydrology test wells in 1996 and conducted aquifer testing of those wells in 1997. Water quality data from these wells were submitted with the 1996 PMC annual report to WDEQ LQD.

Cameco sampled representative wells in June and September 2010. These wells were selected to provide spatial and stratigraphic distribution within the production zone and the overlying F Sand Aquifers. Existing monitoring wells were inspected to verify location, completion information, well integrity, and to establish standard measuring points. Two sets of water quality samples were collected from selected wells in 2010 for comparison to baseline water quality data and to analyze for constituents required by recent updates to LQD guidelines. Ore zone wells sampled included SSE-L, SS1-L, SS2-L, SSE-M, SS1-M, SS2-M, and SS1-U. F Sand wells sampled included UM-1, UM-3, UM-5, and UM-7.

The baseline water quality data collected up through 1988 are presented in Tables D6-1.2 and D6-1.3 of Addendum D6 and Tables D6-3 through D6-7 of Appendix D6 of the North Butte WDEQ Permit. A summary of the baseline water quality data are presented in Tables D6-8 through D6-13 of the same Appendix D6. Uranerz drilled and completed a well in the Lower aquitard, the 1 Sand, as a part of Hydro Test NB2. In addition to serving as an observation well for the aquifer pump test, Uranerz planned to sample the well for water quality analysis. Uranerz was unable to obtain sufficient water from the 1 Sand aquifer to provide a representative sample.

Cameco compared the 2010 data to the 1980s age baseline data to evaluate whether baseline water quality had changed since the North Butte Remote Satellite was originally permitted. With respect to the ore zone water quality (A, B and C Sands) Cameco found that the 2010 data compared favorably to the historical baseline water quality. Out of the 384 analyses that were performed, only eight analyses fell outside of the previously established baseline in the production zone wells. These analytes are highlighted in bold in Table D6-1.2 of Addendum D6 of the North Butte WDEQ Permit. Five fell below the minimum value reported in the original WDEQ permit, one chloride concentration and four uranium concentrations. The minimum value exceedance is likely due to increased lab precision. Three analyses exceeded the maximum value established by baseline sampling. One analysis barely exceeded the maximum ammonium concentration. Monitoring well SS1-L contained two values that exceeded the maximum established baseline value for radium-226, 183 and 184 pCi/liter. Baseline water quality sampling established radium-226 concentrations ranging between 0 and 82.4 pCi/liter. Given the natural variability of radium concentrations and its mobility under the current pH/Eh conditions, these two analyses are not considered problematical. The 2010 data confirmed the viability of the original baseline water quality characterization.

Analytical results from the two rounds of water quality samples collected in 2010 were similar between the two sampling events, and as such establish relative stability of the individual wells. The ore zone water quality is dominated by calcium-sodium bicarbonate-sulfate water. Radium-226 and Gross Alpha concentrations exceed the WDEQ Water Quality Division (WQD) Class III standards and make these waters unsuitable for livestock use.

Baseline water quality data was established in 1989 for the F Sand Aquifer using samples collected from wells SS2-U, SSE-U, and SS1-F. These wells were not sampled in 2010. F Sand wells located near SSE-U were sampled and include UM-1, UM-3, UM-5, and UM-7. As was done for the ore zone wells, Cameco compared 2010 F Sand water quality to established baseline. PMC collected four quarterly samples from

these wells in 1996 to characterize water quality in the F Sand in the vicinity of Mine Units 1 and 2. The 1996 PMC data were submitted to WDEQ LQD in the 1996 Annual Report.

Water quality within the F Sand exhibits more variability compared to the Production Sand Aquifer. Of the 264 constituents analyzed, Cameco identified 18 analyses that fell outside of the values measured in the 1996 baseline water quality summary for the F Sand. Ten are less than the minimum values established during baseline sampling including one calcium concentration measured in Well UM-1 and two pH measurements in Well UM-5. The other minimum value exceedances are likely due to increased lab precision in radium analysis. Eight analyses exceeded the maximum baseline values. Well UM-1 has one concentration that slightly exceeds the maximum value for fluoride. Well UM-5 has seven analyses that exceed the maximum value established during 1996 baseline sampling. UM-5 has elevated levels of magnesium, sulfate, TDS, iron, and manganese. Although these wells are all completed in the F Sand, it appears that F Sand water quality is highly variable. An isopach map (Plate D5-1.2 in Addendum D5-1 of the North Butte WDEQ Permit) indicates the F Sand unit is discontinuous over the site, which could explain the variability in water quality.

Overall, F Sand water quality is dominated by calcium-sodium bicarbonate-sulfate water. Based on both the historic and the 2010 water quality data, radium-226 and pH exceed the WDEQ WQD Class III (livestock use) standards.

In addition to the above mentioned sampling effort, Cameco started monitoring private stock wells within 2 kilometers (1.2 mile) of the North Butte Satellite beginning in 2011 (see **Table 3.4-8, North Butte Wells within 2 Kilometers**). The following wells were sampled in June and September of 2011; Brown #1, CCI#2, Beck Well, Red Barrel #1, Brown #5, Dobie Hill #1, and City Service Brown. **Table 3.4-9, North Butte Groundwater Quality Results** contains the groundwater quality baseline data for private wells within 2 kilometers (1.2 miles) of the North Butte Remote Satellite.

3.4.3.2.8 Groundwater Use and Water Rights

All groundwater rights located within a 5 kilometer (3 mile) radius of the North Butte Remote Satellite are presented on **Figure 3.4.5, North Butte Surface Water and Groundwater Rights** and in **Table 3.4-10, North Butte Groundwater Rights.** According to the WSEO database, there are 778 groundwater rights within this radius. Approximately half of the water rights are related to CBM production wells, most of which were installed since 2000. Since these wells are installed in clusters and are only located to the nearest quarter section, the symbols on **Figure 3.4.5** indicate the quarter sections where the locations of the wells are reported on the WSEO database. The remaining water wells are primarily used for industrial purposes with a limited number (approximately 39) of groundwater wells, which are dedicated to livestock watering and domestic use. The industrial use consists of water for exploration drilling, and environmental wells for water quality monitoring and hydrologic studies for proposed uranium mining.

There are three non-industrial water wells (with pumps) within the North Butte Remote Satellite license area. All three wells are utilized by the T-Chair Land Company for stock watering. There are five permitted domestic wells located within 5 kilometers (3 miles) of the site. Three are located northwest, one is located northeast, and one is located southeast of the North Butte Remote Satellite. There is one non-permitted domestic well located at the Pfister Ranch (Beck Well). This well is used for lawn and stock watering. Water for household consumption is trucked in. There are 31 additional wells within this radius that are permitted for stock watering. The locations of all permitted domestic and stock wells are shown on **Figure 3.4.5** along with the WSEO permit numbers.

Wells located within 2 kilometers (1.2 miles) of the North Butte Remote Satellite boundary are presented in **Table 3.4-8.** These wells are presented on Figure D6-1.3 of the North Butte WDEQ Permit. Several of these wells are no longer in operation and include the Calving Shed, Sheeptick Well #1, North Pfister #2, and Brown #2. The remaining wells are in operation and include Brown #1, CCI#2, Beck Well, Red Barrel #1, Brown #5, Dobie Hill #1, and City Services Brown. These wells have been sampledheader houseNRC Regulation 4.14 and will continue to be monitored in the future.

There are three PWS in the vicinity of the North Butte Remote Satellite. They include Exxon Hertzog Draw Unit (PWS # 5601192), Four J School (PWS # 5601056), and Sussex Unit Well #1 (5600241). They are located 11 kilometers (7 miles) northeast, 40 kilometers (25 miles) northeast, and 51 kilometers (32 miles) southwest, respectively.

3.4.4 Gas Hills

The *Safety Evaluation Report for Operation of the Gas Hills Project In Situ Leach Uranium Recovery Facility in Fremont and Natrona Counties, Wyoming (2004)* states that the NRC has reviewed and accepted the hydrologic site characterization contained in the Environmental Assessment for the Operation of the Gas Hills Project Satellite In Situ Leach Uranium Recovery Facility (2004). The approved hydrologic site characterization for the Gas Hills is summarized in the following sections. Updated water rights and water quality data and an updated potentiometric surface map are included in this report.

3.4.4.1 Surface Water

3.4.4.1.1 Hydrology and Stream Flow

Within the Gas Hills Remote Satellite, surface drainage is primarily to West Canyon Creek, with lesser amounts of drainage to Fraser Draw. West Canyon Creek has its headwaters at the Beaver Divide in the southern portion of the site. Its tributaries drain approximately 70% of the Gas Hills Remote Satellite area. West Canyon Creek is tributary to Canyon Creek, then to Deer Creek, and subsequently to Poison Creek. Fraser Draw and its tributaries drain approximately 25% of the southwest portion of the Gas Hills Remote Satellite area. Fraser Draw is tributary to Muskrat Creek, but is impounded by a reclaimed waste dump at Pathfinder's Central Gas Hills surface mine. Both Poison Creek and Muskrat Creek are within the Wind River Basin. Only a minor portion (less than 2%) of the area lies within the West Sage Hen Creek drainage in the Sweetwater River Basin. The local topography and surface water drainage system are shown on Plate D6-2 of the Gas Hills WDEQ Permit.

Tributaries to West Canyon Creek and to Fraser Draw drain in a northwesterly direction through the Gas Hills Remote Satellite area. The headwaters of these tributaries are located along steep slopes of the Beaver Divide, which trends along the southeast boundary of the site. The tributary drainages are generally small and have drainage basin areas that range from 0.05 to 0.62 kilometers^2 (0.02 to 0.24 miles^2). Basin slopes are relatively steep, averaging from 10 to 15%. The drainage basins are elongate, and sub-dendritic in pattern. The natural elaboration of the stream network is characterized by the ongoing development of channel headcuts.

Many of the basin areas have been disturbed by previous surface and underground mining activities. These disturbances include total blockage of channels by spoils piles, stream capture by mine pits, and surface disturbance by exploration activities. Gully erosion and headcutting are actively occurring adjacent to the pit highwalls and oversteepened reaches near the basin divide. Sedimentation and ephemeral ponding occurs where drainages are impounded by spoil piles. Areas disturbed by historic mining are summarized in Table D6-1-1 and located on Plate D6-1 of the Gas Hills WDEQ Permit.

Drainages in the Gas Hills region are generally ephemeral. They flow only in response to snowmelt or rainfall events. Therefore, with the exception of isolated spring-fed reaches, these channels are dry for the majority of the year. These channels are generally above the local water table except at a few locations where springs or seeps may exist. Springs originating from perched aquifers within the White River Formation or at the contact between the White River and the underlying Wind River Formation exist. Discharge from these springs can create a limited reach of perennial flow.

Hydrologic analysis points have been selected for the purposes of surface hydrology evaluation. These sites are depicted on Plate D6-2 of the Gas Hills WDEQ Permit. The locations of the hydrologic design points were selected to evaluate surface water discharge at key locations. Therefore, they either coincide with the surface water monitoring sites (WCC-1 and WCC-2 [West Canyon Creek]), the WDEQ permit boundary (WFD [West Fraser Draw] and EFD [East Fraser Draw]), or the confluence with a higher order stream (WCC-3). Discharge at hydrologic analysis points WCC-3, WFD, and EFD is ephemeral, therefore, surface water monitoring stations have not been established. In the event that discharge is occurring at the time that water quality sampling is taking place, water quality samples will be obtained at these locations.

Each of the two permanent monitoring locations (WCC-1 and WCC-2) has been equipped with a combination v-notch/cipolletti weir to facilitate sample collection and discharge measurement. Calibrated staff gages allow for instantaneous discharge measurement at the time of sample collection. The weirs are capable of accurately measuring discharges as low as 19 liters/minute (5 gallons/minute) and as high as 7,950 liters/minute (2,100 gallons/minute). Rating tables for the staff gages are included in Addendum D6-1 of the Gas Hills WDEQ Permit.

Discharge from the spring (WCC-1, September 1996) was measured at 34 liters/minute (9 gallons/minute). Based on fourth quarter, 1996 observations, flow from this spring is predicted to occur year-round. At the time of third quarter gaging activities, there was no difference in flow between the upstream (WCC-1) and downstream (WCC-2) gaging sites. Approximately 150 meters (500 feet) downstream from WCC-2, surface discharge disappears. In summary, approximately 2.7 kilometers (1.7 miles) of West Canyon Creek flows on a perennial or intermittent basis. The average (fall 1996) surface flow ranged from 34 to 38 liters/minute (9 to 10 gallons/minute).

In the Mine Unit 3 area, Cameron Spring discharges to the East Fork of Fraser Draw. The spring flows at a rate of approximately 8 to 11 liters/minute (2 to 3 gallons/minute) and feeds a local stock pond. Discharge from the spring can be monitored at a 3-inch Parshall flume.

Runoff from intense rainfall (i.e., thunderstorms) and from spring snowmelt will occur. Methods for characterizing stream discharge in ungaged watersheds have been developed by Lowham (1988) and Craig and Rankl (1978). Lowham examined streamflow data for several hundred gaged watersheds and developed regression relationships based upon basin characteristics such as size, geographic factors, and elevation. Lowham's regression equations are generally applicable to basins greater than 13 kilometers^2 (5 miles^2) in area. Craig and Rankl's (1978) methodology is generally accepted as more appropriate for small drainage basins. Table D6-2-2 of the Gas Hills WDEQ Permit presents the basin characteristics used in the hydrologic estimations. For the purposes of comparison, estimates of flood flows using both methods are tabulated in Table D6-2-3 of the Gas Hills WDEQ Permit. Flood volumes, estimated using Craig and Rankl's (1978) methodology, are also presented. These calculations are for characterization purposes only. Cameco has developed a hydrologically based watershed model (HEC-1) for the design of drainage control and diversion structures. The flow data from this model compare reasonably well with the empirically derived estimates.

3.4.4.1.2 Surface Water Use and Quality

Surface water quality within the study area was characterized using data collected during the 1996 and 1997 water quality monitoring effort, augmented with data obtained from previous mine permits. Two permanent water quality monitoring locations were established, and preliminary data were evaluated. The locations and descriptions of the stations (WCC-1 and WCC-2) are described above. The data collected from WCC-1 and WCC-2 have been augmented with data obtained from existing mine permits and more recently obtained measurements (2011) to characterize background water quality.

The surface water quality data are presented in a spreadsheet format in Addendum D6-2 of the Gas Hills WDEQ Permit. Historic data at sites no longer monitored have also been included in the same addendum (i.e., SW-1, SW-2, SM-5, SM-6, and SM-7). In some cases, the historic data are incomplete, and sampling techniques cannot be verified. However, the data are useful for comparative purposes with the current data, and can be used to document long-term water quality trends, as well as spatial variability of water quality within the study area. Historic and existing surface water monitoring sites are shown on Plate D6-1 of the Gas Hills WDEQ Permit.

Several types of water bodies have been sampled. Data are available from groundwater-fed impoundments (i.e., Buss and PC Pits), springs (i.e., Cameron Spring), and spring-fed perennial stream reaches (i.e., West Canyon Creek). Monitoring stations SM-5, SM-6, and SM-7 are surface water discharge monitoring sites. These sites were equipped with a crest gage to measure the maximum water surface elevation of an event and a self-sampling water sampler. These sites were established by Pathfinder Mine and monitored intermittently from 1984 to 1989.

In general, the surface water sources in the Gas Hills Remote Satellite area are acceptable for wildlife and livestock consumption. Surface water quality in the study area varies greatly with the type of water body sampled. Stream water quality also varies greatly with discharge. Trace metal concentrations are generally present in levels below livestock standards and are mostly below detectable limits. Iron, manganese, arsenic, and zinc are frequently present in detectable levels but generally do not exceed livestock standards. TDS concentrations are consistently below the livestock standard of 5,000 milligrams/liter. Uranium and radium-226 are generally below the livestock standards of 5 milligrams/liter and 5 pCi/liter, respectively; however, these levels are occasionally exceeded. Additional surface water quality characterization is presented in the Gas Hills WDEQ Permit. **Table 3.4-11, Gas Hills Surface Water Quality** has been updated and includes historic water quality data and recent water quality sampling results.

Sediment samples were collected from West Canyon Creek, the Buss Pit, impoundments, and ephemeral drainages in and near the Gas Hills Remote Satellite between August 30 and September 1, 2011. **Table 3.4-12, Gas Hills Sediment Quality Data** presents the results of radionuclide analysis completed on all sediment samples. In general, radium-226 concentrations average 2.7 pCi/gram, lead-210 concentrations average 3.5 pCi/gram, uranium concentrations average 2.9 milligram/kilogram, and thorium-230 concentrations average 2.0 pCi/gram.

3.4.4.1.3 Surface Water Rights

Surface water rights within 2 kilometers (1.2 miles) of the Gas Hills Remote Satellite are identified in **Table 3.4-13, Gas Hills Surface Water Rights**. As of November 2011 there are eight surface water rights according to the WSEO records. All but one of the surface water rights are for stock watering or wildlife purposes. One surface water right is permitted for industrial purposes and is associated with the B-Spoils Reservoir. A map showing the approximate locations (nearest quarter quarter) of the surface

water rights within 2 kilometers (1.2 miles) is presented on **Figure 3.4.6, Gas Hills Surface Water and Groundwater Rights**.

3.4.4.2 Groundwater

3.4.4.2.1 Hydrogeologic Stratigraphy

The hydrogeologic units and site-specific hydrology are presented within Appendix D6 of the Gas Hills WDEQ Permit. The following section summarizes hydrogeologic units within the Gas Hill Remote Satellite area.

Post-Wind River Aquifers - Post-Wind River Formations that crop out within the Gas Hill Remote Satellite area are, in descending order, the Quaternary Alluvium, the Miocene Split Rock, the Oligocene White River, and the Eocene Wagon Bed Aquifers. Quaternary alluvium occurs along Fraser Draw and West Canyon Creek and consists of unconsolidated sand, silt and clay. It is recharged vertically by precipitation and by discharge from springs, which originate from the post Wind River sediments. The primary aquifer of the Post-Wind River Formations is the Split Rock Aquifer, which crops out south of, and caps, the Beaver Divide. The Split Rock Aquifer is both stratigraphically and topographically higher than the Wind River Aquifer and consists of arkosic sands and conglomerates. It is a source of springs and a significant groundwater resource south of the Gas Hills Remote Satellite area. The Wagon Bed and White River Formations are generally considered aquitards in the area.

Wind River Aquifer - The Wind River Aquifer is the uranium host and aquifer of primary importance within the Gas Hills Remote Satellite area. The Eocene Wind River Formation consists of alternating layers of sandstone, siltstone, claystone, and conglomerate. The ore and water-bearing sand and conglomerate units are collectively referred to as the Wind River Aquifer. Localized faulting combined with regionally discontinuous low permeability shale horizons have resulted in the perching of some saturated sand horizons above the main saturated zone of the aquifer. Subcropping and outcropping pre-Wind River deposits tend to restrict the regional flow of the Wind River Aquifer, forcing it to discharge through West Canyon Creek northwest of the Mine Unit 4 area, and Fraser Draw northwest of the Mine Unit 3 area. These discharge zones lie outside of the Gas Hills Remote Satellite boundary.

Recharge of the Wind River Aquifer from precipitation occurs within the Gas Hills Remote Satellite where the formation crops out and by vertical migration through overlying younger sediments. Recharge of upper perched horizons occurs along the Beaver Divide and from overlying younger sediments to the south. Recharge may also occur where subcropping pre-Wind River aquifers discharge into the Wind River Formation.

Pre-Wind River Aquifers - A thick sequence of pre-Wind River sediments containing several aquifers underlie the Gas Hills Remote Satellite. The primary aquifers in this sequence are the Cretaceous Cloverly, Jurassic Nugget, Permian Phosphoria, and Pennsylvanian Tensleep Aquifers. The Cloverly and Nugget Aquifers are recharged north of the Gas Hills Remote Satellite on the flanks of the Dutton Basin Anticline and discharge into the Wind River Aquifer. The Permian Age Phosphoria Formation is classified as a leaky confining layer and locally provides recharge to the underlying Tensleep Sandstone. The Phosphoria Formation is a hydrocarbon-bearing unit and is occasionally a target for oil and gas development in the area. The Tensleep Aquifer is recharged at high elevations along the southern and western flanks of the Wind River Basin. These formations primarily discharge into the Wind River Aquifer, south of the project area. The Tensleep is a highly producing aquifer and in places contains water hot enough to provide a geothermal energy source. A complete stratigraphic column showing the aquifers in the Gas Hills Remote Satellite area is presented as Table D5-2-1 in Appendix D5 of the Gas Hills WDEQ Permit.

3.4.4.2.2 Producing Sands and Confining Unit Characteristics

Faulting has disrupted the continuity of the ore sands and confining layers within the Gas Hills Remote Satellite. Plate D5-2 in the Gas Hills WDEQ Permit shows the locations of the major faults in the Wind River Formation across the Gas Hills Remote Satellite. The main saturated zone within the Wind River Aquifer ranges in thickness from approximately 18 meters (60 feet) at the Mine Unit 1 area, where the 70 Sand is confined by substantial shale breaks, to more than 31 meters (100 feet) at the Mine Unit 3 area, where the 30-40-50-60 Sands act as a single hydrostratigraphic unit. The hydrostatic head in the ore zone monitoring wells at the Mine Unit 1 area is approximately 70 meters (230 feet) above the screened interval. The static water level in a well completed in an overlying unit (MO-1) is 24.4 meters (80 feet) higher than the static water level in the adjacent production zone wells.

At the Mine Unit 2 area the majority of the wells are screened across the 70 Sand. The 70 Sand in wells BSMP-1 and BSMP-2 has been displaced downward by faulting. Despite the faulting, the hydrostatic heads in all the Mine Unit 2 wells appear to be continuous at approximately 2,000 meters (6,630 feet) above mean sea level (AMSL). Plate D5-6 of the Gas Hills WDEQ Permit presents a cross section through the Mine Unit 2 area and shows water the potentiometric surface in the 70 Sand. Downgradient from the Buss Pit in Mine Units 2 and 4, the potentiometric surface is relatively flat due to the lingering effects of conventional mine dewatering in the East Gas Hills. At the Mine Unit 3 area, the hydrostatic head occurs approximately 15 meters (50 feet) above the top of the screen in each well. The static water level in well PCHMO97-1 which is screened 32 meters (105 feet) higher than the adjacent ore zone monitoring well is 2 meters (5 feet) higher than a nearby ore zone monitor well.

At the Mine Unit 4 area, the 50-60 Sands interfinger with a portion of the East Canyon Conglomerate, and are confined above and below by continuous claystone horizons. The hydrostatic head in production zone wells south of the Buss Fault is approximately 61 meters (200 feet) above the top of the 60 Sand (Cross Section L-L, Plate D5-13 of the Gas Hills WDEQ Permit). Hydrostatic head above the 60 Sand increases to 72 meters (235 feet) above the screened interval at well BUMP97-1. Static water levels are 12 meters (38 feet) higher in an adjacent well which is screened in the 90 Sand.

The 50 Sand is the ore-bearing zone at the Mine Unit 5 Area. Borehole data indicate that this unit is confined above and below by continuous claystone strata (Cross Section O-O, Plate D5-16 of the Gas Hills WDEQ Permit). Well data show the static water levels range from 12 to 46 meters (40 feet to 150 feet) above the top of the 50 Sand. The static water level in well PIXMU97-1 (an underlying well) is 27.4m (90 feet) lower than the water level in Well PIXMP97-1 completed in the adjacent 50 Sand. Well PIXMU97-1 is screened in the East Canyon Conglomerate.

The ore zone sands are upwardly confined by continuous claystone strata at Mine Units 1, 2, and 5. At Mine Unit 3 mineralized zones occur in the 30-40-50 Sands which together form a single hydrostratigraphic production unit. This unit is semi-confined and may be hydraulically connected with the overlying 60-70 Sands. Additional hydrogeologic studies will address confinement at this location. At Mine Unit 4, ore zones occur in the 50 through 80 Sands, south of the Buss Fault. North of the fault, mineralized zones are present in the 60-70 Sands. The 60 Sand is confined by continuous claystone strata. The 70 Sand is connected hydraulically with the overlying 80-90 Sands. Again, additional hydrogeologic studies will address confinement at this location.

With the exception of Mine Unit 4, all the ore sands are confined below by continuous claystone layers or pre-Wind River aquitards. At Mine Unit 4 the 60 Sand is underlain by the 50 Sand, which interfingers with the East Canyon Conglomerate. These underlying units are confined by a continuous claystone layer.

Core samples have been collected from the overlying confining unit at Mine Unit 1. Laboratory vertical permeabilities obtained from these core samples are low, ranging from 8.6E-6 to 8.6E-8 m/day (2.8E-5 to 2.8E-7 feet/day). Typical permeabilities for unweathered claystones and siltstones range from 8.6E-5 to 8.6E-7 meters/day (2.8E-4 to 8.6E-6 feet/day) (Freeze and Cherry, 1979). Actual vertical permeabilities of the confining units and their continuity will be determined at other Gas Hills Remote Satellite mine units prior to the initiation of any production. As was the case at Mine Unit 1, vertical permeability will be determined by laboratory testing of cored material and from long-term pump test results utilizing appropriate analytical procedures. Continuity of mine units will be established during the delineation drilling program.

3.4.4.2.3 Aquifer Pump Tests and Analysis

Aquifer tests have been conducted by Cameco on wells located in all of the mine units within the Gas Hills Remote Satellite area. The aquifer tests were conducted to determine the characteristics of the ore zone aquifer and overlying and underlying units, evaluate the hydrologic significance of adjacent faults, and determine if the ore zone is hydraulically isolated from overlying and underlying units. A detailed discussion is available in Appendix D6 of the Gas Hills WDEQ Permit.

The results of the aquifer testing are summarized in Table D6-3-2 of the Gas Hills WDEQ Permit. Transmissivity for the Wind River Aquifer within the Gas Hills Remote Satellite area varies from 6.5E-2 to 89.7 meters^2/day (0.7 to 966 feet/day). Horizontal hydraulic conductivities range from 0.01 to 2.9 meters/day (3.3E-2 to 9.5 feet/day). In Mine Unit 3 where the highest hydraulic conductivities were reported, the values are believed to be influenced by proximity to faults which were acting as recharge boundaries. The representative horizontal hydraulic conductivities by Mine Unit area are:

Area	Average Hydraulic Conductivity (m/day)	Minimum (m/day)	Maximum (m/day)
Mine Unit 1	7.1E-1	4.2E-1	1.2
Mine Unit 2	5.8E-1	2.9E-1	2.0
Mine Unit 3	1.3	2.4E-2	2.9
Mine Unit 4	3.7E-1	1.1E-2	1.0E-2
Mine Unit 5	1.1E-1	1.3E-3	3.1E-1
* Meter to foot conversion – 1 meters ≈ 3.28 ft			

Hydraulic conductivities generally increase from east to west across the Gas Hills Remote Satellite area corresponding to coarsening texture of the Wind River sediments. Calculated storage coefficients range from 8.5E-5 in Mine Unit 4 to 1.3E-3 in Mine Unit 2. The average storage coefficient for the Wind River Aquifer throughout the Gas Hills Remote Satellite area is 3.1E-4. Additional aquifer testing will take place during the Hydrologic Unit Testing phase prior to wellfield development.

3.4.4.2.4 Aquifer Potentiometric Surfaces

Completion information for wells located in and near the project area is summarized in Table D6-3-1 of the Gas Hills WDEQ Permit. Water-level elevations and static water levels measured in conjunction with water quality sampling are included in the spreadsheets in Addendum D6-7 of the Gas Hills WDEQ Permit. Based on the fourth quarter 1997 static water level measurements, potentiometric contours for the Wind River Aquifer have been developed and are presented on Plate D6-3 of the Gas Hills WDEQ Permit. The static water levels on this drawing include some characteristic of a locally perched horizon. The potentiometric surface contours reflect the main saturated zone of the Wind River Aquifer only. Water levels from wells screened in underlying formations and overlying perched systems are noted on the figure but were not used in the construction of the potentiometric surface map (Plate D6-3 of the Gas Hills WDEQ Permit). Static water levels were collected again in 2010 and an updated potentiometric

surface map for the Gas Hills Remote Satellite area was prepared (**Figure 3.4.7, Updated Gas Hills Potentiometric Surface Map**).

The potentiometric contours indicate that groundwater flow is generally to the west and southwest, but is influenced by past mining practices. Regional flow has a northward component. North of Mine Unit 3 and in the East Gas Hills where historic open pit mining and associated dewatering occurred, depressions in the potentiometric surface are evident. In Mine Unit 3 potentiometric contours are deflected north towards the PMC Central Gas Hills Disturbance. In Mine Unit 4, dewatering has ceased and water levels associated with a cone of depression around the Buss Pit are partially recovering.

3.4.4.2.5 Groundwater Quality

Beginning in the early 1980s, groundwater quality data have been collected from the Gas Hills Remote Satellite. The purpose of the sampling is to characterize background water quality of the Wind River Aquifer within the Gas Hills Remote Satellite. In many cases, the historical data (pre-1996) are incomplete, and sampling techniques cannot be verified. The data are useful for comparative purposes with the current data, and document long-term water quality trends, and spatial variability of water quality within the Wind River Aquifer. Historical groundwater quality data are available for wells in the vicinity of the Gas Hills Remote Satellite and are included in Addendum D6-7 of the Gas Hills WDEQ Permit. The historic groundwater quality data has been combined with recent (2011) water quality data and are presented in **Table 3.4-14, Gas Hills Historical Water Quality Data**. The monitoring wells and water quality sample sites are presented on Plate D6-1 of the Gas Hills WDEQ Permit. As wellfields are developed within a specific unit, additional water quality and aquifer characterization data will be collected and presented to WDEQ and NRC within the framework of their mine unit hydrologic testing program, permitting and annual reports. An extensive discussion on the Gas Hills Remote Satellite water quality is presented in Appendix D6 of the Gas Hills WDEQ Permit. A summary is provided below.

The water quality in the Wind River Aquifer is dominated by calcium sulfate water in the east transitioning to calcium-sodium bicarbonate-sulfate water in the west. In areas affected by past disturbance and reclamation activities and where groundwater has flowed through backfilled mine pits (Mine Units 4 and 5), TDS can range between 1,000 to 3,070 milligrams/liter. Downgradient from these locations, calcium sulfate type water predominates.

West of the East Gas Hills area, Mine Units 1 and 2 are located in relatively undisturbed lands downgradient from the Beaver Divide. Waters from many of the Mine Unit 2 wells (single completion into the 70 Ore Sand) average 573 milligrams/liter TDS. The major cations contributing to TDS are bicarbonate (primarily) and sulfate (secondarily). As the groundwater moves downgradient from the Divide and into the vicinity of Mine Units 1 and 3, average TDS increases from 623 to 863 milligrams/liter and sulfate content also increases.

Uranium concentrations are relatively low in all monitoring wells including the ore zone wells. Maximum uranium concentrations were identified at Well BSMP-1 (0.32 milligrams/liter), Peach MP-1 (0.31 milligrams/liter) and Veca MW3A (0.21 milligrams/liter). The BSMP and Peach wells were completed in the ore zone within Mine Units 2 and 3, respectively. The Veca well is completed downgradient from extensive AML reclamation and reflects some influence of waste dump spoils backfilled into an abandoned mine pit.

Radium-226 concentrations in the groundwater are variable. Radium is in equilibrium with uranium in the aquifer, and higher concentrations are found near existing and mined out uranium deposits. For example, Peach MP-1 (722 pCi/liter) and MUMP 97-1 (898 pCi/liter) are completed in ore bodies (Mine

Units 3 and 1, respectively). These values exceed the Class IV standard by 100 to 180 times. Outside the ore bodies, radium levels are significantly lower. Upgradient from these deposits, radium-226 is typically less than 5 pCi/liter. Downgradient values are higher, but still less than 50 pCi/liter. Mean values of radium-226header houseMine Unit are presented on Table D6-3-3 of the Gas Hills WDEQ Permit. These mean values are skewed on the high end of the spectrum, based on the influence of the ore zone wells. Nevertheless, radionuclide levels within the mine units generally make these waters unsuitable for Class III (livestock use).

The baseline groundwater within the Gas Hills Remote Satellite and within the mine units is typically low in trace metals. Most constituents are below method detection limits. Occasionally undisturbed groundwater will exhibit low concentrations of manganese, arsenic, boron, selenium, iron, and zinc. However, typically these concentrations are well below Class III water quality standards.

In the groundwater affected by historical disturbance and reclamation activities, certain trace metals including iron, manganese, and arsenic are routinely elevated. The increase in iron and manganese can be attributed to the oxidation and dissolution of iron-bearing minerals (pyroxenes, amphiboles, phyllosilicates, and sulfides) and the local reduction in pH and increase in Eh.

The natural pH of the groundwater in the Gas Hills is slightly greater than 8, although values ranging from 6.5 to 8.5 are common. In some of the northern portions of the Gas Hills, and in the vicinity of Iron Springs, natural pH values below 4.0 were recorded in the 1950s. Within the mine units, groundwater pH typically ranges from 6.3 to 9.7.

Near the historical mining disturbances, pH values are generally lower than those measured in the typical Gas Hills Remote Satellite groundwater. Based on collected sample data, groundwater pH ranges from 6.3 to 7.9 within or immediately adjacent to historical mining disturbances. Studies in adjacent areas have documented a similar range in pH values immediately following reclamation. As groundwater continues to recover in the backfilled pits, pH values are predicted to increase towards background or upgradient conditions.

Additional characterization of groundwater quality within Mine Units 1, 2, 3, 4, and 5 are presented in Appendix D6 of the Gas Hill WDEQ Permit.

3.4.4.2.6 Groundwater Rights

A list of all groundwater rights within the Gas Hills Remote Satellite and a boundary of 2 km (1.2 mi), as of November 2011 are included in **Table 3.4-15, Gas Hills Groundwater Rights**. The locations of the groundwater rights are shown on **Figure 3.4.6**.

There are 177 groundwater rights on file with the WSEO within and adjacent to the Gas Hills Remote Satellite area. The vast majority of these groundwater rights are for wells installed for hydrologic monitoring or industrial purposes. There are seven groundwater rights associated with wells installed for livestock watering. There are no domestic use groundwater rights within 2 kilometers (1 mile) of the Gas Hills Remote Satellite according the WSEO.

The nearest PWS in the vicinity of the Gas Hills Remote Satellite is the Wyoming Transportation Department Waltman Rest Area (5600964). It is located 37 kilometers (23 miles) northeast of the site.

3.4.5 Ruth Remote Satellite

3.4.5.1 Surface Water

3.4.5.1.1 Hydrology and Stream Flow

The Ruth Remote Satellite is located in the Dry Fork of the Powder River drainage which is a tributary of the Powder River located approximately 35 kilometers (22 miles) upstream of the confluence of Dry Fork and the Powder River. The Powder River is tributary to the Yellowstone River which is part of the Missouri River drainage basin. Dry Fork flows in a northerly direction through the center of the Ruth Remote Satellite. The Dry Fork drainage system is shown on Figure 10.6 of Volume II (Ruth Supplemental Report). The Dry Fork of the Powder River is classified as an intermittent stream and mainly flows in response to snow melt and large convective rainstorms. However, the alluvium is partially saturated and supports cottonwood trees and willows.

The size of the drainage area above the Ruth Remote Satellite is approximately 156 kilometers^2 (60 miles^2). The Dry Fork channel has a gradient of about 0.007 m/m; an active channel width of 2 meters (7 feet); and a length of approximately 6 kilometers (4 miles) through the Ruth Remote Satellite area. Figures 9.2 and 9.3 of Volume II (Ruth Supplemental Report) show the Dry Fork and smaller tributary drainages in the Ruth Remote Satellite area.

There are no stream gauging stations located on the Dry Fork of the Powder River. Using methods from Craig and Rankl (1978) the mean annual flow of Dry Fork at the Ruth Remote Satellite is estimated to be 0.1 meters^3/second (5 feet^3/second). Peak flows with recurrence intervals between 2 and 100 years have been calculated with the "Basin Characteristics Method" of Craig and Rankl, with the "Channel Geometry Method of Lowham (1976) and with the triangular unit hydrograph method in HEC-1. The basin characteristics, rainfall depth, and results of these calculations are presented in Table 10.16 of Volume I (Ruth Supplemental Report). Figure 10.6 of Volume II (Ruth Supplemental Report) presents drainage divides of the three basins for which peak flows were obtained.

3.4.5.1.2 Surface Water Use and Quality

Two surface water quality sampling sites were established along the Dry Fork of the Powder River. The first station is located downstream of the Ruth Remote Satellite and the other site is located upstream. The downstream sampling site is at the same location for the Research and Development (R&D) operations. The upstream location was moved from the original location to accommodate the increased license boundary. The sites are identified as SWS L, SWS U (old) and SWS U (new) on the Monitoring Site map, Figure 14.1 of Volume II (Ruth Supplemental Report). A total of 35 samples were collected from the three sites between 1980 and 1988. The surface water quality data is presented in Tables 10.17, 10.18, and 10.19 of Volume I (Ruth Supplemental Report).

Surface water within and adjacent to the Ruth Remote Satellite is used for livestock and wildlife watering, and contributes to the riparian vegetation along the Dry Fork of the Powder River.

Sediment samples were collected at two locations on the Dry Fork of the Powder River upstream and downstream from the Ruth Remote Satellite. One sample was collected at the upstream sample site (SWS U New) and four were collected at the downstream sample site (SWS L). The results of the sediment sample analyses are presented in Table 14.3 of the Ruth Supplemental Report.

3.4.5.1.3 Surface Water Rights

Surface water rights within 2 kilometers (1.2 miles) of the Ruth Remote Satellite are identified in **Table 3.4-16, Ruth Surface Water Rights**. As of November 2011, there are 32 surface water rights according to the WSEO records. All but one of the surface water rights are for stock watering purposes. One surface

water right is permitted for industrial purposes and is associated with the Ruth ISL Retention Reservoir. The Ruth ISL Retention Reservoir consists of a two-celled solar evaporation pond located off-channel in the Dry Fork of the Powder River drainage (NENE, Sec. 14, T42N, R77W). A map showing the approximate locations (nearest quarter quarter) of the surface water rights within 2 kilometers (1.2 miles) is presented on **Figure 3.4.8, Ruth Surface Water and Groundwater Rights**.

3.4.5.2 Groundwater

The hydrogeologic units within the Ruth Remote Satellite were mentioned previously in the regional setting. The uranium producing sands are hosted within the Eocene-age Wasatch Formation and are summarized below.

3.4.5.2.1 Hydrogeologic Stratigraphy

The Ruth Remote Satellite ore zone aquifer is hosted in the Wasatch Formation. The Wasatch Formation is a fluvial deposit and consists of brown to gray claystone, siltstone, and carbonaceous shales interbedded with buff sandstone lenses and coal beds. At the Ruth Remote Satellite area, the Wasatch Formation is approximately 443 meters (1,350 feet) thick. The major sands can be correlated for miles and are the basis for regional aquifers in the Powder River Basin. Aquifer properties are locally variable due to large variations in local lithologies. Recharge to the Wasatch Formation is mainly by exposure to outcrops with some influx of groundwater from vertical movement through adjacent aquifers. Regionally, the Wasatch Formation combined with the underlying Fort Union Formation is developed extensively for shallow domestic and stock wells in the area.

3.4.5.2.2 Producing Sands and Confining Unit Characteristics

Locally the Ruth Remote Satellite stratigraphy consists of alternating layers of sand and shale with lignite marker beds. The A Sand (ore sand) is approximately 176 meters (535 feet) below ground surface and generally 16 meters (50 feet) thick. Above the A Sand lies the B Sand with the B-A Aquitard separating the two sands. The B-A Aquitard is approximately 13 meters (40 feet) thick. Below the A Sand lies the 1 Sand with the A-1 Aquitard separating the two sands.

Within the B-A Aquitard occasional sand lenses divide the aquitard into two or three thinner shale sequences. The shale lenses still provide a continuous, low permeability cap over the A Sand but locally reduce the total thickness of the B-A Aquitard. The interbedded sand lenses are discontinuous and are not laterally traceable for any significant distances. These sand lenses are saturated but due to their discontinuous lithology and limited size they cannot be considered aquifers. Over most of the Ruth Remote Satellite, the B-A Aquitard is vertically continuous and not compromised by sand lenses.

The A-1 Aquitard consists of two unequal shale layers separated by a thin coal seam. This is not expected to significantly affect the ability of the A-1 Aquitard to prevent lixiviant migration to the underlying 1 Sand during ISR operations. Figure 10.1 of Volume II (Ruth Supplemental Report) presents a schematic of the hydrogeologic setting at the Ruth Remote Satellite.

Vertical permeability of confining units has been determined in the laboratory from actual cored material and from pump test results utilizing the Neuman-Witherspoon method. Table 10.3 of Volume I (Ruth Supplemental Report) contains estimates of the vertical permeability of the confining units. These vertical permeabilities are considered representative of confining conditions throughout the Ruth Remote Satellite area.

3.4.5.2.3 Aquifer Pump Tests and Analysis

A total of seven aquifer tests were conducted at the Ruth Remote Satellite in the 1980s. Six aquifer tests were conducted for the R&D license and one for the Ruth Supplemental Report. Aquifer tests for the

R&D license were numbered sequentially and include pump tests No. 1, 2, 4, 9, 14, and 15. These pump tests produced useful aquifer properties. Additional tests including step drawdown and variable rate injection tests were not very useful in defining aquifer properties. Aquifer tests No. 9 and 15 were the most thorough tests conducted for the R&D license with pumping times of 38.5 and 7.3 hours. Aquifer properties obtained from aquifer tests on the A Sand during the R&D project are presented in Table 10.2, Volume I (Ruth Supplemental Report).

The aquifer test conducted for the Ruth Supplemental Report consisted of a seven day test (four days pumping and three days of recovery). The test was named Hydro Test No. 24 and was conducted at the Ruth Remote Satellite area between July 5 and July 12, 1988. The A Sand (ore zone) was stressed by pumping well A1 (see Figure 10-2 of Volume I of Ruth Supplemental Report) at an average rate of 18 liters/minute (5 gallons/minute). The adjacent aquitards including the B-A and the A-1 Aquitards were monitored to obtain field vertical permeabilities. The B Sand and the 1 Sand were also monitored for potential response to pumping from the A Sand. Aquifer properties obtained from the Hydro Test No. 24 are presented in Table 10.2, Volume I (Ruth Supplemental Report). Drawdown impacts to the A Sand at the end of Hydro Test No. 24 are presented on Figure 10.3, Volume I (Ruth Supplemental Report). The complete results of Hydro Test No. 24 including drawdown data are presented in the Groundwater Hydrology Supplement, Volume III of the Ruth Supplemental Report.

Based upon the above mentioned testing the A Sand exhibits an average transmissivity of 1.4 meters^2/day (15 feet^2/day) and a horizontal permeability of 0.09 meters/day (0.29 feet/day). The A Sand is a confined aquifer with a storage coefficient of 8.0E-5.

3.4.5.2.4 Aquifer Potentiometric Surfaces

Groundwater levels were collected from monitoring wells on July 5, 1988 prior to aquifer testing. Figure 10.4 of Volume I and Figure 10.4A of Volume II (Ruth Supplemental Report) present potentiometric surface maps of the A Sand. Based on these water levels, groundwater flows towards the northwest. The groundwater gradient is 0.005 with a movement rate of 0.4 centimeters/day (0.16 inches/day), an average permeability of 0.09 meters/day (0.29 feet/day), and an effective porosity of 0.1.

3.4.5.2.5 Groundwater Quality

The groundwater sampling program for the Ruth Remote Satellite started in February 1980. During the Ruth R&D operation from 1982 to 1984, water sampling was conducted on a quarterly basis. Well sampling was discontinued after the R&D restoration phase in 1984. However, during 1985 the Moore South well was sampled quarterly.

The monitoring data included nine sample points in the A Sand, two in the B Sand, and one in the 1 Sand. The well sampling locations are identified on Figure 10.5 of Volume II (Ruth Supplemental Report). All quarterly water samples collected from the Ruth Remote Satellite were sent to an outside commercial laboratory. The baseline water quality results are presented in Tables 10.4 through 10.12 of Volume I (Ruth Supplemental Report). A summary of key water quality parameter from the 1 Sand, A Sand, and B Sand is summarized in Tables 10.13, 10.14, and 10.15 of Volume I (Ruth Supplemental Report).

3.4.5.2.6 Groundwater Rights

A list of all groundwater rights within the Ruth Remote Satellite and a boundary of 2 kilometers (1.2 miles), as of November 2011 are included in **Table 3.4-17, Ruth Groundwater Rights**. The locations of the groundwater rights are shown on **Figure 3.4.8**.

There are 125 groundwater rights on file with the WSEO within and adjacent to the Ruth Remote Satellite area. The vast majority of these groundwater rights are for wells installed for CBM development. There are 22 groundwater rights associated with wells installed for livestock water. There are three monitoring wells remaining that were installed by Uranerz in the 1980s. There is one dual use domestic and stock groundwater right within approximately 0.8 kilometers (0.5 mile) southeast of the Ruth Remote Satellite area.

The nearest municipal water source is located at the unincorporated community of Linch located 8 kilometers (5 miles) west of the Ruth Remote Satellite area. Linch does not have an EPA PWS number.

3.4.6 References

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3.5 Ecological Resources

3.5.1 Smith Ranch, Highland and Reynolds Ranch Vegetation Surveys

Cameco completed an updated vegetation survey which commenced in the spring of 2011. The focus of the survey is on threatened and endangered (T&E) plant species. A copy of all correspondence with the WGFD and USFWS regarding updated vegetation and wetlands mapping along with the Vegetation and Wetlands Survey Methodology are included in Appendix D8 of the Smith Ranch WDEQ Permit under the heading "Supplemental Information."

Cameco completed a wetland survey effort in the Smith Ranch, Highland and Reynolds Ranch areas between June 20 and June 30, 2011 in accordance with regulations issued by the USACE. During a meeting which took place on May 2, 2011, Hayden-Wing and Associates (HWA), Cameco, and USACE determined that wetland surveys would be necessary within areas of proposed mining disturbance, but not within the entire permit area. It was also decided that the goal of initial surveys would be to determine whether wetlands were present within the proposed mine units and full delineations would be required if direct disturbance (i.e., filling) would result from ISR recovery activities. It was also agreed that the locations of the drainages would be verified. A total of 19 potential wetland sites were surveyed during June 2011 within the Smith Ranch, Highland and Reynolds areas. The wetlands survey is included as **Appendix A, Wetlands Survey – 2011**.

Sections 3.5.1.1 through 3.5.1.3 describe previous vegetation studies completed at the Smith Ranch, Highland and the Reynolds Ranch Satellite to date.

3.5.1.1 Smith Ranch Historical Vegetation Surveys

Cameco and their predecessors conducted vegetation studies at Smith Ranch in 1976, 1978, and 1979 when the project was under Kerr McGee ownership. Additional survey work was completed in the summer of 1990 and a final Baseline Vegetation Assessment was prepared in 1997.

The vegetation studies conducted at Smith Ranch and mentioned above can be found in Appendix D8 of the WDEQ Permit in the following locations:

- Addendum D-8 A1 – Smith Ranch Tables
- Addendum D-8 A2 – Smith Ranch Figures and Plates
- Addendum D-8 A3 – Smith Ranch Supplemental Information

3.5.1.2 Highland Historical Vegetation Surveys

Highland was originally permitted as an ISR operation by the Everest Minerals Corporation. Cameco and their predecessors completed a vegetation inventory at Highland in 1987. United Nuclear Corporation completed a vegetation inventory for the lands comprising the North Morton property. This information was utilized for Section 14 and portions of the West Highland Amendment areas. Supplemental information was later provided for Mine Unit J.

The vegetation studies conducted at Highland and mentioned above can be found in Appendix D8 of the Smith Ranch WDEQ Permit in the following locations:

- Addendum D-8 B1 – Highland Tables
- Addendum D-8 B2 – Highland Figures and Plates
- Addendum D-8 B3 – Highland Supplemental Information

3.5.1.3 Reynolds Ranch Historical Surveys

Cameco and their predecessors completed a vegetation inventory (including vegetation mapping) for the Reynolds Ranch Satellite in 1997. This work was updated and supplemented by BKS Environmental Associates, Inc. as part of the 2007 BLM EA. In 1997 the Reynolds Ranch Satellite was under RAMC ownership. Since 1997, the surface area of the Reynolds Ranch Satellite has been reduced such that the study performed in 1997 encompasses a greater area than the contemporary Reynolds Ranch Satellite boundary.

The vegetation studies conducted at the Reynolds Ranch Satellite and mentioned above can be found in Appendix D8 of the Smith Ranch WDEQ Permit in the following locations:

- Addendum D-8 C – Reynolds Ranch Vegetation
- Addendum D-8 C2 – Reynolds Ranch Figures and Plates
- Addendum D-8 C3 – Reynolds Ranch Supplemental Information

3.5.1.4 Existing Vegetation Resource Information Summary

Vegetation surveys completed to date have consistently shown that the study area is primarily grassland, with sagebrush/grassland vegetation present throughout the affected area. For more specific conclusions related to cover, diversity, productivity, and shrub height please see Section 3.0 in Appendix D8 of the Smith Ranch WDEQ Permit.

The results of the vegetation mapping for Smith Ranch are shown on Figure D-8.1 of WDEQ Addendum D-8 A2 and in Table D-8.5 of Addendum D-8 A1 in Appendix D8 of the Smith Ranch WDEQ Permit. Highland vegetation mapping was completed according to plant community on Plate D8-1 of WDEQ Addendum D-8 B2 and aerial extent data are provided in Table D8-1 of Addendum D-8 B1 in Appendix D8 of the WDEQ Permit. The results of the vegetation mapping for the Reynolds Ranch license area are displayed spatially in the figure entitled "Vegetation Map" in Addendum D-8 C2 in Appendix D8 of the WDEQ Permit.

A discussion of the baseline vegetation information including vegetation, mapping, site photographs, T&E species, noxious weeds, and selenium indicator species can be found in Appendix D8 of the WDEQ Permit. The existing condition at the time of the Smith Ranch Supplement to the LRA (SUA-1548) can be characterized by an affected ISR environment which includes roads, wells, header houses, satellite facilities, a CPP, a CPF, various office buildings, mine reservoirs, a selenium treatment plant and irrigators. Reclamation is an ongoing process where sites have been disturbed by drilling and/or construction activities.

3.5.2 Smith Ranch, Highland and Reynolds Ranch Wildlife

Cameco, Grouse Mountain, and HWA are updating the historical wildlife surveys commencing in the spring of 2011. The surveys focus on T&E species. Wildlife surveys are conducted in and around Smith Ranch, Highland and the Reynolds Ranch Satellite during the appropriate survey windows and in accordance with agency-approved protocols for each species as outlined in the Draft Wildlife Monitoring

Plan. Species surveyed in 2011 include: wintering bald eagles (*Haliaeetus leucocephalus*), greater sage grouse (*Centrocerus urophasianus*), raptors, mountain plover (*Charadrius montanus*), black-tailed prairie dog (*Cynomys ludovicianus*), burrowing owl (*Athene cunicularia*), swift fox (*Vulpes velox*), shorebirds, and waterfowl.

Agency correspondence can be found in Appendix D9 of the Smith Ranch WDEQ Permit under the heading "Supplemental Information."

Sections 3.5.2.1 through 3.5.2.3 describe previous wildlife studies completed at the Smith Ranch, Highland and the Reynolds Ranch Satellite to date.

3.5.2.1 Smith Ranch Historical Wildlife Surveys

Wildlife and wildlife habitat studies were performed in 1976, 1979, and 1990 at Smith Ranch. Multiple ground surveys were completed to address seasonality of species with a minimum of four separate surveys performed over the space of at least one year. Additionally, a series of three aerial surveys were conducted over a portion of the permit area in February, August, and December 1990 to record numbers, distribution and habitat affinity, as well as pre- and post-hunt population statistics.

The wildlife studies conducted at Smith Ranch and mentioned above can be found in Appendix D9 of the WDEQ Permit in the following locations:

- Addendum D-9 A1 – Smith Ranch Tables
- Addendum D-9 A2 – Smith Ranch Figures and Plates
- Addendum D-9 A3 – Smith Ranch Supplemental Information

3.5.2.2 Highland Historical Wildlife Surveys

Wildlife surveys were performed at Highland in 1987 and 1989. Multiple ground surveys were completed to survey wildlife species. A minimum of four separate surveys were performed over the space of at least one year. Additionally, a series of three aerial surveys were conducted over a portion of the permit area in February, August, and December 1990 to record numbers, distribution and habitat affinity, as well as pre- and post-hunt population statistics.

The wildlife studies conducted at Highland and mentioned above can be found in Appendix D9 of the Smith Ranch WDEQ Permit in the following locations:

- Addendum D-9 B1 – Highland Tables
- Addendum D-9 B2 – Highland Figures and Plates
- Addendum D-9 B3 – Highland Supplemental Information

3.5.2.3 Reynolds Ranch Historical Wildlife Surveys

Baseline wildlife surveys were conducted at the Reynolds Ranch Satellite by Cameco and their predecessors in January of 1997 and 1998. At this time the Reynolds Ranch Satellite was under RAMC ownership. Since 1997, the surface area of the Reynolds Ranch Satellite has been reduced such that the study performed in 1997 encompasses a greater area than the contemporary Reynolds Ranch Satellite boundary.

Wildlife surveys were completed on the Reynolds Ranch Satellite in the winter, spring, and summer of 2007 and 2008 by Cameco and their predecessors. These surveys investigated wildlife use on site and in a 1 kilometer (0.5 mile) observation area surrounding the license boundary. Observations were

conducted to document the presence or absence of big game, T&E species, migratory birds of high federal interest (MBHFI), nesting raptors, sage grouse and wildlife habitat.

The wildlife studies conducted at the Reynolds Ranch Satellite and mentioned above can be found in Addendum D-9 C3 in Appendix D9 of the Smith Ranch WDEQ Permit.

3.5.2.4 Ecology

The Smith Ranch, Highland and the Reynolds Ranch Satellite are located in the western part of the Great Plains in a region referred to as short-grass prairie. Many animals are associated with the short-grass prairie of eastern Wyoming. The pronghorn antelope, mule deer, coyote, prairie dog, badger, deer mouse, horned lark, and meadowlark are abundant. During the past century however, some animal populations have changed as a result of increased human settlement. For example, the bison and gray wolf were both formerly abundant on the short-grass prairie, but have been virtually extirpated from this habitat in the past 140 years. Today the pronghorn antelope is the dominant big game species of the prairie, and more antelope occur in Wyoming than in any other state (Sundstrom et al., 1973). For additional information on area ecology in and around Smith Ranch, Highland and the Reynolds Ranch Satellite please see Sections 3.0 and 4.0 in Appendix D9 of the Smith Ranch WDEQ Permit.

3.5.2.5 Existing Wildlife Resource Information

A discussion of the baseline wildlife information including big game, small to medium-sized mammals, birds, reptiles and amphibians, invertebrates, T&E species, and aquatic habitats can be found in Appendix D9 of the WDEQ Permit.

3.5.3 North Butte Vegetation

Vegetation sampling was conducted at the North Butte Remote Satellite in 1979 and compiled in the "Cleveland-Cliffs North Butte Vegetation Report." This original report can be found in Attachment D8-1 in Appendix D8 of the North Butte WDEQ Permit.

Cameco completed updated vegetation studies at the North Butte Remote Satellite in 2010. Based on examination of all the available license application information, it was concluded that no additional sampling would be required in 2010. Revisions and supplemental information compiled by Real West Natural Resources Consulting (Real West) for the update include:

1. Preparation of a new vegetation map.
2. Update of the plant species list.
3. Identification of any wetlands in the license area.
4. Identification of the potential for any T&E plant species to occur on the license area.

Site surveys to update the plant species list, identify the potential for T&E species, and determine wetland areas (wetlands are reported in Appendix D11 of the North Butte WDEQ Permit) were conducted by Real West on June 17, July 6 and 7, and August 5 and 6, 2010.

3.5.3.1 Existing Vegetation Resource Information

The North Butte Remote Satellite area supports four vegetation community types including sagebrush-grassland, grassland, bottomland and juniper-sagebrush. Photographs of the Satellite taken in 2010 are included as Figures D8-1.1 through D8-1.7 in Addendum D8-1 in Appendix D8 of the WDEQ Permit. Photo points are identified on the 2010 vegetation map (Plate D8-1.1 in WDEQ Addendum D8-1 in Appendix D8 of the WDEQ Permit). For additional information on specific species observed, cover data, noxious weeds, T&E species (including the Ute ladies'-tresses and blowout penstemon) see Addendum D8-1 in Appendix D8 of the WDEQ Permit.

3.5.4 North Butte Wildlife

In 2010, Cameco and their predecessors conducted field surveys in and around the North Butte Remote Satellite for wildlife species of management concern to the WGFD and the USFWS. These are species that are known to occur or have a high probability for occurring in and around the license area.

The 2010 wildlife species surveys include: 1) aerial and ground surveys for raptor nests in and within 2 kilometers (1 mile) of the license boundary; 2) ground surveys to locate and delineate potential mountain plover (*Charadrius monfanus*) habitat in and within 0.4 kilometer (0.25 mile) of the license boundary; 3) ground surveys to locate and delineate black-tailed prairie dog (*Cynomys ludovicianus*) colonies within the license boundary; and, 4) spotlight surveys for swift foxes (*Vulpes velox*) in and within 0.4 kilometer (0.25 mile) of the license boundary. Greater sage grouse (*Centocercus urophasianus*) leks were surveyed by another consultant for an adjacent CBM project in April 2010 and HWA obtained the locations, status, and peak male counts of leks within 3 kilometers (2 miles) of the license boundary from WGFD. Wildlife surveys were performed in accordance with the WGFD protocols and/or the respective USFWS survey protocols.

3.5.4.1 Existing Wildlife Resource Information

Appendix D9 of the WDEQ Permit contains updated information on survey methodology and the results of wildlife surveys for the following: big game, medium-sized and small mammals and predators, avifauna, raptors, sage grouse, passerine and other birds, herpetofauna, T&E species, and fisheries and aquatics. Section 3.11 of Appendix D9 of the WDEQ Permit also contains information on wildlife related recreation in the area.

Addendum D9-1 in Appendix D9 of the WDEQ Permit contains the updated Wildlife Monitoring Plan. The purpose of this Wildlife Monitoring Plan is to set forth protocols and schedules for monitoring the status of wildlife species identified by the regulatory agencies as species of concern that may occur in or proximal to the North Butte Remote Satellite. This plan has been tailored to meet the specific wildlife monitoring needs of the North Butte Remote Satellite and does not address species that are unlikely to occur in the survey area.

3.5.5 Gas Hills Vegetation

Vegetation sampling was conducted by Cameco and their predecessors in the summer of 1997 for the WDEQ permit requirements and by HWA in 2010. According to the environmental assessment for the operation of the "Gas Hills Project Remote Satellite In-Situ Leach Uranium Recovery" prepared for the NRC in 2004 (Docket No. 40-8857), five native vegetation types occur within the project area — mixed sagebrush grassland, rough breaks, bottomland sagebrush, upland grassland, and wetlands. Table 2.8-1 of the Gas Hills EA presents the area vegetation map units for the Gas Hills Remote Satellite. Section 2.8.1.1 of the Gas Hills EA contains additional information on the existing vegetation resources at the Gas Hills satellite including a description of native vegetation types, disturbed lands, and noxious weeds.

No federally listed plant species were observed during the 2010 surveys of the project area. Based on records of the Wyoming Natural Diversity Database, plant species of concern include devil's gate twinpod (*Physaria eburniflora*), cedar rim thistle (*Cirsium aridum*), and Nelson's milkvetch (*Astragalus nelsonianus*). These species are all considered rare in the state.

Eleven hectares (28 acres) of potential wetland were mapped based on the presence of wetland vegetation. Most of this wetland vegetation exists along and within the stream channel of West Canyon Creek, but wetland vegetation also occurs along the margins of Cameron Spring Reservoir and several small seeps which issue from the base of the Beaver Divide in the southern portion of the site. Wetland

species on the site include creeping spikerush (*Eleocharis palustris*), bulrush (*Scirpus pungens*), sedges (*Carex* spp.), and rushes (*Juncus* spp.). A small stand of willows (*Salix* spp.) occurs in the upper portion of West Canyon Creek. A delineation of jurisdictional wetlands in the satellite area has not been conducted, but will likely be required should direct disturbance (i.e., filling) be proposed as ISR recovery activities are more clearly defined (after delineation drilling is completed).

3.5.6 Gas Hills Wildlife

Surveys of the Gas Hills Remote Satellite were conducted by Shell Valley Consulting in 2006, 2007, and 2008. HWA conducted surveys in 2009, 2010, and 2011. Wildlife surveys include evaluation of big game species, upland game birds, raptors, small mammals, and MBHFI. Section 2.8.1.2 of the Gas Hills EA contains a description of wildlife survey work completed to date at the satellite. Table 2.8-2 of the Gas Hills EA lists all federally listed T&E or Candidate Species and Wyoming Species of Concern that could potentially occur at the Gas Hills Remote Satellite.

3.5.7 Ruth Vegetation

Uranerz used the Extended Reference Area (EXREFA) concept when describing vegetation at the Ruth Remote Satellite. In addition, a vegetation map, discussion of the communities and species present, and a comparison of vegetation studies previously conducted in the region was prepared. The original baseline data was collected by NUS Corporation and baseline verification was performed by Applied ECOsystems in the summer of 1988.

As presented in Section 12, Volume 1 of the Ruth Supplemental Report, vegetation types at the Ruth Remote Satellite were delineated into one of four mapping units:

1. Drainage Bottomland,
2. Sprayed Sagebrush-Grassland,
3. Sagebrush-Grassland, and
4. Grassland.

Section 12.2 of the Ruth Supplemental Report presents descriptions and photographs of all four mapping units. No rare or endangered plant species were encountered at the Ruth Remote Satellite.

Section 12.3 of the Ruth Supplemental Report presents a comparison of vegetation cover and productivity data from studies conducted on the Ruth Remote Satellite area and others done in the region. The comparison included the following projects and owners: the Ruth property (Uranerz), the North Butte property (Cleveland-Cliffs), the Greasewood Creek property (Cleveland-Cliffs), the Charlie property (Cotter Corp.), the Christensen Ranch property (Malapai Resources) and the Irigaray property (Malapai Resources).

Figure 12.1 in the Ruth Supplemental Report includes the vegetation mapping and upland and lowland EXREFA. Table 12.3 in the Supplemental Report lists all plant species encountered.

3.5.8 Ruth Wildlife

The baseline wildlife study at the Ruth Remote Satellite is a composite of work initiated in the fall of 1987 and supplemented by earlier work. The wildlife study area included the license area and a buffer of 2 kilometers (1 mile) for raptors and 1 kilometer (0.5 mile) for all other wildlife. Field investigations for big game, mammalian predators, small and medium-sized mammals, raptors, game birds, passerine birds, herptiles, and T&E species were completed on the Ruth Remote Satellite area and adjacent habitats.

3.5.8.1 Existing Wildlife Resource Information

No big game migration routes or critical habitat are known to occur on the Ruth Remote Satellite area. No nesting or other significant use by raptor species is expected. At the time of the 1989 Ruth Supplemental Report, three T&E species had the potential to occur at the Ruth Satellite; the bald eagle, the peregrine falcon, and the black-footed ferret. The bald eagle was occasionally sighted in the winter, no sightings of the peregrine falcon were reported and neither the black-footed ferret nor its presence was identified.

Tables 13.1, 13.2 and 13.3 in the Ruth Supplemental Report contain a list of all mammal, avian and amphibian species expected or having the potential to occur at the Ruth Satellite. Sage grouse leks are not known to occur at the Ruth Satellite. Section 13.4 of the Ruth Supplemental Report contains a wildlife management plan.

3.5.9 References

Sundstrom, C., W.G. Hepworth, and K.L. Diem. 1973. Abundance, distribution and food habits of the pronghorn. Wyoming Game and Fish Commission, Cheyenne. 61 pp.

3.6 Meteorology, Climatology and Air Quality

3.6.1 Regional Meteorology, Climatology and Air Quality

All SUA-1548 license areas (Smith Ranch, Highland, Reynolds Ranch, North Butte, Gas Hills and Ruth) are located in the northeast quadrant of Wyoming. Section 3.6.1 describes the temperature, precipitation, wind, evaporation and severe weather in regional terms. Site-specific climatologic data are presented in Sections 3.6.2 through 3.6.5 and air quality information is in Section 3.6.6.

3.6.1.1 Temperature

Wyoming's elevation results in relatively cool temperatures. Much of the temperature variations within the state can be attributed to elevation with average values dropping 1 to 2°C (1.8 to 3.6°F) per 300 meters (1,000 feet). Summer nights are almost invariably cool, even though daytime readings may be quite high at times. For most places away from the mountains, the mean minimum temperature in July ranges from 10 to 16°C (50 to 60°F). The mountains and high valleys are cooler with average lows in the middle of the summer from -1 to 4°C (30 to 40°F) with occasional drops below freezing (Curtis and Grimes, 2004). The fall, winter, and spring can experience rapid changes with frequent variations from cold to mild periods. Freezes in early fall and late spring are typical and result in long winters and a short growing season. In the mountains and high valleys, freezes can occur any time in the summer. During winter warm periods, nighttime temperatures can remain above freezing. Valleys protected from the wind by mountain ranges can provide ideal pockets for cold air to settle and temperatures in the valley can be considerably lower than on nearby mountainsides.

3.6.1.2 Precipitation

Precipitation within Wyoming varies, with spring and early summer being the wettest time for much of the state. Mountain ranges are generally oriented in a north-south direction. This is perpendicular to the prevailing westerly wind direction. Therefore, these mountains often act as moisture barriers. Air currents of the Pacific Ocean rise and drop much of their moisture along the western slopes of the mountains. Summer showers are frequent, but typically result in rainfall amounts of a few hundredths of an inch. Usually several times a year, local thunderstorms will result in 2.5 to 5 centimeters (1 to 2 inches) of rain in a 24-hour period. On rare occasions, rainfall in a 24-hour period can reach 7.5 to 12.5

centimeters (3 to 5 inches) (Curtis and Grimes, 2004). Heavy rains can create flash flooding in headwater streams, and this flooding intensifies if these storms coincide with snowpack melting.

3.6.1.3 Wind

Wyoming ranks first in the United States for wind with an annual average speed of 6 meters/second (12.9 miles/hour). During winter, Wyoming frequently experiences periods where wind speed reaches 13 to 18 meters/second (30 to 40 miles/hour) with gusts 22 to 27 meters/second (50 to 60 miles/hour) (Curtis and Grimes, 2004). Prevailing wind direction varies by location but usually ranges from west-southwest through west to northwest. Because the wind is normally strong and constant from those directions, trees often lean to the east or southeast.

3.6.1.4 Evaporation

Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 centimeters (48 inches) in diameter and 25 centimeters (10 inches) tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data are typically available only from May to October. Freezing conditions often prevent collection of quality data during the other parts of the year. Pan evaporation rates in the northeast quadrant of Wyoming range from 89 to 114 centimeters/year (35 to 45 inches/year) (NOAA, 1982).

3.6.1.5 Severe Weather

Hailstorms are the most destructive storm event in Wyoming. Most hailstorms pass over open rangeland with minimal impact. When a hailstorm passes over a city or farmland, the property and crop damage can be severe. Most of the severe hailstorms occur in the southeast corner of the state.

Low elevations typically experience light to moderate snowfall from November to May. Snowfall within Wyoming varies by location with the mountain ranges typically receiving the most. Significant storms of 25 to 40 centimeters (10 to 16 inches) of snowfall are infrequent outside of the mountains (Curtis and Grimes, 2004). Wind often coincides or follows snowstorms and can form snow drifts several meters deep. Snow can accumulate to considerable depths in the high mountains. Blizzards that last more than two days are uncommon.

3.6.2 Smith Ranch Meteorology and Climatology

Appendix D4 of the WDEQ Smith Ranch Permit Update provides a qualitative description of Smith Ranch, Highland and Reynolds Ranch site climatology using the closest official weather station located at the Natrona County International Airport near Casper.

Cameco installed an on-site meteorological station at Smith Ranch in November 2010, which is collecting continuous site-specific data. The first 6 months of data received from the station have been certified and compared with the regional data from the Natrona County airport data. This site-specific data and comparison are provided in the following subsection. Once 12 months of data have been received, they will be analyzed and compared to the regional climatological data to determine representativeness of the regional data to site conditions. This updated report will be submitted to NRC as a supplement to this LRA.

3.6.2.1 Site Specific Meteorological Information

A meteorological station installed at Smith Ranch continuously collects data on wind speed, temperature, relative humidity, precipitation, and solar radiation. **Appendix B, Smith Ranch Meteorological Summary** presents summary data tables for all of the above mentioned variables from November 2, 2010 through August 8, 2011. Wind rose diagrams indicate that wind direction is primarily

out of the west southwest most of the year and more variable in the summer months. Diurnal variation curves are also presented for wind speed, temperature and relative humidity. Average monthly temperatures range from -5°C (23°F) in January to 34°C (93°F) in July. Monthly precipitation totals show that the bulk of annual precipitation falls between April and July, indicative of the region. The data indicate consistency with previous assessments and are similar to the regional data obtained from the National Weather Service (NWS) at the Natrona County Airport.

3.6.3 North Butte Meteorology and Climatology

Appendix D4 and Addendum D4-1 of the North Butte WDEQ Permit Update provide a qualitative description of the North Butte Remote Satellite climatology using the closest official weather station located at the Campbell County Airport near Gillette as well as ten other regional NWS weather stations located within close proximity to the site.

The Antelope Mine weather station is located at Cloud Peak Energy's coal mine, the closest weather station to the North Butte Remote Satellite, 55 miles north of Douglas. Wind speed, direction and stability class in addition to temperature data collected from the Antelope Mine were compared to those collected at the North Butte Remote Satellite. Relative humidity, snowfall, evaporation and degree day data are presented from regional weather stations in Gillette and at the Wyodak Mine, 10 kilometers (6 miles) east of Gillette.

3.6.3.1 Site Specific Meteorological Information

Cameco installed an on-site meteorological station at the North Butte Remote Satellite in November 2010, which is collecting continuous site-specific data. An analysis has been completed comparing the first 12 months of data collected (December 2010 through January 2012). Wind rose diagrams indicate that wind direction is primarily out of the west southwest in the winter months and more variable in the summer months. Diurnal temperature variation curves show that the greatest variation in temperature occurs during the summer daytime period. Average monthly temperatures range from -8°C in February to 24°C in June. Monthly precipitation totals show that April and May were by far the wettest months of the year with 6.6 and 18.3 centimeters (2.6 and 7.2 inches) of precipitation respectively. **Appendix C, North Butte Meteorological Summary** presents summary data tables for all of the above mentioned variables from data collected from December 21, 2010 through January 5, 2012.

3.6.3.2 Comparison of Site Data with Regional Data

Cameco has prepared a comparison of the long term regional data from several weather stations in the area to the site-specific North Butte data. This site specific data and comparison is provided in **Appendix D, North Butte Site and Regional Meteorological Comparison.** Although some variations in wind direction were noted between the regional (Antelope Coal Mine) and the North Butte Remote Satellite due to the local influence of North Butte on the wind direction, the comparison shows that the long term regional climatological data is representative of the North Butte Remote Satellite.

3.6.4 Gas Hills Meteorology and Climatology

The climate of the area surrounding the Gas Hills Remote Satellite is semi-arid and cool. The following climatic and meteorological information for the Gas Hills site is based on the data collected at the Gas Hills 4E NWS station, located at the Gas Hills site, and the Casper NWS station located at the Natrona County International Airport near Casper. The Casper NWS station is 90 kilometers (56 miles) east of the Gas Hills Satellite. The Gas Hills 4E NWS station records temperature and precipitation data only.

Cameco installed an on-site weather station at the Gas Hills Remote Satellite in November 2010. This weather station collected continuous data through 2011; however, due to equipment malfunction the

data are not currently available. All data will be compiled upon receipt from the subcontractor and submitted to NRC as a supplement to this LRA.

Wind conditions at the Gas Hills Remote Satellite are represented by the data collected at the NWS station at Casper. Although there is another first-class NWS station in Lander about 88 kilometers (55 miles) west of the Gas Hills site, the data at this station are not considered representative of the Gas Hills site because of its proximity to the Wind River Mountains. A comparison of wind data at the Casper NWS station and those recorded at the Lucky Mc Mine indicated that the Casper wind data are representative of the Gas Hills site. The Lucky Mc Mine, located adjacent and immediately north of the Gas Hills license area recorded wind data intermittently from September 1978 through January 1983.

At the Gas Hills 4E weather station, July is the warmest month and January the coldest. Based on 34 years of record (September 1962 - July 1996), the mean maximum temperatures are 28.2°C (82.8°F) and 12.1°C (53.7°F) respectively in July and the mean minimum temperatures are -1.6°C (29.1°F) and -1.7°C (10.9°F) respectively in January. The highest and lowest temperatures recorded during this period are 35.6°C (96°F) and -36.7°C (-34°F). The mean annual precipitation at the Gas Hills 4E station is approximately 22.6 centimeters (8.9 inches). About half of the annual precipitation occurs between April and June, while less than a third occurs from October through March. Snow commonly falls as early as October and often as late as May.

From 1964 to 1994, annual snowfall at the NWS station in Casper averaged 200 centimeters (78.8 inches) and no measurable amount of snowfall was observed in July and August. Monthly snowfall amounts are unusually uniform from November through February, but increase slightly during March and April.

Annual-average relative humidity in the area ranges from 64 to 71% for the nighttime hours and from 43 to 46% for daytime hours. The NWS station recording evaporation data nearest to the Gas Hills site is located at the Pathfinder Reservoir about 97 kilometers (60 miles) southeast of the site. Annual mean lake evaporation is estimated at approximately 107 centimeters (42 inches). The U.S. Weather Bureau estimates the mean annual potential evapotranspiration rate for the site to be about 56 centimeters (22 inches). Based on the wind data collected by the EPA in Casper for the period of 1984 through 1992, average wind speed is about 20.8 kilometers/hour (12.9 miles/hour). The dominant wind direction is from the southwest at an average wind speed of about 28.2 kilometers/hour (17.5 miles/hour).

3.6.5 Ruth Meteorology and Climatology

The most recent presentation of meteorological or climatological data associated with the Ruth Remote Satellite is included in the 1988 report entitled "Supplemental Information for Wyoming D.E.Q. Permit to Mine Application and U.S.N.R.C. Source Material License Application" (Ruth Supplemental Report).

Cleveland-Cliffs operated a meteorological data collection program from 1978 to 1979. The meteorological station was located 22.5 kilometers (14 miles) northeast of the Ruth Remote Satellite. Parameters measured include wind speed and direction, temperature, relative humidity and particulate concentrations. Sounding balloons were also used to determine atmospheric stability.

Data from both the Cleveland-Cliffs meteorological data collection program and regional NWS stations in Kaycee, Midwest, Casper, and one additional station 29 kilometers (18 miles) southeast of Gillette are used to describe meteorology and climate conditions at the Ruth Remote Satellite. Sections 8.2 through 8.8 in Volume 1 of "Supplemental Information for Wyoming WDEQ Permit to Mine Application and U.S.N.R.C. Source Material License Application" (Ruth Supplemental Report) presents the results of the

compilation of the most recently analyzed data associated with the Ruth property. The following data are presented in the Ruth Supplemental Report:

1. Table 8.1 – Maximum snowfall amounts.
2. Table 8.2 – Average relative humidity.
3. Tables 8.3 to 8.6 – Regional monthly precipitation.
4. Table 8.7 – Mean sky cover.
5. Tables 8.8 to 8.11 – Regional monthly temperature.
6. Figures 8.2 and 8.3 – Wind rose diagrams.

3.6.5.1 Site Specific Meteorological Information

There is presently no meteorological station in operation at the Ruth Remote Satellite. The Ruth Remote Satellite is 18.5 kilometers (11.5 miles) southwest of the North Butte Remote Satellite. At this time, the contemporary dataset most relevant to Ruth is being collected at North Butte. This data set is described in Section 3.6.3.1. When development commences at the Ruth Remote Satellite, a meteorological station will be established at the site and at least 12 months of climatological data will be collected and assessed.

3.6.6 Air Quality

The WDEQ, Air Quality Division (AQD) has the responsibility to protect, conserve, and enhance the quality of Wyoming's air resource. The AQD helps ensure that the ambient air quality in the State of Wyoming is maintained in accordance with the National Ambient Air Quality Standards (NAAQS). To carry out this goal, AQD operates and maintains a network of ambient air quality monitors and requires industrial sources of air pollutants to conduct source-specific ambient air monitoring. Stations in Wright (56-005-0099) and Casper (56-025-0001) are the closest stations to Smith Ranch. The Casper station has gathered data since the early 1990s and the Wright station has only been operational since 2002.

The Air Quality System (AQS) is a repository of ambient air quality data established by the EPA. AQS stores data from over 10,000 monitors, 5,000 of which are currently active. State (WDEQ AQD), local and Tribal agencies collect the data and submit it to AQS on a periodic basis. The most recent air quality data available on AQS for the State of Wyoming are from 2002. **Table 3.6-1, AQS Data** present tonnage of carbon monoxide (CO), ammonia (NH_3), nitrogen oxides (NOx), particulate matter smaller than 10 micrometers (PM_{10}), particulate matter smaller than 2.5 micrometers ($PM_{2.5}$), sulfur dioxide (SO_2) and volatile organic compounds (VOC).

In 2002, slightly less than 1.4 million tons of air pollutants were reported. Fifty percent of the identified source air pollution is related to highway and off-highway vehicle traffic. In fact, 18% of the total air pollution tonnage reported is carbon monoxide from highway vehicle travel (**Table 3.6-1, AQS Data**). In addition to carbon monoxide, the bulk of the air pollution tonnage reported in 2002 is particulate matter, 85% of which comes from miscellaneous sources. $PM_{2.5}$ concentrations have been very low at most monitoring sites. Wyoming has some of the lowest average concentrations of $PM_{2.5}$ observed in the contiguous United States, as demonstrated by long-term monitoring at Interagency Monitoring of Protected Visual Environments (IMPROVE) sites (Debell et al., 2006). The PM_{10} concentrations across the WDEQ AQD air monitoring network have also been generally low. Overall, the only air quality issues in Wyoming have been associated with oil and gas drilling in western Wyoming.

No potential impacts to NAAQS parameters or PSD Class I, II or III areas are expected to occur as the result of continued Smith Ranch operations. The primary emissions from Smith Ranch, including the North Butte and Reynolds Ranch Remote Satellites, will be tailpipe emissions of nitrogen oxides, carbon

monoxide, sulfur dioxide, non-methane-ethane volatile organic compounds and particulate matter with a diameter less than 10 micrometers (4E-4 inches) resulting from vehicle traffic within the TCEA. The majority of the emissions generated during construction will be fugitive dust and vehicle combustion emissions. Effects of air emissions and impacts associated with construction and operations are discussed in Section 7.2 of the TR.

3.6.6.1 Site-Specific Air Quality – Fugitive Dust

Fugitive dust from vehicular traffic on unpaved roads is the primary emission associated with SUA-1548 operations. Fugitive dust is released by traffic on the main access roads, the secondary access roads to the satellites, and traffic within the mine unit areas. Fugitive dust is also generated from trucks transporting IX resin, yellowcake slurry, chemical deliveries to process facilities, and deliveries of supplies. Employee travel on unpaved roads to the various operating units is also a significant component of the total fugitive dust emissions. Wellfield traffic, including drilling rigs, water trucks, pipe trucks, and geophysical logging trucks provides the largest contribution to fugitive dust emissions.

The fugitive dust estimates were calculated using the methodology provided in the EPA's AP-42 publication. The amount of fugitive dust (PM_{10}) generated during operations can be estimated using equations provided in EPA Publication AP-42. The non-SI (metric) units in the following equations were maintained for consistency with the publication. For reference, the metric conversion from lb/vmt (vehicle mile travelled) to grams (g) per vehicle kilometer travelled (vkt) is as follows:

1lb/vmt = 281.9 g/vkt.

Two equations are provided in U.S. EPA Publication AP-42, *Section 13.2.2 Unpaved Roads* as follows:

$$E = k \times \left(\frac{s}{12}\right)^{a} \left(\frac{W}{3}\right)^{b} \times \left(\frac{365 - p}{365}\right) \quad (1)$$

$$E = \left[\frac{k\left(\frac{s}{12}\right)^{a} \times \left(\frac{S}{30}\right)^{d}}{\left(\frac{M}{0.5}\right)^{c}} - C\right] \times \left[\frac{365 - p}{365}\right] \quad (2)$$

where

E= emission factor (lb/vmt)
C = emissions factor for 1980s fleet exhaust, brake wear and tire wear
a = 0.9 (Industrial Roads, 1.0 Public Roads)
b = 0.45 (Industrial Roads)
c = 0.2 (Public Roads)
d = 0.5 (Public Roads)
k = particle size multiplier –assumed 0.36 (particle ≤10%μm)
s = silt content of road surface material (%) – assume 10%
S = mean vehicle speed (mph)
W= mean vehicle weight (tons)
p = number of days with at least 0.01 inches of precipitation per year – assume 100 days.

Equation 1 is used to estimate emissions from vehicles travelling on unpaved surfaces at industrial sites such as secondary access roads, wellfield roads and other minor roads. Equation 2 provides an estimate of emissions from publicly traveled roads which include unpaved roads to the license area and the main access road at the ISR facility. Reasonable weights were assumed for the various vehicles, and to be conservative, the vehicles were assumed to be fully loaded the entire trip. Again, the most significant emissions source was wellfield traffic followed by employees commuting to the ISR facilities. A summary of the estimated annual fugitive dust emissions (PM10) in metric tons (tons) is provided below.

Smith Ranch is operational and for the purposes of this LRA, baseline conditions are those present in the fall of 2011. Current operations at Smith Ranch are estimated to produce roughly half of the amount of fugitive dust as compared to the long term projections. The North Butte and Gas Hills Remote Satellites are not currently operational; however exploratory drilling programs are running at both locations. Employee pickup trucks, drill rigs, water trucks and backhoe tractors comprise the existing sources of fugitive dust at the remote satellites. There is no current activity at the Ruth Remote Satellite and accordingly no existing sources of fugitive dust.

Facility	Employee Travel	Service or Delivery Trucks	Drilling Support	Construction Traffic	Operations Supply Support	Total Emissions
Smith Ranch	0.0 (0.0)	0.0 (0.0)	51.5 (56.7)	4.0 (4.5)	15.1 (16.7)	70.6 (77.9)
North Butte Remote Satellite	6.7 (7.4)	0.5 (0.6)	2.8 (3.1)	2.7 (3.0)	1.2 (1.3)	14.0 (15.4)
Gas Hills Remote Satellite	17.1 (18.9)	0.0 (0.0)	2.8 (3.1)	1.1 (1.2)	1.2 (1.3)	22.2 (24.5)

*All units are in metric tons (tons)

3.6.7 References

AATA Meteorological Instrument Raw Data Files. Dec. 2010 to Jan. 2012. (North Butte Baseline Year data).

Curtis, J., and K. Grimes. 2004. Wyoming Climate Atlas. Office of the Wyoming State Climatologist, 100 E. University Ave., Laramie, WY 82071, 328 pp. plus data CD. Available online at: http://www.wrds.uwyo.edu/wrds/wsc/climateatlas/title_page.html.

Debell L.J., K.A. Gebhart, W. Malm, M.L. Pitchford, B.A. Schichtel, and W.H. White. 2006. Spatial and seasonal patterns and temporal variability of haze and its constituents in the United States, Report IV, Chapter 2: Spatial distributions of reconstructed mass and mass budgets and reconstructed light extinction and light extinction budgets. Prepared for the Interagency Monitoring of Protected Visual Environments, November.

High Plains Regional Climate Center. March 1902 to December 2010. (Gillette temperature, precipitation and snowfall data).

IML Meteorological Database. 1986 to 2012. (Antelope Mine data).

IML Meteorological Database. 2005 to 2012. (Black Hills Power, Wyodak site relative humididty data).

M.E. Jensen, R.D. Burman, and R.G. Allen. 1990. Evapotranspiration and Irrigation water Requirements , ASCE manuals and Reports on Engineering Practice NO.70 American Society of Civil Engineers NY 1-332.

National Oceanic and Atmospheric Administration (NOAA). 1982. NOAA Technical Report NWS 33 – Evaporation Atlas for the Contiguous United States.

Western Regional Climate Center. 1925 to 2005. (Gillette pan evaporation data).

3.7 Noise

3.7.1 Smith Ranch

ISR operations, rangeland, and wildlife habitat have been the primary land uses within 3 kilometers (2 miles) of Smith Ranch. Other land uses include oil and gas exploration and production, as well as wind farming. There are only four ranch homes in the vicinity of the Smith Ranch. These ranches are the Vollman Ranch, Fowler Ranch, Duck Creek Ranch, and the Boner Ranch. As a result of the remote location of the project and the low population density of the surrounding area, impacts from noise or congestion within the project area or in the surrounding 3 kilometer (2 mile) area are not anticipated. Any existing ambient noise in the vicinity of Smith Ranch is dominated by the ongoing ISR operations and oil and gas exploration and production operations with some additional noise during wind farm construction and operation. Such noise levels include plant operations, road traffic, heavy machinery involved in either well field preparation or reclamation of well fields as well as drilling and pipeline construction activities. There have been no changes in noise generation or receptors since the last renewal.

3.7.2 North Butte Remote Satellite

As with Smith Ranch, rangeland and wildlife habitat have been the primary use for the lands within and surrounding (3 kilometers [2 miles]) the North Butte Remote Satellite. These lands are also being used for CBM production and uranium ISR operations. Within close proximity of the North Butte Remote Satellite, there is one occupied ranch unit, the Pfister Ranch house, which is located approximately 1 kilometer (0.5 mile) south of the satellite license boundary. Due to the remoteness of this location, typical noise levels are relatively low. Any noise created by adjacent land uses, including CBM and nearby ISR uranium recovery operations (i.e., Nichols Ranch and Willow Creek), remains part of the ambient noise levels. The primary difference from the last renewal is that there has been an increase in CBM development and operations within the last 10 years, possibly adding to the ambient noise levels. Additionally, uranium ISR development to the south and west of the North Butte Remote Satellite may add additional ambient noise to the area during the next renewal period. No new permanent receptors have been identified within or adjacent to the North Butte Remote Satellite.

3.7.3 Gas Hills Remote Satellite

Rangeland and wildlife habitat are the primary use for the land within and surrounding the Gas Hills Remote Satellite. Historically, the surrounding area and lands within the Gas Hills Remote Satellite were mined for uranium by conventional mining (both underground and open pit). Currently, there is ongoing mine-land reclamation activity within 3 to 6 kilometers (2 to 4 miles) of the Gas Hills Remote Satellite. Within proximity of the Gas Hills Remote Satellite, the nearest occupied residence is the JE Ranch, which is located approximately 19 kilometers (12 miles) northeast of the satellite license boundary, and is occupied year-round. Due to the remoteness of this location, typical noise levels are relatively low. Any noise created by adjacent land uses, including mine reclamation activities remains part of the ambient noise levels. Because of the distance and topography, construction activities near or within the Gas Hills Remote Satellite do not extend to the nearest occupied residence. There have been no changes in noise generation or receptors since the last renewal.

3.7.4 Ruth Remote Satellite

Because the Ruth Remote Satellite is located only 18 kilometers (11 miles) from the North Butte Remote Satellite, the usage of the area can be likened to that of the North Butte Remote Satellite area. As with the North Butte Remote Satellite, rangeland and wildlife have been the primary use for the lands within and surrounding the Ruth Remote Satellite. These lands are also being used for CBM production. There

are no occupied units within 3 kilometers (2 miles) of the satellite license boundary, and CBM production contributes to the ambient noise levels. Due to the remoteness of this location, typical noise levels are relatively low. Any noise created by adjacent land uses, including CBM, are generally insignificant. The only difference from the last renewal is that there has been an increase in CBM development and operations within the last 10 years, possibly adding to the ambient noise levels. No new receptors have been identified within or adjacent to the Ruth Remote Satellite.

3.8 Historic and Cultural Resources

3.8.1 Smith Ranch

Several detailed historic and cultural resource surveys have been conducted at Smith Ranch and adjacent areas. The surveys and referenced addenda are included in separate volumes in order that the information can be kept confidential. As such, the referenced cultural reports and addenda are not physically attached to Appendix D3 of the Smith Ranch WDEQ Permit. To protect any archaeological resource information as required under 43 CFR 7.8 "Confidentiality of archaeological resource information," the information contained in the addenda is exempt from public disclosure under 10 CFR 9.17(a) (3). An updated affidavit to withhold cultural resource information from public disclosures pursuant to 10 CFR Part 2.390 is being submitted as part of this LRA. The affidavit applies to the remote satellite sites as well as Smith Ranch.

Surveys in the vicinity of the Highland satellites and mine units, (1985 Everest Minerals license application), are included as Addenda D3-1, D3-2, and D3-3A respectively, Archaeology of the Highland Uranium Project (confidential submittal). The North Morton Ranch property was acquired from the TVA in September 1985. Much of the northern portion of the Highland project area of Smith Ranch lies within the former North Morton Ranch permit area. The cultural resource inventory performed as a part of the North Morton application (Permit No. 230C) is provided as Addendum D3-3B (confidential submittal).

A cultural resources inventory of Smith Ranch, Addendum D3-3C (confidential submittal), was surveyed by Kerr McGee Nuclear in 1985 as a part of the South Powder River Basin Solution Mining Project application submitted to WDEQ in April 1988. In 1991, an "Assessment of Effect for the Bozeman Trail Smith Ranch Project" was completed and is provided in Addendum D3-3D (confidential submittal). Prior to expansion of the project, RAMC conducted a Class III cultural resource inventory in December 1998 for areas: T36N, R73W; T35N, R74W; and, T36N, R74W, as described in Addendum D3-4 (confidential submittal). Cameco also performed a Class III Cultural Resources Inventory for the expansion of the boundary to include a 640-acre block in the southwest portion of the licensed area as provided in Addendum D3-5 (confidential submittal).

Cameco surveyed the Reynolds Ranch Satellite area of Smith Ranch in September 1997 (Pronghorn Archaeological Services). The report is provided in Addendum D3-C of Appendix D3 of the Smith Ranch WDEQ Permit. Thirteen sites were located. Six of the sites were deemed historic and seven prehistoric. In addition, 18 isolated artifacts were recorded. All of the sites were considered ineligible for inclusion into the National Register of Historic Places and no further work was recommended for any of these sites. Another assessment of potential impacts to the Bozeman Trail and other historical sites within the Reynolds Ranch area was conducted by RAMC in 1997 (Rosenberg Historical Consultants). This survey is contained within Addendum D3-C (confidential submittal). The assessment included a 5.3 kilometer (3.3 mile) long segment of the Bozeman Trail known as the Holdup Hollow segment (T36N, R74W, Sections 3, 10, and 15), as well as 4 kilometers (2.5 miles) of trail just north of the Reynolds Ranch Satellite license area. The Holdup Hollow segment is listed in the National Register of Historic Places.

The Rosenberg report recommended that no ground disturbing activity of any kind associated with ISR operations, including no exploratory drilling, should occur within the recognized boundaries of the Holdup Hollow segment. As a result of this recommendation, the sections of land in which the Holdup Hollow segment is located were not included in the Reynolds Ranch Satellite license area of Smith Ranch. Therefore, no ground disturbance, ISR operations, nor exploratory drilling will occur in that area, and, as such, there will be no adverse impacts under 36 CFR Part 800.

In addition to the Bozeman Trail, three historic dry-land homesteads were recorded and evaluated. All three sites were considered to be ineligible for listing in the National Register of Historic Places, and a determination of No Effect under 36 CFR 800 was recommended.

If any previously unidentified historical or cultural finds are discovered on the property, they will be protected and the appropriate state and/or federal office notified. See Section 5.8 for specific mitigation measures relating to historic and cultural resources including but not limited to plans surrounding an unanticipated discovery. See Section 4.8 for a discussion of potential impacts to cultural resources.

3.8.2 North Butte Remote Satellite

Two episodes of large-scale cultural resource studies in and around the North Butte Remote Satellite occurred in response to initial plans for uranium mining (1970s) and CBM proposals and later development in the 2000s. The first group of investigations was performed during two studies by the Office of the Wyoming State Archeologist (Walker and Zeimens 1977; Eckles and Welty 1980). The principal investigator for these projects was George M. Zeimens. Map 1 in Exhibit D3-1.1 of Addendum D3-1 of the WDEQ Permit illustrates the areas inspected and the sites recorded by these two studies within the North Butte Remote Satellite license area. Table D3-1.1 of Addendum D3-1 of the WDEQ Permit summarizes the areas evaluated by the two studies.

Due to changing cultural resource standards for inventory, recording techniques and eligibility assessment, studies conducted prior to 1981 are generally not accepted as adequate today. As a result, most of the North Butte Remote Satellite was again evaluated by studies related to CBM development. Most of the North Butte Remote Satellite was inventoried in 2005-2006 for the CBM operator by SWCA Environmental Consultants (Sedar et al. 2006; Scott Slessman, principal investigator). Relatively small parcels of the satellite were inventoried in 2005 by North Platte Archaeological Services (Frizell et al. 2005; Jon Frizell, principal investigator) and in 2006 by Arcadis U.S., Inc. (Graves et al 2007; Adam Graves, principal investigator). The BLM acted as the lead agency for these three CBM investigations because of federal leasing beyond the boundaries of the North Butte Remote Satellite.

In September of 2010, Cameco (LTA, Inc.) conducted a file search for the North Butte Remote Satellite through SHPO's Cultural Records Office (File Search 26209), as well as a Class III cultural resource inventory of three parcels totaling 84 hectares (207 acres) in Section 13, T44N, R76W (Larson and Taylor 2010; Thomas K. Larson principal investigator). These parcels encompass all of the areas within the North Butte Remote Satellite not previously inspected by Frizell et al. (2005), Sedar et al. (2006), or Graves et al. (2007).

Map 2 in Exhibit D3-1.1 of Addendum D3-1 of the WDEQ Permit shows the areas inspected and sites recorded or revisited by the four contemporary studies conducted from 2005 to 2010. Table D3-1.2 of Addendum D3-1 of the WDEQ Permit summarizes the amount of area inspected within the license area by these studies. All of the sites initially recorded by Walker and Zeimens (1977) and Eckles and Welty (1980) within the North Butte Remote Satellite license boundary were revisited and re-evaluated by either Sedar et al. (2006) or Graves et al. (2007).

The cultural resource investigations described in Frizell et al. (2005), Sedar et al. (2006), Graves et al. (2007), and Larson and Taylor (2010) are consistent with the Secretary of Interior's Standards and Guidelines for Archeology and Historic Preservation (http://www.nps.gov/history/local-law/arch_stnds_0.htm) and the format, guidelines, and standards established by SHPO for Class II and Class III reports (http://wyoshpo.state.wy.us/pdf/class3.pdf). The findings and recommendations in all four reports have been reviewed by SHPO and, where appropriate, the federal land management agency. Concurrence correspondence related to these studies is presented in Exhibit D3-1.2 of Addendum D3-1 of the WDEQ Permit.

A total of 16 cultural resource sites are present within the North Butte Remote Satellite (Table D3-1.3 of Addendum D3-1 of the WDEQ Permit). Two of the sites have been determined eligible for the National Register of Historic Places. The remaining 14 sites have been determined ineligible.

The Pumpkin Buttes historic site is an extremely large, discontinuous historic property that encompasses the tops and sides of the physiographic features making up the Pumpkin Buttes – Dome Butte, North Butte, North Middle Butte, South Middle Butte, Indian Butte, and South Butte. In the case of North Butte, the base of the area considered part of the historic site is the 1,609 meter (5,280 foot) contour line. This definition results in the North Butte historic site extending into the northern portion of the North Butte license area (see Map 2, Exhibit D3-1.1 of Addendum D3-1 of the WDEQ Permit).

Studies by Phillips et al. (2006) have led to the determination that the Pumpkin Buttes are eligible for the National Register of Historic Places under Criteria A (associated with events that have made a significant contribution to our history), Criteria B (associated with the lives of significant persons) and Criteria D (have yielded information important in history). Interviews, ethnographic, and ethnohistoric data have also led to the determination that the Pumpkin Buttes qualify as a traditional cultural property (TCP).

The second site is a diffuse scatter of chipped stone artifacts. Test excavations and shovel tests indicate that the site may yield significant scientific information, and has been determined eligible for the National Register of Historic Places.

The SHPO report recommended archeological clearance with the stipulation that, if subsurface cultural remains are found during construction activities the appropriate state and federal agencies will be contacted immediately. Cameco will fully comply with this stipulation. The report also concluded that "no additional investigation is recommended". See Section 5.8 for specific mitigation measures relating to historic and cultural resources including but not limited to plans surrounding an unanticipated discovery. See Section 4.8 for a discussion of potential impacts to cultural resources.

3.8.3 Gas Hills Remote Satellite

A Class III Cultural Resources Inventory was performed over most of the Gas Hills Remote Satellite area in 1992. This survey identified over 30 potential sites and was reviewed by the BLM Lander Resource Office. Only 5 of the 30 potential sites were determined to be potentially eligible for status on the National Register of Historic Places (see Addendum D3-1 to Appendix D3 of the Gas Hills WDEQ Permit). Plates D3-1 and D3-2 in Appendix D3 of the Gas Hills WDEQ Permit show the cultural resource survey area and known sites associated with the 1992 survey.

In May 1997, an intensive Class III cultural resources inventory was conducted for the 1,149 hectares (2,840 acres) not previously inventoried in 1992 at the Gas Hills Remote Satellite. At the conclusion of the 1997 inventory, three previously recorded prehistoric sites were relocated and a Wyoming

Isolate/Short Form was completed for each site. Of the 20 prehistoric sites and 14 isolated artifacts newly recorded in the 1997 inventory, one prehistoric site was assigned a cultural affiliation. Only one site was considered eligible for inclusion on the National Register of Historic Places.

In summary, 1,797 hectares (4,440 acres) of the project area (total area of 3,440 hectares or 8,500 acres) were surveyed for archaeological sites. Additional portions of the project area had been previously surveyed in 1980 and only re-examination of the previously recorded sites was necessary. Of those sites re-examined, two sites were considered eligible for listing on the National Register of Historic Places, and seven sites have not yet been tested sufficiently to determine their eligibility status and must therefore be treated as eligible. A portion of proposed Mine Unit 5 may require a Class III cultural resource inventory prior to commencement of mining related activities. See Section 5.8 for specific mitigation measures relating to historic and cultural resources including but not limited to plans surrounding an unanticipated discovery. See Section 4.8 for a discussion of potential impacts to cultural resources.

3.8.4 Ruth Remote Satellite

In June of 1980, David Eckles, Paula Tibesar and Karin Mallock of the Office of the Wyoming State Archeologist conducted an archeological survey of 16 hectares (40 acres) at the request of Uranerz U.S.A., Incorporated. The survey location is shown on Figure 1, in Section 7 (Appendix "D-3", Archaeology) of the Ruth Supplemental Report. In addition to the survey, a file search was conducted through the Office of the Wyoming State Archeologist – SHPO in May of 1980. No surveys had previously been conducted in the area nor were any previously recorded sites known.

No cultural resources were located during the 1980 survey and archeological clearance was recommended with the stipulation that if subsurface cultural remains were found that the appropriate state and federal agencies be contacted immediately. Remarks related to the paleontological scenic inventories can be found in Section 7 (Appendix "D-3", Archaeology) of the Ruth Supplemental Report. Prior to commencement of ISR activities at the Ruth Remote Satellite, an additional cultural resource survey will be performed to update and confirm the findings of the 1980 survey.

3.8.5 References

Eckles, David, and Larry Welty. 1980. Archeology of the Pumpkin Buttes: Final Report on the Archeological Investigations Carried Out in the Cleveland Cliffs Iron Company North Butte Project Area, Campbell County, Wyoming. Office of the Wyoming State Archeologist, Laramie, Wyoming. Submitted to the Cleveland Cliffs Iron Company.

Frizell, Jon P., Jeffrey Derks, and Elizabeth Frizell. 2005. A Class III Cultural Resource Inventory of the Lance Oil & Gas Savageton 4 POD in Campbell County, WY. North Platte Archaeological Services, Casper, Wyoming. Submitted to the Lance Oil & Gas Company, Inc., Denver, Colorado.

Graves, Natalie, Sam Cason, Omar Ramirez, and Amy Schlenker. 2007. Anadarko Petroleum Corporation Dry Willow Phase 3 POD, Class III Cultural Resource Inventory, Campbell County, Wyoming. Arcadis U.S., Inc., Buffalo, Wyoming. Submitted to Anadarko Production Corporation, Denver, Colorado.

Larson, Thomas K., and Charity Taylor. 2010. Results of a Class III Cultural Resource Inventory for the Cameco Resources North Butte In Situ Uranium Project. LTA, Inc., Laramie, Wyoming. Submitted to Cameco Resources, Casper, Wyoming.

Phillips, Scott, Maxine Seletstewa, Paul Burnett, Joshua McNut, and Stott Slessman. 2006. Pumpkin Buttes Cultural Resources: Ethnohistoric, Ethnographic, and Traditional Cultural Properties Investigations in Campbell and Johnson Counties, Wyoming. SWCA Environmental Consultants, Sheridan, Wyoming. Submitted to the Bureau of Land Management, Buffalo Field Office, Buffalo, Wyoming.

Sedar, Dena, Robert Schweitzer, Alan Hutchinson, Clint Lindsay, and Julie Risenhoover. 2006. Class III Cultural Resources Inventory of the Dry Willow POD 1 Coal Bed Methane Plan of Development, Campbell County, Wyoming. SWCA Environmental Consultants, Sheridan, Wyoming. Submitted to Anadarko Petroleum Corporation, The Woodlands, Texas.

Walker, Danny, and George M. Zeimens. 1977. An Inventory of Archeological Resources on the Browns Ranch Uranium Project. Office of the Wyoming State Archeologist, Laramie, Wyoming. Submitted to the Tennessee Valley Authority.

3.9 Visual and Scenic Resources

3.9.1 Proposed Action

Visual resources at SUA-1548 had not been described in the past as it did not become an application or renewal requirement until the publication of NUREG-1569 and 1748 in 2003, two years after the approval of the previous LRA. Therefore, Cameco is providing a visual resources description of SUA-1548 in this section. Section 4.9 discusses potential impacts to SUA-1548 visual resources due to the proposed action, no-action, and the alternative action scenarios. Smith Ranch is a mix of private, state, and public lands. The public lands within Smith Ranch comprise approximately 1,214 hectares (3,000 acres) or approximately 8% of the total area within the Smith Ranch boundary and are administered by the Casper Field Office of the BLM. The North Butte Remote Satellite is located completely on private land. North Butte is located in prairie landscape of the Powder River Basin southwest of Gillette and near the Pumpkin Buttes. Although the remote satellite does not contain any public lands, it is within close proximity to public lands that are administered by the Buffalo Field Office of the BLM. The Gas Hills Remote Satellite is located approximately 129 kilometers (80 miles) west of the Southern Powder River Basin, within the Wind River Basin, and has lands that are administered by the Lander Field Office of the BLM. The Ruth Remote Satellite is located on the southwest flank of the Pumpkin Buttes District, approximately 18 kilometers (11 miles) southwest of the North Butte Remote Satellite. The lands for the Ruth Remote Satellite are a mixture of private and public lands, the latter of which are administered by the Buffalo Field Office of the BLM.

3.9.2 General Visual Resource Management Methodology

The BLM has inventoried visual resources of all lands within the boundaries of the Buffalo, Casper, and Lander Field Offices including private lands, with the Visual Resource Management (VRM) system. The VRM system is the basic tool used by the BLM to inventory and manage visual resources on public lands. The VRM inventory process involves rating the visual appeal of a tract of land, measuring public concern for scenic quality, and determining whether the tract of land is visible from travel routes or observation points.

3.9.2.1 Visual Resource Management Classes

The VRM system is based on research that has produced ways of assessing aesthetic qualities of the landscape in objective terms. In accordance with the BLM Handbook H-8410-1, a visual resource can be

evaluated using three categories. These categories include scenic quality, visual sensitivity levels, and distance zones, as described below:

Scenic Quality – A measure of the visual appeal of a tract of land. In the visual resource inventory process, public lands are assigned an A, B, or C rating based on the apparent scenic quality, which is determined using seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. During the rating process, each of these factors is ranked comparatively against similar features within the physiographic province.

Visual Sensitivity Level – A degree or measure of viewer interest in the scenic qualities of the landscape. Factors to consider include (1) type of users; (2) amount of use; (3) public interest; (4) adjacent land uses; and, (5) special areas. Three levels of sensitivity have been defined:

- Sensitivity Level 1 – The highest sensitivity level, referring to areas seen from travel routes and use areas with moderate to high use.
- Sensitivity Level 2 – An average sensitivity level, referring to areas seen from travel routes and use areas with low to moderate use.
- Sensitivity Level 3 – The lowest sensitivity level, referring to areas seen from travel routes and use areas with low use.

Distance Zones – Areas of landscapes denoted by specified distances from the observer, particularly on roads, trails, concentrated-use areas, rivers, etc. The three zones are foreground-middleground, background, and seldom seen.

- Foreground-Middleground – The area is visible from a travel route, use area, or other observer position to a distance of 5 to 8 kilometers (3 to 5 miles). The outer boundary of this zone is defined as the point where the texture form of individual plants are no longer apparent in the landscape and vegetation is apparent only in pattern or outline.
- Background – The viewing area of a distance zone that lies beyond the foreground and middleground. This area usually measures from a minimum of 5 to 8 kilometers (3 to 5 miles) to a maximum of approximately 24 kilometers (15 miles) from a travel route, use area, or other observer position. Atmospheric conditions in some areas may limit the maximum to about 13 kilometers (8 miles) or increase it beyond 24 kilometers. Vegetation should be visible at least as patterns of light and dark.
- Seldom Seen – The area is screened from view by landforms, buildings, other landscape elements, or distance.

The visual resource inventory categories described above are used to develop VRM classes, which are generally assigned by the BLM through the resource management plan process. VRM objectives are developed to determine how the land should be managed to protect the scenic quality of the lands, especially those lands that receive the greatest amount of public viewing. The following four VRM class objectives outline the amount of disturbance an area can tolerate before it no longer meets the visual quality of that class.

- **Class I Objective**: To preserve the existing character of the landscape. This objective provides for natural ecological changes but also does not preclude very limited management

activity. The level of change to the characteristic landscape should be very low and must not attract attention.

- **Class II Objective**: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of a casual observer. Any changes must repeat the basic elements of form, line, color and texture found in the predominant natural features of the characteristic landscape.
- **Class III Objective**: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
- **Class IV Objective**: To provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance and repeating the basic elements.

The Scenic Quality, Sensitivity Level, and Distance Zone inventory levels are combined to assign the VRM Class to inventoried lands as shown in the following matrix:

Determining BLM Visual Resource Inventory Classes								
Visual Sensitivity		High			Medium			Low
Special Areas		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	III	IV	III/IV	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
Distance Zones		f/m	b	ss	f/m	b	ss	ss
f/m = foreground-middleground (0-5mi) b = background (5-15mi) ss = seldom seen (>15mi)				A = 19 or more B = 12-18 C = 11 or less				

Site-specific VRM evaluations were conducted at Smith Ranch and the North Butte, Gas Hills, and Ruth Remote Satellites during 2011 using the methodology provided in BLM Handbook 8410-1 as well as a review of the factors contributing to the existing Class IV inventory for Smith Ranch and the Ruth Remote Satellite, and Class II and III for the North Butte and Gas Hills Remote Satellites.

3.9.3 Smith Ranch Visual Resource Management Rating

The existing condition of the Smith Ranch license area was measured for visual resources. No developed parks or recreation areas are located within the VRM study area and the area is a producing ISR operation. The landscape is characterized by a gently rolling topography with large open expanses of upland grasslands, pasture, and sagebrush shrubland dissected by ephemeral drainages that seasonally drain the adjacent uplands. There are also altered areas of landscape within the area, including ranch residences, wind energy farms, oil production facilities, roads, overhead utility lines and electrical substations, fences, stock tanks, livestock water windmills, and uranium production facilities. These latter production facilities consist of well fields, monitor wells, access roads, buildings, processing facilities and fences. A wind energy farm is located immediately west of the study area. A site-specific VRM evaluation was conducted in 2011 at Smith Ranch utilizing the methods described above as well as

a review of the factors that contribute to the existing VRM Class IV inventory for the area. 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 ranged 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. The results of the inventory and the associated score for each key factor are summarized in **Table 3.9-1, Scenic Quality Inventory and Evaluation for Smith Ranch**. According to the NRC NUREG-1569, if the visual resource evaluation rating is less than 19, no further evaluation is required. Based on field reconnaissance conducted in July 2011 the total score of the scenic quality inventory for Smith Ranch is 5; therefore, no further evaluation of existing scenic resources is required. Further, no significant changes to the scenic resources are anticipated.

Photo 3.9-1, Smith Ranch Area presents photographs of the view from the scenic quality evaluation site as well as photographs taken from nearby roads and structures. As indicated by **Photo 3.9-1, Smith Ranch Area**, Smith Ranch is not visible beyond a distance of approximately 16 kilometers (10 miles) in all directions due to low-lying hills that surround the site. When viewing the area from the north, it is no longer visible from a distance of approximately 8 kilometers (5 miles) due to these low-lying hills (see **Photo 3.9-1A**.

Photo 3.9-1, Smith Ranch Area

Photo A - Looking north towards Smith Ranch as seen from the corner of Highway 31 and Highway 93; approximately 16 kilometers (10 miles) south of the site boundary.

Photo B - Looking north towards Smith Ranch as seen from Ross Road; approximately 8 kilometers (5 miles) south of the site boundary.

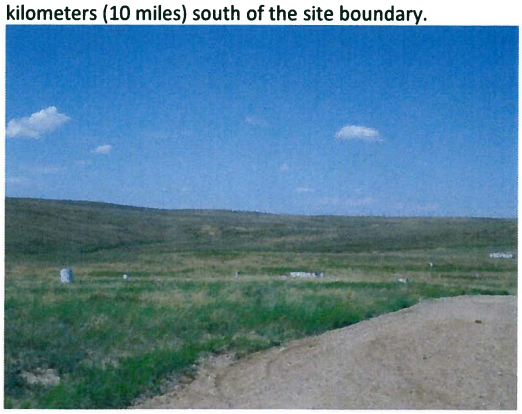

Photo C - Looking west from the eastern boundary of Smith Ranch as seen from Wellfield H Road.

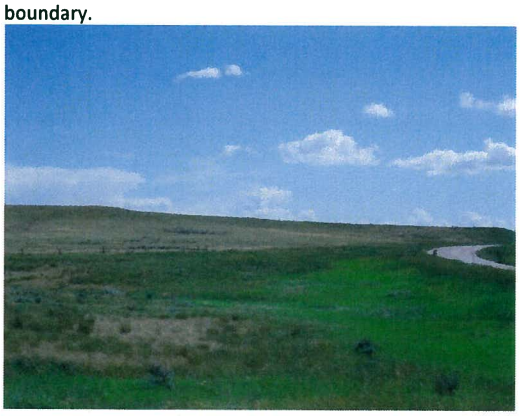

Photo D - Looking south towards Smith Ranch as seen from Ross Road; approximately 8 kilometers (5 miles) north of the site boundary.

3.9.4 North Butte Visual Resource Management Rating

The area considered for visual resources includes the North Butte Remote Satellite and a surrounding 3 kilometer (2 mile) area. The BLM has rated approximately half of the area, the northwestern portion in the vicinity of the North Butte Remote Satellite, as Class II, while the other half has been assigned a rating of Class III. The remote satellite is located on the south flank of the North Butte in the Pumpkin Buttes District. The landscape is characterized by gently rolling hills and low ridges, as well as steep terrain near the North Butte and some deeply eroded areas associated with Willow Creek, an ephemeral drainage located near the southern boundary of the project site. The area is dissected by a series of ephemeral drainages that generally drain southward toward Willow Creek. Altered areas of landscape within the study area include oil production facilities, CBM facilities, ranch residences, overhead utility lines, roads, fences, stock tanks and monitor wells. The Pumpkin Buttes are the most important visual resource in the area.

The results of the site-specific inventory and the associated score for each key factor are summarized in **Table 3.9-2, Scenic Quality Inventory and Evaluation for the North Butte Satellite.** Based on field reconnaissance conducted in 2011 the total score of the scenic quality inventory for the North Butte Remote Satellite is 17; therefore, no further evaluation of existing scenic resources is required. Furthermore no significant changes to the scenic resources are anticipated.

Photographs taken at the North Butte Remote Satellite in the four cardinal directions as well as photos taken from nearby roads and homes are included in **Photo 3.9-2, North Butte Remote Satellite Area.** As shown in **Photo 3.9-2, North Butte Remote Satellite Area**, the North Butte Remote Satellite is not visible beyond a distance of approximately 16 kilometers (10 miles) in all directions due to low-lying hills that surround the site. The site does, however, become partially visible from a distance of approximately 8 kilometers (5 miles) in all directions except from the north. From the north, there is no visibility of the remote satellite.

3.9.5 Gas Hills Visual Resource Management Rating

The area considered for visual resources includes the Gas Hills Remote Satellite and a surrounding 3 kilometer (2 mile) area. The remote satellite encompasses one BLM rating: Class IV. The site is located approximately 129 kilometers (80 miles) west of the Southern Powder River Basin District, where Smith Ranch is located. The landscape is characterized by gently rolling hills, deeply dissected drainages, badland topography to the west, extensive remnants of past mining practices including reclaimed mine pits and waste dumps, low ridges, and the predominant Beaver Rim. The drainage pattern originates from the Beaver Rim and flows towards the north into West Canyon Creek, which is the dominant drainage on the eastern portion of the license area. Fraser Draw, which is the dominant drainage on the western portion of the license area, is blocked by a large mine dump and open pit mine and does not flow through. All drainages are ephemeral except where a spring provides a short reach of intermittent flow. Cameron Springs is the dominant water body in the area and exists year round. Altered areas of landscape within the remote satellite area include conventional mined and reclaimed properties both within and adjacent to the remote satellite area, monitoring wells, Carol Shop, a radium treatment building, roads, and fences. The Beaver Rim is the most important visual resource in the area.

The results of the site specific inventory and the associated score for each key factor are summarized in **Table 3.9-3, Scenic Quality Inventory and Evaluation for the Gas Hills Satellite Area**. Based on field reconnaissance conducted in 2008, the total score of the scenic quality inventory for Gas Hills Remote Satellite is 10; therefore, no further evaluation of existing scenic resources is required. Furthermore, no significant changes to the scenic resources are anticipated.

Photo 3.9-2, North Butte Remote Satellite Area

Photo A - Looking west towards the North Butte Remote Satellite as seen from Van Buggenum Road; approximately 24 kilometers (15 miles) from site boundary.

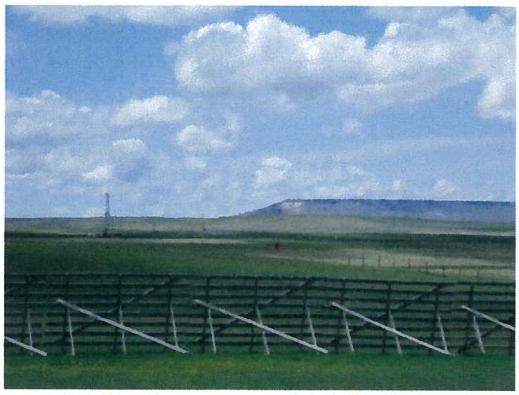

Photo B - Looking west towards the North Butte Remote Satellite as seen from Van Buggenum Road; approximately 16 kilometers (10 miles) from site boundary.

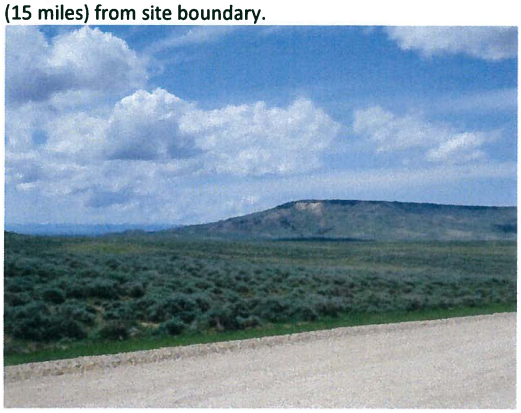

Photo C - Looking west towards the North Butte Remote Satellite as seen from Van Buggenum Road; approximately 8 kilometers (5 miles) from site boundary.

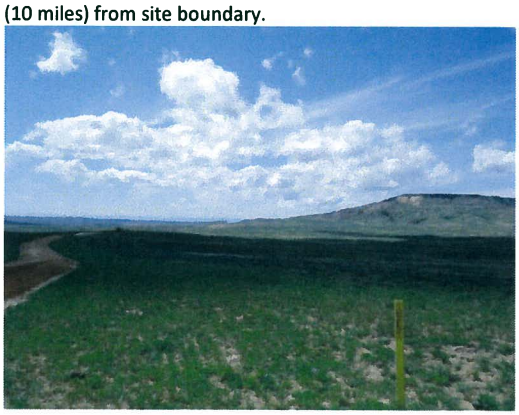

Photo D - Looking west from the eastern boundary of the North Butte Remote Satellite as seen from Christensen Road.

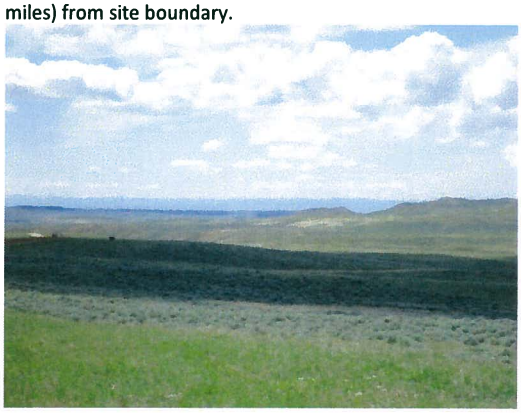

Photo E - Looking west from the northeastern corner of the North Butte Remote Satellite as seen from Christensen Road.

Photo F - Looking north from the southeastern corner of the North Butte Remote Satellite as seen from Christensen Road.

Photographs taken at the Gas Hills Remote Satellite are included in **Photo 3.9-3, Gas Hills Remote Satellite Area.** As shown in **Photo 3.9-3, Gas Hills Remote Satellite Area**, the Gas Hills Remote Satellite is not visible beyond a distance of approximately 16 kilometers (10 miles) to the west due to the presence of the Beaver Rim. The Beaver Rim also prevents the remote satellite from being visible from a distance of approximately 2 kilometers (1 mile) from the south. In all other directions, the site is visible for approximately 16 kilometers (10 miles) only, due to low-lying hills and other landforms that exist in the distance.

Photo 3.9-3, Gas Hills Remote Satellite Area

Photo A - Looking south towards the Beaver Rim from within the remote satellite boundary.

Photo B - Looking southwest from within the remote satellite boundary. Note Carol Shop on the right-hand side.

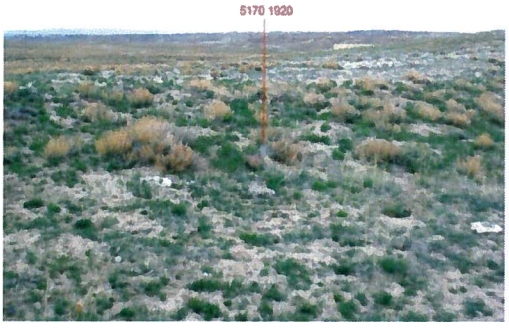

Photo C - Looking west from within the remote satellite boundary. Note Carol Shop on the right-hand side.

Photo D - Looking northwest from within the remote satellite boundary. Note the mine spoils and reclamation in the background.

Photo E - Looking south from within the remote satellite boundary. Note the mine reclamation in the foreground.

3.9.6 Ruth Visual Resource Management Rating

The area considered for visual resources includes the Ruth Remote Satellite and a surrounding 3 kilometer (2 mile) area. The remote satellite area encompasses a BLM rating of Class IV, and is located on the southwest flank of the Pumpkin Buttes District, approximately 18 kilometers (11 miles) southwest of the North Butte Remote Satellite. The landscape is characterized by gently rolling hills, plains, and low ridges. Altered areas of landscape within the remote satellite include a processing plant, a warehouse, a generator building, three monitoring wells, two evaporation ponds, and one access road. The Pumpkin Buttes are the most important visual resource in the area.

The results of the site-specific inventory and the associated score for each key factor are summarized in **Table 3.9-4, Scenic Quality Inventory and Evaluation for the Ruth Satellite Area.** Based on field reconnaissance conducted in 2010, the total score of the scenic quality inventory for the Ruth Remote Satellite is 5; therefore, no further evaluation of existing scenic resources is required. Furthermore, no significant changes to the scenic resources are anticipated.

The Ruth Remote Satellite is shown in **Photo 3.9-4**. The Ruth Remote Satellite is not visible beyond a distance of approximately 16 kilometers (10 miles) in all directions due to low-lying hills that surround the site. The site does, however, become partially visible, from a distance of approximately 8 kilometers (5 miles) in all directions.

Photo 3.9-4, Ruth Remote Satellite Area

Looking north from within the remote satellite boundary. Note the old Research & Development processing building (tan), the warehouse building (silver), and the generator building (brown) on the left-hand side.

3.9.7 References

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). Buffalo Resource Management Plan. http://www.blm.gov/rmp/WY/application/rmp_toc.cfm?rmpid=101. Accessed May 24, 2011.

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). 2007 Visual Resource Inventory. BLM Handbook 8410-1. 2007.

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). 2007. Visual Resource Contrast Rating. BLM Manual 8431. 2007.

3.10 Socioeconomics

3.10.1 Introduction

Information presented in this section is directly related to the demographic and social characteristics of the counties and communities that may be affected by SUA-1548 operations pursuant to NUREG-1748. For each location, Smith Ranch and the North Butte, Gas Hills and Ruth Remote Satellites, pursuant to NRC Regulatory Guide 3.46, a perimeter or boundary with an 80 kilometer (50 mile) radius was identified to incorporate surrounding counties and communities into the socioeconomic analysis. All counties that predominately lie within the 80 kilometer (50 mile) boundary for each site are described below and are used to determine the demographic and social characteristics that could be affected under this LRA (January 2012). Counties that cover a small percentage of the 80 kilometer (50 mile) boundary and are not anticipated to have any significant impacts on demographic or social characteristics are not included in the socioeconomic analysis.

Smith Ranch is located in western Converse County. The 80 kilometer (50 mile) boundary covers portions of eight counties in northeastern Wyoming (Campbell, Converse, Natrona, Albany, Johnson, Niobrara, Platte, and Weston County). Because only a small portion of the 80 kilometer (50 mile) radius around Smith Ranch extends into Albany, Platte, and Weston Counties, these three counties are not addressed in the data analysis in Section 3.10.2.

The North Butte Remote Satellite is located in southwestern Campbell County, with its 80 kilometer (50 mile) radius extending into portions of Natrona, Converse and Weston Counties. Similar to Smith Ranch, Weston County is largely unaffected by development at North Butte and is not included in the data analysis in Section 3.10.3.

The Gas Hills Remote Satellite is located in Fremont County, but the 80 kilometer (50 mile) radius also includes parts of Natrona, Carbon, Sweetwater, Hot Springs, and Washakie Counties. Both Hot Springs and Washakie Counties make up less than 10% of the 80 kilometer (50 mile) boundary and do not significantly impact socioeconomics in and around the Gas Hills license area. These two counties are omitted from the data analysis in Section 3.10.4.

The Ruth Remote Satellites is located in southeastern Johnson County and includes portions of Natrona, Converse and Weston Counties within its 80 kilometer (50 mile) radial boundary. Similar to North Butte, Weston County is not addressed in the socioeconomic analysis in Section 3.10.5.

3.10.2 Smith Ranch (Converse County)

3.10.2.1 Demography

3.10.2.1.1 Regional Population

Figure 3.10.1, Population Centers within 80 kilometers of the Smith Ranch Project shows the five significant counties that are partially encompassed by the 80 kilometer (50 mile) radius surrounding Smith Ranch, which are Converse, Campbell, Johnson, Natrona, and Niobrara. The nearest communities from Smith Ranch are Glenrock, a Converse County incorporated town located southwest of the site on Highway 20, and the cities of Casper and Douglas. Casper is located southwest of Smith Ranch in Natrona County, and Douglas is located southeast of Smith Ranch in Converse County. Both Casper and Douglas are located along Highway 20 and I-25.

Historical and current population trends in counties and communities within an 80 kilometer distance of the Project are shown in **Table 3.10-1, 1980-2008 Historical and Current Population Change for Counties and Communities within the 80 kilometer Radius of Smith Ranch**, which summarizes past

growth trends in the counties relative to state population trends between 1980 and 2008. The largest growth rates in the five-county region since 2000 occurred in Campbell, Johnson, and Natrona counties, primarily because of ongoing mineral and oil and gas resource development in the Powder River Basin (U.S. Department of Commerce, 1980-2008). Between 1980 and 1990, the state population declined primarily because of declines in historic agricultural economic sectors, while the high growth rates in Campbell, Johnson, and Converse Counties indicated boom years in oil, coal, and gas development during this decade. The population in Converse County grew at a slower rate between 2000 and 2008 than in previous decades, and therefore the growth rates are more in line with state growth rates. The overall county and state economies are more diverse in the current decade than they were during the 1980s.

3.10.2.1.2 Population Characteristics

The 2009 population by age and sex for counties within 80 kilometers of Smith Ranch is shown in **Table 3.10-2, 2010 Population by Age and Sex for Wyoming and the Counties within the 80 kilometer Radius of Smith Ranch.** Overall, the 40- to 64-year age group (which includes the 'baby boom' cohort) is the largest age group in each of the counties. According to the Wyoming Economic and Demographic Forecast (Wyoming Department of Administration & Information: Economic Analysis Division (WDAI EAD), 2005), from 2005 to 2014, the early baby boom population in Wyoming will be one of the highest in the nation as a result of the influx of workers during the oil boom years in the late 1970s and early 1980s. In contrast, the population of the 27- to 42-year age group is relatively low because there was a high net outflow (outflow greater than inflow) in this age group between 1995 and 2000 as young adults left the state during the declining economy (WDAI EAD, 2000c).

In 2009, an average of 94% of the five-county population was classified as white. Native American persons comprised an average of 1% (U.S. Department of Commerce, 2010a), while persons of Hispanic origin comprised an average of 6% out of the total five-county population of 146,469 (U.S. Department of Commerce, 2010a). The populations in all other racial categories account for less than 1% of the total population when averaged among the five counties. The racial characteristics of each county were similar to the racial characteristics of the state of Wyoming as a whole.

3.10.2.1.3 Population Projections

The projected populations for selected years by county within the 80 kilometer radius of Smith Ranch are shown in **Table 3.10-3, 2000-2030 Population Projections for Wyoming and the Counties within the 80 kilometer Radius of Smith Ranch.** The population projections between 2010 and 2030 anticipate that the relatively stable population trends evident between 2000 and 2010 will continue for the selected counties and the state as a whole. The projected population growth in Campbell and Johnson Counties will continue to outpace population growth in the state as a whole in response to ongoing and potential new mineral development projects located in these counties. The population of Niobrara County will experience very slow growth or perhaps even a decline in population, indicating that it is not anticipated to see influx of new residents seeking employment in the mineral development of nearby counties. It is not expected that there will be the large influx of populations that were typical of the 1980s (WDAI EAD, 2000b).

3.10.2.1.4 Seasonal Population and Visitors

Smith Ranch and its satellites in Converse County consist of a mix of private, state and federal lands. The surrounding area within an 80 kilometer (50 mile) radius contains mostly private lands, but also some federal and state lands, which provide open space for a variety of dispersed outdoor recreational opportunities. No developed recreational opportunities are provided on federal and state lands within the 80 kilometer (50 mile) radius.

According to the official State of Wyoming website (Wyoming State Parks, Historic Sites, and Trails), the main documented trails located within the 80 kilometer (50 mile) area are the Casper Mountain Trails and the Muddy Mountain Trails. The Casper Mountain Trails are located approximately 7 kilometers (4 miles) south of Casper on Casper Mountain, and the Muddy Mountain Trails are located approximately 29 kilometers (18 miles) south of Casper in the Laramie Mountains. Visitation statistics are not compiled for these trails (Rails-to-Trails, 2011).

Included in the northeastern portion of the 80 kilometer (50 mile) boundary, north of Douglas and located in the Powder River Basin, is the Thunder Basin National Grassland. Approximately half of the Thunder Basin National Grassland is included within the 80 kilometer (50 mile) boundary, located approximately 55 kilometers (34 miles) east of Smith Ranch. Recreational activities in this area include hiking, hunting, fishing, and bird and wildlife viewing. Camping is also allowed in the area, but there are no developed campgrounds or recreational facilities within the National Grassland. Recreational use accounted for an average of 64,100 Recreation Visitor Days annually between 1992 and 1996 (Wyoming Tourism, 2010).

Also included in the 80 kilometer (50 mile) boundary, south of Glenrock and Douglas, is the Medicine Bow National Forest. Recreational activities in this area include rock-climbing, rafting, boating, fishing, hiking trails, and camping. French Creek campground is a developed campground found within the 80 kilometer (50 mile) boundary (U.S. National Forest, 2011).

A primary source of seasonal population for Smith Ranch and the remote satellites is short-term labor for mineral resource development, construction, and service industries engaged in tourism/recreation. A review of reports prepared by the Wyoming Economic Analysis Division indicates that these workers are most likely to relocate temporarily from neighboring counties and states including Montana, Nebraska, Colorado, and South Dakota. The seasonal labor force for these economic sectors is not included in any available population or labor force data for the counties.

3.10.2.1.5 Schools

Smith Ranch is located within Converse County School District #2, which serves approximately half of Converse County. The nearest Converse County community that provides educational services to residents in the vicinity of Smith Ranch is Glenrock, which is located approximately 29 kilometers (18 miles) southwest of Smith Ranch on Highway 20. Three schools are located in Glenrock: Grant Elementary School serves K-4; Glenrock Middle School serves grades 5-8; and Glenrock High School serves grades 9-12. Total enrollment in these three schools for the 2010-2011 school year was 242 in the elementary school, 108 in the middle school, and 233 in the high school (Wyoming Department of Education, 2011). The elementary school currently has a student to teacher ratio of 11:1, the middle school currently has a student to teacher ratio of 7:1, and the high school also has a student to teacher ratio of 11:1 (Converse County School District 2, 2011).

The Natrona County school system provides classes for students from preschool through grade 12. Enrollment for the 2009-2010 school year was 11,500 and includes not only the city of Casper, but also the surrounding towns of Alcova, Bar Nunn, Edgerton, Evansville, Mills, Midwest, and Powder River. Starting in the 2007-2008 school year, average class sizes have been decreased to 17:1 (student to teacher ratio) (Natrona County, 2011).

3.10.2.1.6 Sectorial Population

Existing population within the 80 kilometer (50 mile) radius centered on Smith Ranch was estimated for 16 compass sectors, by concentric circles of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70, and 80 kilometers

from the center of Smith Ranch, for a total of 208 sectors. Sectorial population was estimated with data from the U.S. Census Bureau's Population Estimates Program. Subtotals by sector and compass points, as well as the total population, are shown in **Table 3.10-4, 2010 Population within the 80 kilometer Radius of Smith Ranch.**

The most recent available population data were acquired from the 2010 U.S. Census Bureau for each of the individual towns within the 80 kilometer (50 mile) radius. Using Google Earth, the individual ranches were counted within the 80 kilometer (50 mile) radius, as well as any outlying homes that did not fit within nearby city or town limits. These ranches and outlying homes were counted separately from the city and town population data. Each ranch was assigned a general population of four people, while each outlying home was assigned a population of two since the average household size in Wyoming is approximately two people, according to the 2010 U.S. Census. Using these methods, the total current population within the 80 kilometer (50 mile) radius from the center of Smith Ranch is approximately 75,420 people (U.S. Department of Commerce, 2000-2010b). These methods of determining the sectorial population counts were used for Smith Ranch and the three remote satellites.

Some of the sectors throughout the 80 kilometer (50 mile) radius contain mostly BLM administered public lands and do not contain any residents, and were therefore assigned a zero population. Most of the area within the 80 kilometer (50 mile) radius is rural, with the majority of the population residing in the small communities near Smith Ranch or in larger urban areas in the sectors farthest from Smith Ranch. Some of the urban areas include the towns of Douglas, located approximately 41 kilometers (26 mile) south-southeast of Smith Ranch; Glenrock, located approximately 29 kilometers (18 mile) southwest of Smith Ranch; Edgerton, located approximately 61 kilometers (38 mile) to the northwest; and Midwest, located approximately 63 kilometers (39 mile) to the northwest. The City of Casper is located approximately 58 kilometers (36 mile) to the west-southwest of Smith Ranch.

All urban areas, including the City of Casper, are completely encompassed by the outermost perimeter of the 80 kilometer (50 mile) radius. Therefore, all Census Tracts and Block Groups within these urban areas were included in the 80 kilometer (50 mile) radius from Smith Ranch.

The population within approximately 3 kilometers (2 miles) of Smith Ranch was estimated by locating occupied residences using 2009 aerial photos through Google Earth. The 2000 U.S. Census blocks (blocks are subdivisions of block groups) included in this area were reviewed for the total number of people residing within housing units inside the census blocks. There are no individual block data available for the intercensal years of the U.S. Census Population Estimates Program.

3.10.2.2 Local Socioeconomic Characteristics

3.10.2.2.1 Major Economic Sectors and Labor Forces

Smith Ranch is located in Converse County. However, social and economic characteristics are also described for Natrona County because communities in Natrona County, primarily the City of Casper, provide a relatively large resident labor force for mineral extraction and construction industries in central Wyoming. A substantial portion of the project labor force is likely to be based in Natrona County, primarily residing in the City of Casper. **Table 3.10-5, 2009 Annual Average Labor Force Characteristics and Employment in Economic Sectors for State of Wyoming and Converse County** summarizes unemployment rates and employment in Converse and Natrona Counties (Wyoming Department of Employment (WDE), 2009).

The economy of Converse County depends on the energy sector, primarily that which is mineral-based. The largest employment sector in Converse County is mining, which includes coal and uranium mining.

Additionally, oil and gas extraction, CBM, crude petroleum-natural gas, and gas field service, nonmetallic minerals, and recent wind farm installation and operation, as defined by the U.S. Bureau of Labor Statistics, add to the Converse County employment sector.

A report prepared by the U.S. Bureau of Labor Statistics analyzed the labor supply in Wyoming by place of residence. The analysis concluded that a portion of the available labor pool in Wyoming consists of non-residents. According to the report, approximately 11% of the available labor pool consisted of non-resident workers in 2007.

Table 3.10-5 shows the projected labor force characteristics in Converse County in 2010. In general, unemployment rates were high in the early 1990s and decreased until 2008, whereupon the unemployment rates began to rise once again. The unemployment rates have continued to increase into 2010, but fluctuate throughout any individual year. Annual fluctuations in unemployment rates are driven primarily by short-term changes in production due to changing prices for coal, uranium, oil, and CBM.

Table 3.10-6, Labor Force Statistics for Smith Ranch uses Census Bureau information from the 1990 and 2000 censuses and from 2005-2009 American Community Survey (ACS) five-year estimates of the labor force and employment rates in recent years in the vicinity of Smith Ranch (U.S. Department of Commerce, 2009). Both labor force and employment have increased in the 2005-2009 estimates in all neighboring counties and towns within the 80 kilometer (50 mile) radius from Smith Ranch except for the town of Wright and Glenrock, both of which demonstrated a predicted decrease in population from the year 2000 to 2009 (U.S. Department of Commerce, 2000a), (U.S. Department of Commerce, 2005-2009).

Wyoming's economy is driven primarily by mineral extraction, including extraction of coal, natural gas, crude oil, and trona. The mining sector, which is the single biggest contributor to Wyoming's GDP, grew from $2.65 billion in 1999 (17% of the total state GDP) to $13 billion (34% of the total GDP) in 2009 (Bureau of Economic Analysis, 2010). Other major contributors to the state's GDP include government ($5 billion in 2009), real estate and rental leasing ($3 billion), manufacturing ($2 billion), transportation and warehousing ($2 billion), retail trade ($2 billion), and construction ($2 billion).

In the current recession (2007 to the present), Wyoming lagged the United States by approximately one year; the state's economic recession did not begin until 2008 (WDAI EAD 2010). Additionally, the state's overall unemployment rate did not fall as much as the U.S., sitting at 8% in the first quarter of 2010 compared to an average of 10% for the country as a whole. Wyoming's unemployment rate has been lower than that of the U.S. for the last 10 consecutive years.

3.10.2.2.2 Housing

The nearest permanent housing is located in the communities of Glenrock and Douglas in Converse County, and Casper in Natrona County. According to the 2010 U.S. Census, there were 1,201 housing units in Glenrock. Of these units, the average occupancy rate was 92%. A housing unit is any unit that represents a more permanent living situation, and therefore does not include apartments, mobile homes, recreational vehicles (RV), or any other dwelling unit that may be considered temporary. The vacancy rate for all types of housing units was 8%. In Douglas, there were a total of 2,788 housing units, and of these units, the average occupancy rate was 91%. The vacancy rate for all types of housing units was approximately 9%. In Natrona County, there were 24,536 housing units in Casper, of which 93% were occupied. The vacancy rate was 7% (WDE, 2011b; WDE, 2011e).

It is likely that current vacancy rates in Glenrock and Douglas will decrease as a result of insufficient housing stock and increasing influx of workers for employment in ongoing mineral resource development. A rental vacancy survey shows that rental vacancy rates in Converse County have increased from approximately 4% in 2001 to approximately 6% in 2010 (**Table 3.10-7, Housing Characteristics and the Average Rental Rates in Fourth Quarter 2010 and Change from Fourth Quarter 2009 for Counties within an 80 kilometer Radius of Smith Ranch**). However, the rental vacancy rates in Converse County have decreased over the last year, from approximately 7% in 2009 to approximately 5% in 2010. In Natrona County, the rental vacancy rate has also decreased from a rate of approximately 5% in 2002 to approximately 4% in 2010. The influx of population in these counties as a result of economic growth stimulated by CBM and coal production has outstripped the available housing supply (WDE, 2011b; WDE, 2011e).

Urban areas within Converse and Natrona Counties are generally within a one to two-hour commuting distance from Smith Ranch. Rural areas in the counties are sparsely populated, so that most of the housing units characterized in **Table 3.10-7** are located within the communities of Glenrock (Converse County), Douglas (Converse County), Casper (Natrona County), and other smaller communities located along the I-25 corridor throughout Natrona and Converse Counties. **Table 3.10-7** includes the total number of housing units in the counties, the rental rates, housing costs, and vacancy rates for each county within the 80 kilometer (50 mile) radius from Smith Ranch (Wyoming CDA, 2010; Wyoming CDA, 2011). The rental characteristics are important because most of the labor force that would originate from outside of Converse and Natrona County would likely reside in rental units and other temporary lodging.

The household forecast (a household is defined as all persons occupying a housing unit) projects an increase of 2,215 households in Converse County from 4,694 in 2000 to 6,909 in 2030. The number of renters in Converse County is projected to increase from 1,219 in 2000 to 1,430 in 2030. In Natrona County, the number of households is projected to increase from 26,819 in 2000 to 40,840 by 2030, while the number of renters is expected to increase from 8,079 in 2000 to 10,073 in 2030 (U.S. Department of Commerce, 2000-2010a).

3.10.2.2.3 Temporary Housing

Temporary housing options in the vicinity of Smith Ranch include hotels, motels, and campgrounds. Vacancy rates are not currently available for temporary accommodations in Converse and Natrona Counties. Available local motels/hotels/cabin establishments in the region generally have low vacancy rates during hunting seasons. Many motels and RV campgrounds in the region provide accommodation for long-term visitors by the week or month.

Casper, Glenrock, and Douglas, each located on the I-25 corridor south of Smith Ranch, provide numerous temporary lodging options (Casper Chamber of Commerce, 2011). There are 37 motel/hotels in the Casper area and 11 RV parks/campgrounds in the vicinity of Casper. Glenrock provides lodging in two motels and one RV park, and Douglas provides 11 hotels, four mobile homes, and six apartment complexes.

3.10.2.2.4 Personal Income

Personal income varies across the counties and communities within 80 kilometers (50 miles) of Smith Ranch. Johnson and Niobrara Counties have lower household, family, and per capita incomes than the state as a whole, with Niobrara County also having the lowest level of personal income. Natrona County's income numbers track those of the state fairly closely, whereas Campbell County has a significantly higher income than the rest of the state. **Table 3.10-8, Personal Income Levels for Smith**

Ranch and Nearby Communities summarizes income information for the state as well as the counties and incorporated communities within 80 kilometers (50 miles) of Smith Ranch (U.S. Department of Commerce, 2000-2010a).

Per capita personal income is the income that is received by persons from all sources, including wages and other income over the course of a year. In 2010, personal income in Converse County was $18,744, which was 70% of the state average of $26,925. The county ranks ninth in per capita annual income out of 23 counties in the state (Wikipedia, 2011). Natrona County had a higher per capita income of $18,913, which was more than 57% of the state average and ranked eighth in the state. Most of the Wyoming counties with the highest per capita incomes have strong mineral development economic sectors.

3.10.2.2.5 Public Facilities and Services

Because Smith Ranch is in Converse County, basic emergency services would be the responsibility of Converse County and would be dispatched through the Sheriff's Office. The Converse County Sheriff's Office and Detention Center, located in Douglas, contains approximately 36 beds. Details about the number of deputies, dispatch staff, as well as its current capacity, are unavailable (Converse County Sheriff's Office, 2009).

The Glenrock Fire Department consists entirely of volunteer firefighters. All firefighters have received first-aid, CPR, and HAZMAT training, and are equipped to fight structural, chemical, grass, and wild fires, as well as respond to vehicular accidents. The Glenrock Fire Department consists of two fire halls, one in Glenrock and one in Rolling Hills, making the Glenrock Fire Department the closest firefighting service to the project site (Glenrock Fire Department, 2011).

The Glenrock Ambulance Service provides round-the-clock emergency medical services and transport for critically ill or injured patients over the entire county. The ambulance service is staffed by four individuals, and offers a full range of medical transportation services (Glenrock Ambulance Service, 2011).

The closest hospitals to Smith Ranch are in Casper and Douglas. The Wyoming Medical Center in Casper is a 207-bed acute care hospital with a round-the-clock emergency department, 24-hour physician staffing, and a Regional Trauma Center. The Wyoming Medical Center consists of 150 physicians and is comprised of two centers of excellence: The Heart Center of Wyoming and the Neuroscience and Spine Institute. Services for the Wyoming Medical Center include women's services, radiology, ear, nose, and throat, neurosurgery, pathology, pediatrics, psychology, intensive care, and orthopedics, as well as many other specialties (Wyoming Medical Center, 2011). The Memorial Hospital of Converse County in Douglas is a 25-bed critical access hospital that provides services including a birthing center, cardiopulmonary care, a laboratory, radiology, rehabilitation, surgical services, and several rural health clinics. The number of physicians staffed by the Memorial Hospital of Converse County was unavailable (Memorial Hospital, 2011).

3.10.2.2.6 Taxes and Revenues

Wyoming does not have any personal or corporate income tax, and does not collect tax on retirement income received out of state. The state does have a 4% sales tax on most retail goods and some services, a county lodging tax ranging from 2 to 4%, and a 4% use tax that applies in situations in which sales tax is not collected. Sales and use taxes are the two local sources of revenue for state and local governments. Additionally, all counties in the state except Fremont, Park, and Sublette collect a 1% county sales tax. None of the counties that are included within the 80 kilometer (50 mile) radius

surrounding Smith Ranch impose the optional 1% excise tax dedicated to capital improvement projects authorized through public election. **Table 3.10-9, State and Local Sales and Use Tax Distribution for the Counties within 80 kilometers of Smith Ranch** shows the 2009 sales and use tax revenues for the counties in the 80 kilometer (50 mile) area (WDAI EAD 2009).

Revenue from the sales and use tax is distributed between the state and the county of origin, with 6% going to the state general fund and the remainder distributed among the counties according to each county's decennial census population. County sales tax is returned to the county of origin and distributed to the county and its municipalities proportionally based on decennial census population.

Most of Wyoming's property-tax revenues are derived from a gross product (ad valorem) tax on mineral production. The Converse County average 2009 mill levy applied to 2008 mineral production was 59.9, which resulted in a total tax of $24,723,500 assessed on all minerals (Wyoming Department of Revenue, 2010). The state also imposes a severance tax on minerals; the severance tax rate for uranium was 4% in 2008. In the 2008 production year, the amount of taxable units of uranium in Converse County was 1,235,311, which resulted in a taxable valuation of $11,396,553.

3.10.3 North Butte Remote Satellite Area (Campbell County)

3.10.3.1 Demography

3.10.3.1.1 Regional Population

The area within an 80 kilometer (50 mile) radius of the North Butte Remote Satellite includes portions of four counties in northeastern Wyoming (Campbell, Converse, Johnson, and Natrona Counties), as shown on **Figure 3.10.2, Population Centers within 80 kilometers of North Butte**. The North Butte Remote Satellite is located in southwest Campbell County. The nearest communities are Wright, a small Campbell County incorporated town located northeast of the satellite area on Highway 387, and the Towns of Edgerton and Midwest, which are located in Natrona County southwest of the satellite area on Highway 387. Other nearby towns are Kaycee, located in Johnson County west of the satellite area at the junction of Highway 192 and II-25, and Gillette, located in Campbell County northeast of the satellite area at the junction of Highway 59 and I-90.

Historical and current population trends in counties and communities within an 80 kilometer (50 mile) distance of the Project are shown in **Table 3.10-10, 1980-2008 Historical and Current Population Change for Counties and Communities within the 80 kilometer Radius of the North Butte Remote Satellite**. The largest growth rates in the four-county region since 2000 occurred in Campbell, Converse, and Johnson County, primarily because of ongoing mineral resource development in the Powder River Basin. Population growth in Campbell, Converse, and Johnson Counties has outpaced state population growth for most years since 1980, with the largest average annual growth rate of approximately 14% occurring in Converse County during the 1980s (U.S. Department of Commerce, 1980-2008). The state population declined during this period primarily because of declines in historic agricultural economic sectors, while the high growth rates in Campbell, Converse, and Johnson Counties indicated boom years in oil, uranium, coal, and gas development. As with Converse County, the population in Campbell County grew at a slower rate between 2000 and 2008 than in previous decades, making the growth rates more in line with the state growth rates. The overall county and state economies are more diverse in the current decade than they were during the 1980s.

3.10.3.1.2 Population Characteristics

In 2009, the population by age and sex for counties within 80 kilometers (50 miles) of the North Butte Remote Satellite is shown in **Table 3.10-11, 2010 Population by Age and Sex for Wyoming and the Counties within the 80 kilometer Radius of the North Butte Remote Satellite** (WDAI EAD, 2000a).

Overall, the 40- to 64-year age group is the largest age group in each of the counties. In 2010, an average of 96% of the four-county population was classified as white. Native American persons comprised an average of 1% (U.S. Department of Commerce, 2010a), while persons of Hispanic origin comprised an average of 4% of the total four-county population of 143,985 (U.S. Department of Commerce, 2010a). See **Table 3.10-12, 2010 Race Characteristics of the Population for the Census Tracts Included in the 80 kilometer Radius Surrounding North Butte** for more information on the race characteristics for the North Butte Remote Satellite.

3.10.3.1.3 Population Projections

The projected populations for selected years by county within the 80 kilometer (50 mile) radius of the proposed remote satellite are shown in **Table 3.10-13, 2010-2030 Population Projections for Wyoming and the Counties within the 80 kilometer Radius of the North Butte Remote Satellite.** On a county basis, this area is very similar to the population projections at Smith Ranch described in Section 3.10.2.1.3 above.

3.10.3.1.4 Seasonal Population and Visitors

The North Butte Remote Satellite consists of private lands in southwest Campbell County. The surrounding area within an 80 kilometer (50 mile) radius contains mostly private lands, but also federal and state lands, which provide open space for a variety of dispersed outdoor recreational opportunities. No developed recreational opportunities are provided on federal and state lands within the 80 kilometer (50 mile) radius.

According to the official Wyoming State Parks, Historic Sites, and Trails web site (SPHS, 2011), there are no state parks, historic sites, or known recorded trails within the 80 kilometer (50 mile) area.

Included in the eastern portion of the 80 kilometer (50 mile) boundary, just south and east of Wright, located in the Powder River Basin, is the Thunder Basin National Grassland. Approximately half of the Thunder Basin National Grassland is included within the 80 kilometer (50 mile) boundary, located approximately 44 kilometers (27 miles) east of the North Butte Remote Satellite (Wyoming Tourism, 2011). Refer to Section 3.10.2.1.4 for more information about Thunder Basin National Grassland and other primary sources of seasonal population for the North Butte Remote Satellite.

3.10.3.1.5 Schools

The North Butte Remote Satellite is located within Campbell County School District #1, which serves all of Campbell County. The nearest Campbell County community that provides educational services to residents in the vicinity of the remote satellite is Wright, which is located approximately 40 kilometers (25 miles) east of the remote satellite on Highway 387. Two schools are located in Wright: Cottonwood Elementary School serves K-6 and the Wright Junior & Senior High Schools serve grades 7-12. Total enrollment in these two schools for the 2010-2011 school year was 280 in the elementary school and 228 in the junior and senior high schools (Wyoming Department of Education, 2011). Enrollment in the elementary school has increased by 52 students since the 2005-2006 school year, while enrollment in the high schools has remained the same since the 2005-2006 school year. The elementary school currently has a student to teacher ratio of 25:1 while the high schools have a ratio of 10:1 (Campbell County, Cottonwood, 2011; Campbell County, Wright, 2011).

The North Butte Remote Satellite employees may also utilize schools located in Natrona County. Please refer to Section 3.10.2.1.5 for further information.

3.10.3.1.6 Sectorial Population

The existing population within the 80 kilometer (50 mile) radius from the North Butte Remote Satellite was estimated using the same methods described in Section 3.10.2.1.6. Subtotals by sector and compass points, as well as the total population, are shown in **Table 3.10-14, 2010 Population within the 80 kilometer Radius of the North Butte Remote Satellite.** The total current population within the 80 kilometer (50 mile) radius from the North Butte Remote Satellite is approximately 34,900 people (U.S. Department of Commerce, 2000-2010b).

Urban areas located near the North Butte Remote Satellite include the towns of Wright, located approximately 37 kilometers (23 miles) to the east of the satellite area; Edgerton, located approximately 46 kilometers (29 miles) to the south south-west; Midwest, located approximately 47 kilometers (29 miles) to the south-west; Kaycee, located approximately 56 kilometers (35 miles) to the west; Antelope Valley-Crestview, located approximately 65 kilometers (40 miles) to the north-east; and Sleepy Hollow, located approximately 67 kilometers (42 miles) to the north-east of the remote satellite. The City of Gillette, which contributes the majority of the population within the 80 kilometer (50 mile) radius, is located approximately 69 kilometers (43 miles) to the north north-east of the remote satellite.

3.10.3.2 Local Socioeconomic Characteristics

3.10.3.2.1 Major Economic Sectors and Labor Forces

A substantial portion of the project labor force for the North Butte Remote Satellite is likely to be based in Campbell County, primarily residing in the cities of Gillette and Wright. Some labor may originate from Natrona County and information on labor and employment includes Casper, Midwest and Edgerton. **Table 3.10-15, 2009 Annual Average Labor Force Characteristics and Employment in Economic Sectors for State of Wyoming for Campbell and Natrona Counties** summarizes unemployment and employment rates in Campbell and Natrona Counties (WDE Campbell, 2011; WDE Natrona, 2011).

As with Converse County, the economies of Campbell County and Natrona County depend primarily on the energy sector, especially those that are mineral-based. Refer to Section 3.10.2.2.1 for more information about the energy sector as it applies to the North Butte Remote Satellite.

Table 3.10-15 shows the projected labor force characteristics in Campbell and Natrona Counties in 2010. These characteristics greatly resemble those for Smith Ranch, which are described in Section 3.10.2.2.1.

Table 3.10-16, Labor Force Statistics for the North Butte Remote Satellite uses Census Bureau information from the 1990 and 2000 censuses and the 2005-2009 ACS five-year estimates to summarize the labor force and employment rates in recent years in the vicinity of the North Butte Remote Satellite. Both labor force and employment have increased in the 2005-2009 estimates in all neighboring counties and towns within the 80 kilometer (50 mile) radius from the remote satellite (U.S. Department of Commerce, 2000a), (U.S. Department of Commerce, 2005-2009).

3.10.3.2.2 Housing

The nearest permanent housing is located in the communities of Wright in Campbell County, and Midwest and Edgerton in Natrona County. According to the 2010 U.S. Census, there were 813 housing units in Wright. Of these units, the average occupancy rate was 84%, making the vacancy rate for all types of housing units was 16% (WDE, 2011a).

In Natrona County, there were 111 housing units in Edgerton, of which 81% were occupied. Therefore, the vacancy rate was 19%. In nearby Midwest, 148 of the total 200 housing units were occupied, creating a vacancy rate of 26% (WDE, 2011e).

The rental vacancy rates for the housing most likely utilized by the North Butte Remote Satellite employees are found in **Table 3.10-17, Housing Characteristics and the Average Rental Rates in Fourth Quarter 2010 and Change from Fourth Quarter 2009 for Counties Within an 80 kilometers Radius of the North Butte Remote Satellite**. The rental vacancy rates in Campbell County have decreased from a high of approximately 11% in 2009 to the 2010 rate of approximately 8%. The influx of population in these counties as a result of economic growth stimulated by CBM and coal production has outstripped the available housing supply (WDE, 2011a; WDE, 2011e).

Incorporated communities within Campbell and Natrona Counties are generally within a one hour commuting distance from the North Butte Remote Satellite. Rural areas in the counties are sparsely populated, so that most of the housing units characterized in **Table 3.10-17** are located within the communities of Gillette (Campbell County), Casper (Natrona County), and other smaller communities located along the I-25 and I-90 corridors throughout Natrona, Converse and Campbell Counties. See **Table 3.10-17** for a total number of housing units, the rental rates, housing costs, and vacancy rates for each county within the 80 kilometer (50 mile) radius from the remote satellite (Wyoming CDA, 2010; Wyoming CDA, 2011). Section 3.10.2.2.2 describes the household forecast projections for Natrona County.

The household forecast (a household is defined as all persons occupying a housing unit) in Campbell County is projected to increase from 12,207 in 2000 to 22,973 in 2030, while the number of renters is also expected to increase from 3,218 in 2000 to 6,052 in 2030. In Johnson County, the number of households is projected to increase from 2,959 in 2000 to 6,232 in 2030 and the number of renters is projected to increase from 777 in 2000 to 1,770 in 2030. In Natrona County, the number of households is projected to increase from 26,819 in 2000 to 42,456 by 2030, and the number of renters is expected to increase from 8,079 in 2000 to 12,710 in 2030 (WDE, 2011a; WDE, 2011d; WDE, 2011e).

3.10.3.2.3 Temporary Housing

Temporary housing options in the vicinity of the North Butte Remote Satellite include hotels, motels, and campgrounds. Vacancy rates are not currently available for temporary accommodations in Campbell and Natrona Counties. Available local motels/hotels/cabin establishments in the region generally have low vacancy rates during hunting seasons. There is also a high level of occupancy by the CBM industry workers. Many motels and RV campgrounds in the region provide accommodations for long-term visits by the week or month.

The temporary lodgings closest to the North Butte Remote Satellite are in Wright and Edgerton. Accommodations in Wright include a mobile home park, two hotels, and one apartment complex. One motor lodge is located in Edgerton.

There are 28 hotels/motels in Gillette. In addition, the two campgrounds in the Gillette area provide RV hookups and tent sites. The Cam-Plex is funded by Gillette and Campbell County, and may not compete with private enterprise. The additional 1,821 RV sites at the Cam-Plex are available only for special events and not for the general public (Cam-Plex, 2011).

Refer to Section 3.10.2.2.3 for information on available lodging in city of Casper and the town of Glenrock, which are additional potential temporary housing locations for the North Butte Remote Satellite employees.

3.10.3.2.4 Personal Income

Personal income varies across the counties and communities within 80 kilometers (50 miles) of the remote satellite. Johnson County is the only county within the 80 kilometer (50 mile) radius that has a lower household, family, and per capita income than the state as a whole. **Table 3.10-18,** summarizes the income information for the state as well as the counties and incorporated communities within 80 kilometers (50 miles) of the remote satellite (U.S. Department of Commerce, 2005-2009).

In 2010, personal income in Campbell County was $20,063, which was approximately 75% of the state average of $26,925. The county ranks second in per capita annual income out of 23 counties in the state (Wikipedia, 2011). Natrona County had a smaller per capita income of $18,913, which was approximately 70% of the state average and ranked eighth in the state.

3.10.3.2.5 Public Facilities and Services

Because the North Butte Remote Satellite is in Campbell County, basic emergency services would be the responsibility of Campbell County and would be dispatched through the Sheriff's Office. The Campbell County Sheriff's Office and Detention Center, located in Gillette, employs 57 Detention Officers and 34 uniformed deputies. The Detention Center contains a separate juvenile facility with 16 beds. The duties of the Campbell County Sheriff's deputies include responding to emergency calls, investigating crimes, conducting traffic enforcement, and serving warrants and civil papers. The Sheriff's deputies perform 24-hour rotating patrol shifts seven days a week (Campbell County Sheriff's Office, 2011).

The Campbell County Fire Department, also located in Gillette, is comprised of 29 career and 150 volunteer firefighters. The service provided by the Campbell County Fire Department encompasses approximately 1 million hectares (5,000 square miles). This fire department possesses 80 pieces of apparatus and support vehicles, and provides 24-hour response services which include fire rescue, EMS, and hazardous materials services to about 50,000 citizens. There are 10 fire stations and 11 wildland support stations that are part of the Campbell County Fire Department system. One of these fire stations is located in Wright, which is the closest town to the North Butte Remote Satellite (Campbell County Fire Department, 2011).

The closest hospitals to the project site are located in Gillette. The Campbell County Memorial Hospital is a 90-bed acute care hospital and 150-bed long-term care facility. It possesses two primary clinics, one urgent care clinic, an ear, nose, and throat (ENT) clinic, an OB/GYN clinic, and an orthopedic clinic. Other services provided by the Campbell County Memorial Hospital include dialysis, Home Medical Resources, home health and hospice, medical and radiation oncology, 24-hour daycare, inpatient and outpatient behavioral health services, occupational health services, and rehabilitation services. In addition to these services, Campbell County Memorial Hospital provides 24-hour ambulatory services to the area (Campbell County Memorial Hospital, 2011).

3.10.3.2.6 Taxes and Revenues

As previously stated, sales and use taxes are the two local sources of revenue for state and local governments. None of the counties that are included within the 80 kilometer (50 mile) radius from the project site impose the optional 1% excise tax dedicated to capital improvement projects authorized through public election. **Table 3.10-19, State and Local Sales and Use Tax Distribution for the Counties**

within 80 kilometers of the North Butte Remote Satellite shows the 2009 sales and use tax revenues for the counties within the 80 kilometer (50 mile) radius of the remote satellite (WDAI EAD, 2009)

The Campbell County average 2009 mill levy applied to 2008 mineral production was 58.802, which resulted in a total tax of $283,685,967 assessed on all minerals (Wyoming Department of Revenue, 2010). In the 2008 production year, the amount of taxable units of uranium in Campbell County was 0, which resulted in a taxable valuation of $0. This will change in the future with the onset of production from the North Butte Remote Satellite and other uranium projects in the area that are approved to commence construction and production.

3.10.4 Gas Hills Remote Satellite Area (Fremont and Natrona Counties)

3.10.4.1 Demography

3.10.4.1.1 Regional Population

The area within an 80 kilometer (50 mile) radius of the Gas Hills Remote Satellite includes portions of four potentially-impacted counties in central Wyoming (Fremont, Natrona, Carbon, and Sweetwater County), as shown on **Figure 3.10.3, Population Centers within 80 kilometers of the Gas Hills Project.** The Gas Hills Remote Satellite is located in eastern Fremont County with a single mining unit within Natrona County. The nearest larger communities include Riverton, Arapahoe, and Shoshoni (all in Fremont County), which are located approximately 60 to 80 kilometers (37 to 50 miles) west and northwest of the remote satellite.

Historical and current population trends in counties and communities within an 80 kilometer (50 mile) distance of the Gas Hills Remote Satellite are shown in **Table 3.10-20, 1980-2008 Historical and Current Population Change for Counties and Communities within the 80 kilometer Radius of the Gas Hills Remote Satellite**. The largest growth rates in the four-county region since 2000 occurred in Fremont, Natrona, and Sweetwater counties, primarily because of ongoing mineral, oil and gas resource development in the Powder River Basin (U.S. Department of Commerce, 1980-2008). The overall county and state economies are more diverse in the current decade than they were during the 1980s.

3.10.4.1.2 Population Characteristics

The 2010 population by age and sex for counties within 80 kilometers (50 miles) of the Gas Hills Remote Satellite is shown in **Table 3.10-21, 2010 Population by Age and Sex for Wyoming and the Counties within the 80 kilometer Radius of the Gas Hills Remote Satellite** (U.S. Department of the Census, 2005-2009). Once again, the 40- to 64-year age group is the largest age group in each of the counties (WDAI EAD, 2000c).

In 2010, an average of 90% of the four-county population was classified as white. Native American and Hispanic persons comprised an average of 7% (U.S. Department of Commerce, 2010 of the population total four-county (Fremont, Natrona, Carbon and Sweetwater) population total of 175,264 (U.S. Department of Commerce, 2010a). See **Table 3.10-22, 2010 Race Characteristics for the Census Tracts Included in the 80 kilometer Radius Surrounding Gas Hills** for more information about the race characteristics near the Gas Hills Remote Satellite.

3.10.4.1.3 Population Projections

The projected populations for selected years by county within the 80 kilometer (50 mile) radius of the Gas Hills Remote Satellite boundary are shown in **Table 3.10-23, 2010-2030 Population Projections for Wyoming and the Counties within the 80 kilometer Radius of the Gas Hills Remote Satellite** (WDAI EAD, 2011). The population projections between 2010 and 2030 anticipated that the relatively stable

population trends evident between 2000 and 2010 will continue for the selected counties and the state as a whole (WDAI EAD, 2000b).

3.10.4.1.4 Seasonal Population and Visitors

The Gas Hills Remote Satellite consists of a mix of private, state, federal and Indian (tribal) lands. The surrounding area within an 80 kilometer (50 mile) radius contains mostly federal lands, administered by the BLM. There are state lands (school sections) and private sections within the mass of federal and tribal lands. Private lands include patented mineral, Homestead Act, and Taylor Grazing Act lands. Because of the large amount of federal lands, there are a variety of dispersed outdoor recreation opportunities. Boysen Reservoir, which is a state recreation area that encompasses developed campgrounds, is within the 80 kilometer (50 mile) radius.

According to the official State of Wyoming website (Wyoming State Parks, Historic Sites, and Trails), the main documented trail located within the 80 kilometer (50 mile) area is the Wyoming Heritage Trail. The Wyoming Heritage Trail is 35 kilometers (22 miles) and stretches between Riverton City and Shoshoni Town. Visitation statistics are not compiled for these trails (Rails-to-Trails, 2011).

Included in the northwestern portion of the 80 kilometer (50 mile) boundary, just west of the town of Shoshoni and encompassing Riverton, St. Stephens, and Arapahoe, is the Wind River Indian Reservation. The Boysen Reservoir and approximately 1/6 of the Wind River Indian Reservation are encompassed by the 80 kilometer (50 mile) boundary. The Wind River Indian Reservation spans approximately 2.2 million acres and is home to 2,500 Eastern Shoshone and more than 5,000 Northern Arapahoe Indians. Most of the Shoshone live in the western half around Fort Washakie, while the Arapahoe are centered at Ethete as well as near the Town of Arapahoe. Recreational activities on the reservation include walking and hiking trails, camping, horseback riding, mountain and road biking, and snowshoeing. These activities are stationed mostly out of Dubois, Lander, and Thermopolis, none of which are located within the 80 kilometer (50 mile) radius around the satellite boundary. Fishing and boating, however, is based out of Boysen Reservoir near Shoshoni. This reservoir is located within the 80 kilometer (50 mile) radius (Wyoming's Wind River Country, 2011).

3.10.4.1.5 Schools

The Gas Hills Remote Satellite is located in Fremont County School District #25, which serves approximately one-fifth of Fremont County. The nearest Fremont County community that provides educational services to residents in the vicinity of the remote satellite is Riverton, which is located 80 kilometers (50 miles) northwest of the remote satellite on Highway 136. There is one high school (Riverton High School), one middle school (Riverton Middle School), and four elementary schools (Aspen Park Elementary, Jackson Elementary, Ashgrove Elementary, and Rendezvous Elementary) located in Riverton. Riverton High School serves grades 9-12; Riverton Middle School serves grades 6-8, and the four elementary schools serve grades K-5. Total enrollment in these schools for the 2009-2010 school year was 727 in Riverton High School, with a student/teacher ratio of 15:1, 579 in Riverton Middle School, with a student/teacher ratio of 17:1, 197 in Jackson Elementary, which had a student/teacher ratio of 10:1, 283 in Ashgrove Elementary, with a student/teacher ratio of 15:1, 392 in Rendezvous Elementary, which had a student/teacher ratio of 14:1, and 287 in Aspen Park Elementary, with a student/teacher ratio of 14:1 (School Digger, 2011).

As with Smith Ranch and the North Butte Remote Satellite, the Natrona County school system, primarily in Casper or the surrounding communities, may also be utilized by the Gas Hills Remote Satellite employees. Please refer to Section 3.10.2.1.5 for more information about the schools in the Natrona County School District.

3.10.4.1.6 Sectorial Population

Existing population within the 80 kilometer (50 mile) radius centered on the Gas Hills Remote Satellite was estimated using the same methods described in Section 3.10.2.1.6. Subtotals by sector and compass points, as well as the total population, are shown in **Table 3.10-24, 2010 Population within the 80 kilometer Radius of the Gas Hills Remote Satellite.**

The total current population within the 80 kilometer (50 mile) radius from the center of the Gas Hills Remote Satellite is approximately 13,500 people (U.S. Department of Commerce, 2000-2010b).

Some of the urban areas include the city of Riverton and the town of Arapahoe, located approximately 80 kilometers (50 miles) west-northwest of the satellite area; Shoshoni, located approximately 69 kilometers (43 miles) northwest of the satellite area; Jeffrey City, located 39 kilometers (24 miles) southwest of the satellite area; Bairoil, located 59 kilometers (37 miles) south of the satellite area; Bessemer Bend, located approximately 80 kilometers (50 miles) from the satellite area; and Powder River, located approximately 48 kilometers (30 miles) east-northeast of the satellite area.

All urban areas, except for Bessemer Bend, are completely encompassed by the outermost perimeter of the 80 kilometer (50 mile) radius. Therefore, all Census Tracts and Block Groups within these urban areas, with the exception of Bessemer Bend, were included in the 80 kilometer (50 mile) radius from the remote satellite area. Bessemer Bend is encompassed by the 80 kilometer (50 mile) radius by approximately 75%. Therefore, 75% of the population for Bessemer Bend was included in the overall population count for the 80 kilometer (50 mile) radius.

3.10.4.2 Local Socioeconomic Characteristics

3.10.4.2.1 Major Economic Sectors and Labor Forces

Table 3.10-25, 2009 Annual Average Labor Force Characteristics and Employment in Economic Sectors for State of Wyoming and Fremont County summarizes employment and unemployment rates, as well as employment and occupation types for both Fremont County and the state of Wyoming (U.S Department of Commerce, 2005-2009).

The economy of Fremont County depends on agriculture, ranching, and recreation. As defined by the U.S. Bureau of Labor Statistics, the largest employment sector in Fremont County is agriculture, which includes ranching and farming.

A report prepared by the U.S. Bureau of Labor Statistics analyzed the labor supply in Wyoming by place of residence. The analysis concluded that a portion of the available labor pool in Wyoming consists of non-residents. According to the report, approximately 11% of the available labor pool consisted of non-resident workers in 2007.

Table 3.10-25 shows the projected labor force characteristics in Fremont County in 2009 (U.S Department of Commerce, 2009). In general, unemployment rates were high in the early 1990s and decreased until 2008, whereupon the unemployment rates began to rise once again. The unemployment rates have continued to increase overall into 2009, but will fluctuate throughout any individual year. Annual fluctuations in unemployment rates are driven primarily by short-term changes in production due to changing prices for coal, uranium, oil, and CBM.

Table 3.10-26, Labor Force Statistics for the Gas Hills Remote Satellite uses Census Bureau information from the 1990 and 2000 censuses and from the 2005-2009 ACS five-year estimates of the labor force and employment rates in recent years in the vicinity of the Gas Hills Remote Satellite (U.S. Department of Commerce, 2009). Both labor force and employment have increased in the 2005-2009 estimates in all

neighboring counties and towns within the 80 kilometer (50 mile) radius from the satellite area (U.S. Department of Commerce, 2009).

3.10.4.2.2 Housing

The nearest permanent housing is located in the communities of Jeffrey City and Riverton in Fremont County, and Bairoil in Sweetwater County. According to the 2010 U.S. Census, there were 4,567 housing units in Riverton, and of these units, the average occupancy rate was 93%. In Bairoil, there were a total of 68 housing units, and of these units, the average occupancy rate was 72%. The vacancy rate for housing units overall was approximately 28%. In Jeffrey City, there were 84 housing units, of which 41% were occupied. The vacancy rate was 60% (U.S. Department of Commerce, 2010b).

A rental vacancy survey shows that rental vacancy rates in Fremont County have decreased from approximately 5% to approximately 3% from 2001 to 2009 (**Table 3.10-27, Housing Characteristics and the Average Rental Rates in Fourth Quarter 2010 and Change from Fourth Quarter 2009 for Counties within an 80 kilometer Radius of the Gas Hills Remote Satellite**). The vacancy rates, however, remained the same from 2009 to 2010, at a rate of 5%. The rental vacancy rates in Natrona and Sweetwater County have increased from approximately 2% in 2009 to 4% in 2010 and 5% in 2009 to 6% in 2010 respectively. The influx of population in Natrona County as a result of economic growth stimulated by CBM has outstripped the available housing supply (WDE, 2011d; WDE, 2011e; WDE, 2011f).

Urban areas within Sweetwater, Carbon and Natrona Counties are generally within a two-hour commuting distance from the Gas Hills Remote Satellite. Rural areas in the counties are sparsely populated, so that most of the housing units characterized in **Table 3.10-27** are located within the communities of Jeffrey City (Fremont County), Riverton (Fremont County), Bairoil (Sweetwater County), and other smaller communities located along state highway 287. See **Table 3.10-27** for a total number of housing units in the counties, the rental rates, housing costs, and vacancy rates for each county within the 80 kilometer (50 mile) radius from the remote satellite area (Wyoming CDA, 2010; Wyoming CDA, 2011).

The household forecast (a household is defined as all persons occupying a housing unit) projects an increase of 13,545 households in Fremont County from 6,510 in 2000 to 20,055 in 2030. The number of renters in Fremont County is projected to increase from 3,675 in 2000 to 5,002 in 2030. In Sweetwater County, the number of households is projected to increase from 14,105 in 2000 to 21,938 in 2030. The number of renters is expected to increase from 3,519 in 2000 to 5,033 in 2030 (WDE, 2011d; WDE, 2011e; WDE, 2011f).

3.10.4.2.3 Temporary Housing

Temporary housing options in the vicinity of the Gas Hills Remote Satellite include hotels, motels, and campgrounds. Vacancy rates are not currently available for temporary accommodations in Fremont County. Available local motels/hotels/cabin establishments in the region generally have low vacancy rates during hunting seasons, and many motels and RV campgrounds in the region provide accommodations for long-term visitors by the week or month.

Riverton, Shoshoni, Bairoil, and Jeffrey City, each located on the Highway 287 or Highway 20/26 corridor northwest, south and southeast of the Gas Hills Remote Satellite respectively, provide numerous temporary lodging options. There are 15 motel/hotels and 1 RV park/campground in the Riverton area, as well as six mobile home parks and five apartment complexes. Shoshoni provides lodging in one motel/hotel and one RV park/campground. Bairoil and Jeffrey City do not provide lodging by way of motels/hotels, RV parks/campgrounds, apartment complexes, or mobile home parks.

3.10.4.2.4 Personal Income

Personal income varies across the counties and communities within 80 kilometers (50 miles) of the Gas Hills Remote Satellite. Carbon and Fremont Counties have lower household, family, and per capita incomes than the state as a whole, with Fremont County having the lowest level of personal income. Natrona County has a lower median household and median family income than the state as a whole, but has a higher per capita income. Sweetwater County is the only county within the 80 kilometer (50 mile) radius that has higher levels of household, family, and per capita incomes than the overall state. **Table 3.10-28, Personal Income Levels for the Gas Hills Remote Satellite and Nearby Communities** summarizes income information for the state as well as the counties and incorporated communities within 80 kilometers (50 miles) of the Gas Hills Remote Satellite (U.S. Department of Commerce, 2000-2010a).

In 2010, personal income in Fremont County was $23,868, which was 89% of the state average of $26,925. The county ranks twentieth in per capita annual income out of 23 counties in the state (Wikipedia, 2011). Sweetwater County had a higher per capita income of $29,825, which was more than 110% of the state average, ranking fifth in the state.

3.10.4.2.5 Public Facilities and Services

Because the Gas Hills Remote Satellite is in Fremont County, basic emergency services would be the responsibility of Fremont County and would be dispatched through the Sheriff's Office. The Fremont County Sheriff's Office and Detention Center, located in Lander, is a combined agency with dispatch services to the Lander Police Department (providing 20 officers) and the Shoshoni Police Department (providing 2 police officers). Details about the number of deputies, dispatch staff, as well as its current capacity, are unavailable. The Fremont County Sheriff's Department also dispatches the Fremont County Ambulance service, which provides coverage to the following areas: Riverton, Lander, Dubois, Crowheart, Shoshoni, Pavillion, Morton, and Kinnear. The Fremont County Fire Department provides coverage to the following areas: Fremont County Battalion 1, Lander Rural Fire Department, Lander Valley Fire Department, Shoshoni Fire Department, Crowheart Fire Department, Pavillion Fire Department, Morton/Kinnear Fire Department, and Jeffrey City Fire Department, among others (Fremont County Sheriff's Office, 2011).

The Riverton Area Fire Protection District is an all-volunteer department consisting of 33 members. The services provided are EMT-Paramedic non-transport emergency services, as well as fire extinguishment including brush, vehicle, and structural fires. Riverton Fire and EMS provides fire education and CPR courses throughout Riverton (Riverton Fire and EMS, 2011).

The closest hospital to the Gas Hills Remote Satellite is in Riverton. The Riverton Memorial Hospital in Riverton is a 70-bed acute care hospital with a round-the-clock emergency department, 24-hour physician staffing, and a Regional Trauma Center (Riverton Memorial Hospital, 2011).

3.10.4.2.6 Taxes and Revenues

Wyoming does not have any personal or corporate income tax, and does not collect tax on retirement income received out of state. The state does have a 4% sales tax on most retail goods and some services, a county lodging tax ranging from 2 to 4%, and a 4% use tax that applies in situations in which sales tax is not collected. **Table 3.10-29, State and Local Sales and Use Tax Distribution for the Counties within 80 kilometers of the Gas Hills Remote Satellite** shows the 2009 sales and use tax revenues for the counties within 80 kilometers (50 miles) of the remote satellite area (WDAI EAD 2009).

The Fremont County average 2009 mill levy applied to 2008 mineral production was 71.1, which resulted in a total tax of $53,594,202 assessed on all minerals. The severance tax rate for the minerals mined in Fremont County was 2% in 2008. In the 2008 production year, the amount of taxable units of mined minerals in Fremont County was 574,621, which resulted in a taxable valuation of $1,078,864 (Wyoming Department of Revenue, 2010).

3.10.5 Ruth Remote Satellite (Johnson County)

3.10.5.1 Demography

3.10.5.1.1 Regional Population

The area within an 80 kilometer (50 mile) radius of the Ruth Remote Satellite includes portions of four counties in northeastern Wyoming (Campbell, Converse, Natrona, and Johnson Counties), as shown on **Figure 3.10.4, Population Centers within 80 kilometers of the Ruth Project.** The Ruth Remote Satellite is located in southeastern Johnson County, approximately 10 kilometers (6 miles) southwest of the North Butte Remote Satellite. Because the Ruth Remote Satellite is so close to the North Butte Remote Satellite, both of these remote satellites share the same four counties that lie within an 80 kilometer radius from the site, as well as the same nearby communities.

Historical and current population trends in counties and communities within an 80 kilometer (50 mile) distance of the Project are shown in **Table 3.10-30, 1980-2008 Historical and Current Population Change for Counties and Communities within the 80 kilometer Radius of the Ruth Remote Satellite**.

3.10.5.1.2 Population Characteristics

The 2009 population by age and sex for counties within 80 kilometers (50 miles) of the Ruth Remote Satellite is shown in **Table 3.10-31, 2010 Population by Age and Sex for Wyoming and the Counties within the 80 kilometer Radius of the Smith Ranch Satellite Area.** As with the North Butte Remote Satellite, the 40- to 64-year age group is the largest age group in each of the counties.

In 2010, an average of 95% of the four-county population was classified as white. Native American persons comprised an average of 1% (U.S. Department of Commerce, 2010a), while persons of Hispanic origin comprised and average of 4% of the total four-county population of 143,985 (U.S. Department of Commerce, 2010a). The populations in all other racial categories account for less than 1% of the total population when averaged across the four counties.

3.10.5.1.3 Population Projections

The projected populations for selected years by county within the 80 kilometer (50 mile) radius of the proposed satellite area are shown in **Table 3.10-32, 2010-2030 Population Projections for Wyoming and the Counties within the 80 kilometer Radius of the Ruth Remote Satellite.** The population projections indicate that the relatively stable population trends evident between 2000 and 2010 will continue for the four counties and the state as a whole through 2030 (WDAI EAD, 2000b).

3.10.5.1.4 Seasonal Population and Visitors

The Ruth Remote Satellite consists of private and BLM lands. The surrounding area within an 80 kilometer (50 mile) radius contains private lands, but also some state lands, which provide open space for a variety of dispersed outdoor recreation opportunities. No developed recreation opportunities are provided on private and state lands within the 80 kilometer (50 mile) radius.

According to the official *Wyoming State Parks, Historic Sites, and Trails* website (SPHS, 2011), there are no state parks, historic sites, or known recorded trails within the 80 kilometer (50 mile) area.

Included in the eastern portion of the 80 kilometer (50 mile) boundary, just south and east of Wright located in the Powder River Basin, is the Thunder Basin National Grassland. Please refer to Section 3.10.2.1.4 for more information about the Thunder Basin National Grassland, as well as any other information on potential primary sources of seasonal population.

3.10.5.1.5 Schools

The Ruth Remote Satellite is located within Johnson County School District #1, which serves all of Johnson County. The nearest Johnson County community that provides educational services to residents in the vicinity of the remote satellite is Kaycee, which is located 48 kilometers (30 miles) northwest of the remote satellite on Highway 1002 (Highway 192). Three schools are located in Kaycee: Kaycee Elementary School, which serves K-5; Kaycee Jr. High School, which serves grades 6-8; and Kaycee High School, which serves grades 9-12. Total enrollment in these three schools for the 2009-2010 school year was 54 in the elementary school, 34 in the junior high school, and 49 in the high school (School Digger, 2010). The elementary school currently has a student to teacher ratio of 6:1, the junior high school currently has a student to teacher ratio of 8:1, and the high school has a student to teacher ratio of 6:1 (School Digger, 2010).

School enrollment may also include Wright and Gillette in Campbell County as well as schools in Natrona County. Section 3.10.3.1.5 describes information about the available public schools in Wright and Natrona County.

3.10.5.1.6 Sectorial Population

Existing population within the 80 kilometer (50 mile) radius from the Ruth Remote Satellite was estimated using the same methods described in Section 3.10.2.1.6. Subtotals by sector and compass points, as well as the total population, are shown in **Table 3.10-33, 2010 Population within the 80 kilometer Radius of the Ruth Remote Satellite.**

The total current population within the 80 kilometer (50 mile) radius from the center of the Ruth Remote Satellite is approximately 7,272 people (U.S. Department of Commerce, 2000-2010b).

Some of the urban areas located near the Ruth Remote Satellite include the towns of Wright, located approximately 50 kilometers (31 miles) east-northeast of the remote satellite; Midwest and Edgerton, both located approximately 26 kilometers (16 miles) southwest of the remote satellite; Kaycee, located approximately 48 kilometers (30 miles) west-northwest of the remote satellite; and Bar Nunn, located approximately 80 kilometers (50 miles) south-southwest from the remote satellite.

3.10.5.2 Local Socioeconomic Characteristics

3.10.5.2.1 Major Economic Sectors & Labor Forces

Therefore, **Table 3.10-34, 2009 Annual Average Labor Force Characteristics and Employment in Economic Sectors for State of Wyoming and Johnson County** summarizes unemployment rates and employment in both the state of Wyoming and Johnson County, where the Ruth Remote Satellite is located (U.S. Department of Commerce, 2009), where the Ruth Remote Satellite is located.

Table 3.10-34 shows the projected labor force characteristics in the state of Wyoming and Johnson County in 2009, which are further described in Section 3.10.2.2.1.

Table 3.10-35, Labor Force Statistics for the Ruth Remote Satellite uses Census Bureau information from the 2000 censuses and from the 2005-2009 ACS five-year estimates of the labor force and employment rates in recent years in the vicinity of the Ruth Remote Satellite (U.S. Department of Commerce, 2009). As was the case with the North Butte Remote Satellite, both labor force and

employment have increased in the 2005-2009 estimates in all neighboring counties and towns within the 80 kilometer (50 mile) radius from the remote satellite except for the town of Wright, which demonstrated a predicted decrease in population from the year 2000 to 2009 (U.S. Department of Commerce, 2009).

3.10.5.2.2 Housing

The nearest permanent housing is located in the communities of Kaycee in Johnson County, Midwest and Edgerton in Natrona County, and Wright in Campbell County. According to the 2010 U.S. Census, there were 134 housing units in Kaycee. Of these units, the average occupancy rate was 86% (WDE, 2011a; WDE, 2011d; WDE, 2011e). Section 3.10.3.2.2 describes the housing information for Midwest, Edgerton, and Wright.

A rental vacancy survey shows that rental vacancy rates in Johnson County have increased from approximately 2% in 2001 to approximately 6% in 2010. However, the rental vacancy rates in Johnson County have decreased from 2009 to 2010, from approximately 8% in 2009 to approximately 6% in 2010. In Natrona County, the rental vacancy rate has also increased from a rate of approximately 2% in 2001 to approximately 5% in 2010 (WDE, 2011a; WDE, 2011d; WDE, 2011e). Section 3.10.3.2.2 further describes the housing details for Natrona and Campbell Counties.

Urban (incorporated communities) areas within Johnson, Natrona, and Campbell Counties are generally within a one to two-hour commuting distance from the Ruth Remote Satellite. Rural areas in the counties are sparsely populated, so that most of the housing units characterized in **Table 3.10-36, Housing Characteristics and the Average Rental Rates in Fourth Quarter 2010 and Change from Fourth Quarter 2009 for Counties Within an 80 kilometer Radius of the Ruth Remote Satellite** are located within the communities of Kaycee (Johnson County), Wright (Campbell County), Midwest (Natrona County), Edgerton (Natrona County), and other smaller communities located along the I-25 corridor. See **Table 3.10-36** for a total number of housing units, the rental rates, housing costs, and vacancy rates for each county within the 80 kilometer (50 mile) radius from the satellite area. The rental characteristics are important because most of the labor force that would originate from outside of Johnson and Campbell County would likely reside in rental units and other temporary lodging.

Section 3.10.3.2.2 describes the household forecast projections from 2000 to 2030 for Johnson and Natrona Counties, the two counties anticipated to have the greatest demand for housing by the Ruth Remote Satellite employees.

3.10.5.2.3 Temporary Housing

Temporary housing options in the vicinity of the Ruth Remote Satellite include hotels, motels, and campgrounds. Vacancy rates are not currently available for these accommodations, located in Johnson, Natrona, and Campbell Counties. However, available local motels/hotels/cabin establishments in the region generally have low vacancy rates during hunting seasons.

Kaycee, Midwest, and Edgerton, each located on the I-25 corridor south and west of the Ruth Remote Satellite, provide numerous temporary lodging options. There are four motel/hotels, one RV park, two campgrounds, and 10 apartment complexes in the town of Kaycee. As mentioned in Section 3.10.3.2.3, Wright provides lodging through two motels/hotels and two apartment complexes. Edgerton provides one motel/hotel and one mobile home park.

3.10.5.2.4 Personal Income

Personal income varies across the counties and communities within 80 kilometers (50 miles) of the Ruth Remote Satellite. Johnson County has a lower household, family, and per capita income than the state

as a whole. Natrona County's income numbers track those of the state fairly closely, whereas Campbell County has a significantly higher income than the rest of the state. **Table 3.10-37, Personal Income Levels for the Ruth Remote Satellite and Nearby Communities** summarizes income information for the state as well as the counties and incorporated communities within 80 kilometers (50 miles) of the Ruth Remote Satellite (U.S. Department of Commerce, 2000-2010a).

In 2010, personal income in Johnson County was $19,030, which was 71% of the state average of $26,925. The county ranks seventh in per capita annual income out of 23 counties in the state (Wikipedia, 2011).

3.10.5.2.5 Public Facilities and Services

Because the Ruth Remote Satellite is in Johnson County, basic emergency services would be the responsibility of Johnson County and would be dispatched through the Sheriff's Office. The Johnson County Sheriff's Office and Detention Center is located in Buffalo. Details about the number of deputies, dispatch staff, as well as its current capacity, are unavailable (USA Cops, 2011).

The town of Kaycee consists of one full-time police department, one fire department (complete with two fire stations), and one ambulatory service, which is volunteer-based only. The training that these volunteer firefighters and ambulatory service volunteers receive is unspecified. There is also an ambulatory service and the Wright Volunteer Fire Department, which is stationed out of Wright and provides 24-hour emergency service.

The closest hospitals to the Ruth Remote Satellite are in Casper (83 kilometers [52 miles]) from the satellite boundary). Information about The Wyoming Medical Center in Casper is described in Section 3.10.2.2.5.

3.10.5.2.6 Taxes and Revenues

The state has a 4% sales tax on most retail goods and some services, a county lodging tax ranging from 2 to 4%, and 4% use tax that applies in situations in which sales tax is not collected. None of the counties that are included within the 80 kilometer (50 mile) radius from the project site impose the optional 1% excise tax dedicated to capital improvement projects authorized through public election. **Table 3.10-38, State and Local Sales and Use Tax Distribution for the Counties within 80 kilometers of the Ruth Remote Satellite** shows the 2009 sales and use tax revenues for the counties of the satellite area (WDAI EAD 2009).

The Johnson County average 2009 mill levy applied to 2008 mineral production was 67.3, which resulted in a total tax of $108,595,127 assessed on all minerals (Wyoming Department of Revenue, 2010). The severance tax rate for the minerals mined in Johnson County was 2% in 2008. In the 2008 production year, the amount of taxable units of uranium in Johnson County was 1,424,110, which resulted in a taxable valuation of $1,614,781,191.

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3.11 Public and Occupational Health

3.11.1 Major Radiation Exposure Sources and Rates

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/year (300 mrem/year) but varies by location and elevation (National Research Council of the National Academies, 2006). In addition, the average American receives 0.6 mSv/year (60 mrem/year) from man-made sources including medical diagnostic tests and consumer products (National Research Council of the National Academies, 2006). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/year (360 mrem/year). For a breakdown of the sources of this radiation, see **Figure 3.11.1, Radiation Exposure**.

Levels of natural or background radiation can vary greatly from one location to the next. People residing in Wyoming are exposed to more natural background radiation because of higher levels of cosmic radiation at higher altitudes and more terrestrial radiation from soils enriched in naturally occurring uranium. This naturally occurring uranium in the soil also results in a higher exposure to radon gas. Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite and limestone have higher radon levels than those with other types of soils/bedrock (EPA, 2006).

The TEDE is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic

radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material (TENORM), such as pre-existing radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

For the section of Wyoming where the SUA-1548 license areas are located, the average background radiation dose for the state of Wyoming is used: 3.16 mSv/year (316 mrem/year) (EPA, 2006). This value includes natural and man-made sources, including naturally occurring radon and cosmic radiation.

3.11.2 Major Chemical Exposure Sources and Rates

SUA-1548 operations are located in areas characterized by sparse population and the predominant land uses are agriculture and energy production. The region does not have any industrial activities that constitute a major source of chemical generation. As described in Section 3.0 of the TR, the primary chemical reagents associated with an ISR operation include sodium bicarbonate, carbon dioxide, hydrochloric acid and/or sulfuric acid, hydrogen peroxide, sodium hydroxide and sodium sulfide. Emission rates for these chemicals are typically well below the threshold that would trigger a permit. With respect to fugitive dust, the levels are too low to warrant a permit. Section 3.6 and Section 7.2 of the TR address both current and projected air quality conditions, including calculations of fugitive dust. In conclusion, because emissions are all below permitting action levels, the concentrations are protective of the public.

3.11.3 Occupational Health

According to the U.S. Department of Labor, Bureau of Labor Statistics 2009 report on non-fatal workplace injuries and illnesses, non-oil and gas mining and associated support activities employs just over 530,000 people and reported a total of 15.1 recordable illnesses or injuries (**Table 3.11-1, Labor Statistics**). The mining industry and services associated are Codes 212 and 213 in the National American Industry Classification System.

3.11.4 Summary of Health Effects Studies

Recent studies in the Montrose County, Colorado; the Colorado Plateau; Karnes County, Texas; Monticello City, Utah; and Grants, New Mexico areas specifically investigate health status in relation to possible exposure to uranium and vanadium during mining and milling activities. Summaries are provided below.

- Researchers compared mortality rates between 1950 and 2000 in Montrose County to those in five similar counties. They concluded that there was no evidence that residents in Montrose County experienced an increased risk of dying of cancer or other diseases because of environmental exposures associated with uranium and vanadium milling and mining activities (Boice, et al., 2007).
- Researchers evaluated the mortality experiences of 1,484 men employed in seven uranium mills in the Colorado Plateau for at least one year after January 1, 1940 (Pinkerton, et al., 2004). The study results stated that mortality from all causes and all cancers was less than expected based on U.S. mortality rates. The study found an excess in mortality from hematopoietic and lymphatic malignancies (other than leukemia), trachea, bronchus, and lung cancer, non-malignant respiratory disease, and chronic renal disease. For workers hired prior to 1955, mortality from lung cancer and emphysema was higher, presumably because their exposure to uranium, silica, and vanadium was higher. However, mortality did not increase with employment duration. The researchers' conclusion stated that based on the

study's limitations (i.e., small cohort size, inability to estimate individual exposure, lack of smoking data), that firm conclusions about the relation of increases in mortality and mill exposures were not possible.

- The same researchers that conducted the Montrose County study described above completed a mortality study for Karnes County, Texas in which they contrasted cancer rates in the county before, during, and after uranium operations (Boice, et al., 2003). The study also compared nearby counties with similar demographic characteristics. In conclusion, the study found that those cancers which might be increased following high exposures to uranium and its decay products were not elevated. The researchers qualified their conclusions with a statement that the ecological nature of the study design tempered the strength of the conclusions.
- The Utah Department of Health Office of Epidemiology completed a follow-up study for Monticello, Utah, where from 1943 to 1960 a mill processed uranium and vanadium in a location immediately adjacent to the town. The site and surrounding properties were placed on the EPA's National Priority List in 1986 and 1989 due to the chemical and radioactive contaminants associated with the mill. The initial health study in 2006 did not find conclusive evidence that the cancer rates were increasing in the Monticello area at a greater frequency than the rest of Utah. The current study found lung and bronchial cancer significantly elevated between 1993-1997, 1998-2007, and 1973-2004 and stomach cancer between 1998 and 2004. The study's limitations included low statistical power due to Monticello's small population; lack of data prior to 1973; and the lack of adjustment or evaluation for individual factors such as smoking or family history. The study recommended further investigation and/or monitoring of the area due to the elevations of lung and bronchial cancer.
- The mortality rate of uranium mining and milling workers near Grants, New Mexico between 1955 and 1960 was analyzed (Boice, et al., 2008). The study included 2,745 men and women alive after 1978 who were employed for at least 6 months. Increased mortality due to respiratory diseases and cirrhosis of the liver was found among the underground miners, which was likely attributable to the historically high levels of radon in the uranium mines combined with the heavy use of tobacco products. There was no statistically significant elevation in any cause of death among the non-miners. The study notes that although the population was relatively small, the follow-up was long (up to 50 years) and complete.

3.11.5 Smith Ranch Historical Baseline Radiological Survey Results

3.11.5.1 Vegetation and Soils

Annual soil and vegetation sampling were performed at Smith Ranch and Highland prior to 2000. Based on an NRC inspection that stated that the license did not require annual soil and vegetation sampling (IR 40-8857/99-02), the sampling program was terminated. The pre-2000 data could not be recovered. Soil samples were collected from the Reynolds Ranch Satellite for analysis of baseline radionuclide concentrations (Ra-226, Th-230, and U-238) and provided laboratory data for field correlation to the gamma survey described in Section 3.11.5.2. All soil samples were collected from vertical profiles exposed in back-hoe trenches or from auguring to depths less than 30 centimeters (12 inches) below the ground surface. Sample collection, quality assurance/quality control (QA/QC) and analysis began in 1988.

3.11.5.2 Baseline Gamma Survey

A background pre-mining radiological survey of the O-Sand pilot area was conducted and results were submitted in previous applications. Background gamma surveys were conducted on a 60 meter (200 foot) grid pattern for Wellfield Nos. 1 through 4. The results of these surveys show that the average background gamma radiation levels range from 10 to 17 μR/hour. Comparison of these data with historic background data collected from the Smith Ranch and Highland Air Monitoring Stations shows that the gamma measurements are in close agreement.

Three separate surveys were performed in 1985, 1988 and 1989 on lands covering the Highland portion of Smith Ranch. The results of these survey/sampling efforts are provided as Addenda D-10-1 through D-10-3 of Addendum D-10 B3 in Appendix D10 of the Smith Ranch WDEQ Permit. Figure A.8-1 and Figure No. 8-3 of Addendum D-10 B2 in Appendix D10 of the Smith Ranch WDEQ Permit present baseline gamma survey data for the West Highland Amendment area and the Section 14/24 wellfield area.

A background radiological survey of the Reynolds Ranch portion of Smith Ranch was conducted by SMC as part of their effort to develop a mine permit application for the area in 1989-1990. This survey does not cover the entire proposed area where a significant amount of the mining is expected to occur. Surface gamma levels determined during this survey are consistent with surface gamma surveys conducted previously for the western and eastern portions of the license area. Therefore, Cameco considers this survey representative of the entire license area. Additional baseline radiological surveys will be performed at the Reynolds Ranch portion of the license area as mine unit hydrologic data packages are developed. The survey associated with the Reynolds Ranch portion of the radiological assessment is contained in Addendum D10 C3 of Appendix D10 in the Smith Ranch WDEQ Permit.

3.11.5.3 Thermoluminescent Dosimetry

10 CFR §20.1502 (a)(1) requires exposure monitoring for "adults likely to receive, in one year from sources external to the body, a dose in excess of 10% of the limits in §20.1201 (a)". Ten percent of the dose limit would correspond to a Deep Dose Equivalent (DDE) of 0.500 rem. External radiation exposure was monitored at the Highland facility during the period 1988 through 1993 by the use of personal radiation dosimeters, such as Thermoluminescent Dosimeter badges (TLDs) or Optically Stimulated Luminescent dosimeter badges. All employees, except several office personnel that did not enter areas where potential exposures existed, utilized dosimeters. During the period 1988 through 1993 the monitoring data collected from the dosimeters showed that the annual dose to all workers was less than 10% of the 50 mSv (5,000 mrem) annual limit contained in 10 CFR §20.1201(a). Therefore, consistent with 10 CFR §20.1502, beginning on January 1, 1994, individual monitoring devices, such as TLDs, were only used to monitor occupational exposures to CPF operators because they could potentially exceed 10% of the annual limit contained in 10 CFR §20.1201(a) due to the potential exposure to airborne uranium. Details regarding personnel dosimetry are provided in Section 5.8.1.1 of the TR.

3.11.5.4 Atmospheric Rn-222

Airborne Rn-222 progeny monitoring was conducted in the Smith Ranch facilities for the periods indicated below (and continue to present) and is discussed in detail in the TR Section 5.8.2:

- Smith Ranch Pilot Plant 1999-2004
- CPP 1999-Present
- Satellite Plant SR-1 1999-Present
- Satellite Plant SR-2 2009-Present
- Satellite Plant 1 2000-Present

- Satellite Plant 2 2000-Present
- Satellite Plant 3 2000-Present
- Selenium Plant 2009-Present
- Header Houses 2000-Present

Occupational airborne radioactivity concentrations at Smith Ranch are routinely monitored at a frequency which allows for timely investigations and corrective actions, if needed, to respond to conditions or practices which result in airborne radioactivity concentrations above the action level of 25% of the DAC. Annual average air concentrations for natural uranium and Rn-222 progeny are well below this in all cases. Additionally, the annual average air concentrations are less than the 10% of DAC criteria where occupational monitoring of airborne radionuclides is required by 10 CFR §20.1502.

No increasing trends of workplace airborne radioactivity were identified, except at the header houses. The maximum concentration (6% of the DAC) at the header houses was recorded in 2004, but was reduced to 4% of the DAC by 2005. The decreasing trend continued through 2006 and 2007, but has slightly increased (~0.3%) during 2009 and 2010. There were several exceedances of the 25% of the DAC action level for maximum Rn-222 progeny concentrations during the 2008 to 2010 time period at the header houses. Cameco is committed to limiting occupational airborne radioactivity concentrations to levels which are ALARA.

3.11.5.5 Air Particulates

To ensure compliance with 10 CFR §20.1301, §20.1302 and §20.1501, Cameco maintains a continuous ambient air particulate monitoring program at five separate locations at Smith Ranch. The remote satellites at North Butte, Gas Hills and Ruth will have air particulate monitoring stations installed early in 2012 to collect air particulate data at those locations. An additional air monitoring station will be installed at the Reynolds Ranch satellite facility prior to commencement of operations. This station will be installed to replace the current upgradient station (AS-1, Dave's Water Well). The Highland CPF and the Smith Ranch CPP have the greatest potential for airborne releases to the environment. Two of these stations (AS-4 and AS-5) were used to monitor downwind conditions of the Highland CPF but are inactive as a result of the CPF being placed in standby status in 2002. Monitoring at AS-4 and AS-5 will resume once operations begin again at the refurbished CPF. Data analysis for the particulate monitoring program are reported in semi-annual reports to the NRC. The analyses have been summarized as discussed in Section 5.10.1 of the TR.

Airborne particulate levels at ISR yellowcake processing facilities that employ vacuum dryers are very low since there are no radionuclide emissions (see Section 4.1 of the TR for a description of the vacuum dryers). The primary potential source of airborne uranium is during yellowcake packaging. Between 1999 and 2010 the average and maximum measured concentrations were, excluding the maximum measurement in 1999, well below the DAC for soluble uranium (nat) of 5E -10 µCi/m. Details about the airborne uranium particulate monitoring are found in Section 5.8.2 of the TR.

3.11.5.6 Groundwater Radium-226

Groundwater quality data at Smith Ranch can be found in Section 3.4. More detail and laboratory data sheets can be found in Tables D6-5 through D-6.36 of Addendum D-6 A1 and Tables D6-6 and D6-7 of Addendum D-6 B1 to the WDEQ Permit. Extensive groundwater quality data, including baseline Radium-226 have been collected from each of the two Smith Ranch pilot projects in the western portion of Smith Ranch. These data were previously submitted to NRC and WDEQ in the NRC License Applications and LQD quarterly reports. In addition to sampling at the pilot projects, baseline water quality data was collected from about 30 other wells. These data are representative of the baseline water quality

throughout the western portion of Smith Ranch before ISR operations commenced. Typically five samples were collected from each well over a period of 6 to 9 months and analyzed for the full list of WDEQ approved parameters.

A vast amount of baseline groundwater quality data have been collected since ISR activities started at Highland. Baseline groundwater quality data have been collected from the A, B, C, D, E, F, H, I, and J-well field areas as part of required well field development activities. Numerous water quality samples have been collected from the 10, 20, 30, 40, 50 and 60 Sands to document baseline conditions within these well fields. These data are on file with both the WDEQ and NRC.

A baseline water quality comparison was conducted using Smith Ranch, Highland and Reynolds Ranch Satellite historical water quality data. Average concentrations of constituents from Smith Ranch and Highland (Tables D6-5 and D6-6 of Addendum D-6 A1; Tables D6-8 and D6-9 of Addendum D-6 B1 of the Smith Ranch WDEQ Permit) were combined with averages from Reynolds Ranch Satellite Mine Unit 27 to produce Table D6-9 (Appendix D6 of the WDEQ Permit). An average baseline range of parameters were created using Smith Ranch, Highland, and Reynolds Ranch Satellite data and compared to the approved mine unit baseline data. Averages for approved mine unit baseline data were developed from MP wells (i.e., interior production zone wells). A summary of the water quality data mentioned above is presented in Table D6-9 of Appendix D6 of the Smith Ranch WDEQ Permit.

Comparing the approved mine unit data to the baseline average range of parameters, 98 outliers were identified from the hundreds of analyses that were performed. The majority of outliers were just outside the minimum or maximum average. Of note are uranium values for Mine Units C and D which exceed the average range of concentrations with values of 2.1 and 1.1 mg/L, respectively.

The average water quality results for the approved mine units are similar to the baseline water quality determined for the Smith Ranch, Highland, and Reynolds Ranch Satellite areas. Based on past analyses the Smith Ranch water quality is dominated by calcium-sodium-bicarbonate-sulfate water.

3.11.5.7 Surface Water Radium-226

Surface water use at Smith Ranch is for livestock and wildlife watering. Section 3.4 provides a more specific presentation on water quality. In summary Smith Ranch drainages are ephemeral and flow only in response to snowmelt or major precipitation events. Stock ponds and playas impound the water on a seasonal basis. Exxon regularly analyzed water samples from selected points in the Box Creek drainage during the period of surface mining activities. The data, which historically have been considered to be representative of surface water quality for Smith Ranch, Highland, and Reynolds Ranch Satellite, are included in Table D6-3 in Addendum D-6 B1 of the WDEQ Permit. Sampling locations are shown on Figure D6-1 in Addendum D-6 B2 of the WDEQ Permit.

Sampling for radiological constituents has been conducted at select surface water points within Smith Ranch since 2003 and since 1987 from the Highland area. Figure D6-2 of Appendix D6 of the WDEQ Permit show the radiological surface water sampling locations. The results are summarized in Table D6-2 of Appendix D6 of the WDEQ Permit. Surface water and sediment samples were collected at Reynolds Ranch between August 17 and 18, 2011. In general, surface water radionuclides concentrations meet or exceed state and federal water quality standards. With respect to sediment samples concentrations of radium-226 and lead-210 average 2.7 pCi/gram, uranium concentrations average 1.3 pCi/gram, and thorium-230 concentrations average 0.9 pCi/gram. The results are described in Section 4.0.

3.11.6 North Butte Historical Baseline Radiological Survey Results

Several baseline sampling programs were implemented at the North Butte Remote Satellite in order to characterize pre-mining radiological conditions. Components of the pre-mining environmental radiological sampling program at the Ruth Remote Satellite include vegetation, soils, sediment, gamma ray survey, TLD, atmospheric Rn-222, groundwater (Ra-226), and surface water (Ra-226).

3.11.6.1 Vegetation

Vegetation samples were collected in June of 1998 at three locations adjacent to the air monitoring sites as shown on Plate D10-1 in Appendix D10 of the North Butte WDEQ Permit. All samples were analyzed for Th-230, Ra-226, Pb-210 and U(nat). The results are listed in Table D10-1 in Appendix D10 of the North Butte WDEQ Permit.

3.11.6.2 Soils

Soil samples were collected at the same three locations as vegetation (Plate D10-1 in Appendix D10 of the North Butte WDEQ Permit). Samples were collected from 0 to 5 centimeters (0 to 2 inches), 5 to 10 centimeters (2 to 4 inches), and 10 to 15 centimeters (4 to 6 inches) and analyzed for Th-230, Ra-226, Pb-210 and U(nat). The results are listed in Table D10-2 in Appendix D10 of the North Butte WDEQ Permit. Addendum D10-1 to Appendix D10 of the North Butte WDEQ Permit presents the results of verification soils sampling conducted in 2010.

3.11.6.3 Gamma Survey

A background gamma radiation survey was conducted on portions of the North Butte Remote Satellite in 2010. A total of 423 gamma readings were recorded in the four selected areas. The plant and well field portions were surveyed on a ~15 meter (50 foot) transect interval, the proposed roadway at 46 m (150 foot) intervals in the road center, and the additional permit area was covered by 15 to 168 m (50 to 550 foot) transect intervals. No specific features were encountered showing elevated gamma readings, including sandstone outcrops and drainages.

Radionuclide analyses of soil samples collected in 2010 from the top 15 centimeters (6 inches) were consistent with the historical data collected in the 1980s. Table D10-1.1 in Appendix D10 of the North Butte WDEQ Permit summarizes the data collected during both periods. Generally, the 2010 verification field gamma survey data agrees with the data collected in the mid-1980s.

Readings were taken at six locations on and adjacent to the North Butte Remote Satellite with TLDs as shown on Plate D10-1 in Appendix D10 of the North Butte WDEQ Permit. TLDs were changed quarterly. The results are listed in Table D10-6 in Appendix D10 of the North Butte WDEQ Permit.

Radon-222 was continuously monitored at the TLD stations with Trak-Etch radon monitors that were changed quarterly. The six TLD monitoring stations are shown on Plate D10-1 in Appendix D10 of the North Butte WDEQ Permit. The results are listed in Table D10-7 of the North Butte WDEQ Permit.

3.11.6.4 Air Particulates

Radiological air particulates were measured from three locations using Hi-Volume air samplers (Plate D10-1 in Appendix D10 of the North Butte WDEQ Permit). Samples were collected once each month with between 4,000 and 5,000 meters^3 (140,000 to 175,000 feet^3) of air passing through the sampler. Monthly samples were composited on a quarterly basis and analyzed for Th-230, Ra-226, Pb-210 and U(nat). The results are presented in Table D10-8 in Appendix D10 of the North Butte WDEQ Permit.

3.11.6.5 Groundwater Radium-226

Cameco has sampled groundwater data from 25 wells completed in the ore (A/B and C Sands) and overlying F Sand. Radium-226 values from groundwater samples collected range from <0.2 to 82.4 pCi/Liter with an average of 6.5 pCi/Liter. The analytical results of groundwater sampling are described in Appendix D-6 of the North Butte WDEQ Permit. Additional data will be collected during the hydrologic testing program and will be used to characterize the aquifer for RTVs.

3.11.6.6 Surface Water Radium-226

Cameco has established 18 new surface water quality sampling sites in addition to maintaining the three original points established by Uranerz (SWS1, SWS2, and SWS3). The drainages in and around the permit are ephemeral in nature, which complicates Cameco's ability to collect live flowing and representative surface water samples. The surface water quality sampling sites established by Cameco are all at impoundment locations where a berm or dam structure is trapping water creating a holding pond. The location of all 21 sites and water quality data can be found in the WDEQ Permit (Addendum D6 to Appendix D6).

All 21 surface water quality sampling sites were visited during field data collection in August 2010. During this time, the majority of the historic and contemporary water quality sampling sites were dry preventing the collection of water samples for analysis. Three impoundment sites (NBI5, NBI12 and NBI16) contained ponded water and were sampled. Chemical analysis was completed at Energy Labs for all WDEQ Guideline 8 parameters. Radium-226 concentrations ranged from 1.3 to 3.0 pC/L.

3.11.7 Gas Hills Remote Satellite Historical Baseline Radiological Survey Results

Much of the land at the Gas Hills Remote Satellite has been previously disturbed by mining activities. A baseline radiological survey was performed both to establish the nature of the pre-mining radiological conditions and to document areas exhibiting high radiation as the result of previous conventional mining activities. In addition to a gamma ray survey, baseline data was collected on the radiological characteristics of soil, air, groundwater and surface water.

3.11.7.1 Gamma Survey

The initial gamma survey was completed at the Gas Hills Remote Satellite in the mid-1990s. The area was divided into a 150 meter (500 foot) grid. A Ludlum model 12S scintillometer was held approximately 1 meter above the surface while traversing a serpentine course over each grid transect. Gamma readings were continuously observed and averaged readings were recorded for each grid square. The survey results are presented on Plates D10-1E and D10-1W in Appendix D10 of the Gas Hills WDEQ Permit.

In addition to the gamma survey completed on a 150 meter (500 foot) grid, a more detailed survey completed on a 30 meter grid was done in the vicinity of the Carol Shop. The detailed gamma survey results are shown on Plate D10-2 in Appendix D10 of the Gas Hills WDEQ Permit.

Gamma readings averaged 20 μR/hour across the Gas Hills Remote Satellite which is in line with other Wyoming sites. As was expected, much higher readings were observed in areas previously disturbed by mining activity. More specifically, the areas exhibiting the highest gamma readings are those containing ore and waste rock piles left from previous conventional mining activities. Higher levels were also found on or associated with former ore haul roads (i.e., the Carol Shop Road).

A second evaluation of baseline radiological characteristic was completed in 2008 in response to Condition 9.13 to NRC License SUA-1548 which states:

Before engaging in any uranium recovery operations in an undeveloped area, the licensee shall submit a complete evaluation of the area's baseline radiological characteristics for NRC's review and approval.

Direct gamma radiation measurements were collected at 150-meter intervals with a Ludlum Model 19 microR survey meter in four areas designated as Study Areas A, B, C and D (Map 1: Gas Hills Project Area in Appendix A to Addendum D10-1 in Appendix D10 of the Gas Hills WDEQ Permit). Samples were collected 1 meter (3 feet) above the ground surface. Direct radiation measurements taken in Study Area A ranged from 17 to 73 μR/hour with an average of 21.84 μR/hour. Direct radiation measurements taken in Study Area B ranged from 22 to 150 μR/hour with an average of 39.86 μR/hour. Direct radiation measurements taken in Study Area C ranged from 15 to 19 μR/hour with an average of 16.79 μR/hour. Direct radiation measurements taken in Study Area D ranged from 16 to 28 μR/hour with an average of 21.84 μR/hour.

3.11.7.2 Soil

A total of 40 soil samples were collected from 20 sample locations throughout the Gas Hills Remote Satellite. Samples were collected from 0 to 15 centimeters (0 to 6 inches) and 18 to 61 centimeters (7 to 12 inches) and analyzed for Th-230, Ra-226, Pb-210 and U(nat).

Sampling results corroborate the results of the gamma survey in that the areas containing high background concentrations of radionuclides are those that have been previously disturbed by conventional mining activities. Sample locations are shown on Plate D10-1 in Appendix D10 of the Gas Hills WDEQ Permit. The results are listed in Table D10-1 in Appendix D10 of the Gas Hills WDEQ Permit.

A second set of soil samples were collected in conjunction with the evaluation of baseline radiological characteristics completed in 2008 in response to Condition 9.13 to NRC License SUA-1548 (see Section 3.11.7.1).

3.11.7.3 Air Characteristics

A pre-operational air monitoring program was established at four locations across the Gas Hills Remote Satellite site for ambient gamma exposure and radon concentrations. Gamma measurements resulted in average exposure rates of approximately 170 mR/year and the average radon concentration was 1.6 pCi/Liter.

3.11.7.4 Groundwater Radium-226

Groundwater samples were collected and analyzed from 47 wells at the Gas Hills Remote Satellite. Uranium concentrations in groundwater are relatively low in all monitoring wells including the ore zone wells. Maximum uranium concentrations were identified at Well BSMP-1 (0.320 milligrams/Liter), Peach MP-1 (0.307 milligrams/Liter), and Veca MW3A (0.209 milligrams/Liter). The BSMP and Peach wells were completed in the ore zone within Mine Unit 2 and 3, respectively. The Veca well is completed downgradient from extensive AML reclamation and reflects an anomalously high increase in dissolved uranium.

Radium-226 concentrations in the groundwater are variable. Radium is in equilibrium with uranium in the aquifer, and higher concentrations are found near existing and mined out uranium deposits. For example, Peach MP-1 (540 pCi/Liter) and MUMP 97-1 (898 pCi/Liter) are completed in ore bodies (Mine Units 3 and 1, respectively). These values exceed the Class IV standard by 100 to 180 times. Outside the ore bodies, radium levels are significantly lower. Upgradient from these deposits, radium-226 is typically less than 5 pCi/Liter. Downgradient values are higher, but still less than 50 pCi/Liter. Mean values of

radium-226 per mine unit are presented on Table D6-3-3 in Appendix D6 of the Gas Hills WDEQ Permit. These mean values are skewed on the high end of the spectrum, based on the influence of the ore zone wells. Nevertheless, radionuclide levels within the mine units generally make these waters unsuitable for Class III (livestock use).

3.11.7.5 Surface Water Radium-226

Uranium and radium-226 data collected for surface water sites in 1996 and 1997 are indicative of the extensive surface mining activities in the Gas Hills. Sample sites SW-1 and SW-2 exhibit relatively low uranium contents, ranging from 0.020 to 0.080 milligrams/Liter. Sample sites SM-5 and SM-6, located downstream of mining disturbances, show higher variability in uranium concentrations with observations ranging from 0.006 to 3.2 milligrams/Liter. Variability may be due to the timing of the sampling in relation to the time since previous precipitation events.

Radium in surface waters shows significant variation without regard to the mine disturbances. Radium-226 values are typically below 5 pCi/Liter but elevated levels have been observed. The maximum level within the available data is 372 pCi/Liter recorded at sample site SM-7. Radium levels in the open pits (Buss 1 and 3) are typically below 5 pCi/Liter. West Canyon Creek has shown similar variability in radium concentrations. Since the monitoring sites were established, radium-226 levels have generally been below 1 pCi/Liter; however, a high of 17.1 pCi/Liter was measured at sample site WCC-1.

3.11.8 Ruth Remote Satellite Historical Baseline Radiological Survey Results

Components of the pre-mining environmental radiological sampling program at the Ruth Remote Satellite include vegetation, soils, sediment, gamma ray survey, TLD, atmospheric Rn-222, groundwater (Ra-226), and surface water (Ra-226). The results of the environmental radiological sampling program are presented in Section 14, Volume 1 of "Supplemental Information for Wyoming D.E.Q. Permit to Mine Application and U.S.N.R.C. Source Materials License Application" (Ruth Supplemental Report) and summarized below.

3.11.8.1 Vegetation

Vegetation samples were collected from four locations at the Ruth Remote Satellite as shown on Figure 14.1, Volume 2 of the Ruth Supplemental Report. All samples were analyzed for Th-230, Ra-226, Pb-210 and U(nat). The results are listed in Table 14.1, Volume 1 of the Ruth Supplemental Report.

3.11.8.2 Soils

Soil samples were collected at the same four locations as vegetation (Figure 14.1, Volume 2 of the Ruth Supplemental Report). Samples were collected from 0 to 5 centimeters (0 to 2 inches), 5 to 10 centimeters (2 to 4 inches), and 10 to 15 centimeters (4 to 6 inches) and analyzed for Th-230, Ra-226, Pb-210 and U(nat). The results are listed in Table 14.2, Volume 1 of the Ruth Supplemental Report.

Surface soil samples were collected every 300 meters (91 feet) along the ore body trend in conjunction with a gamma survey completed in the early 1980s. Soil samples were also collected at upwind and downwind sampling sites on the Ruth Remote Satellite but away from the known ore body. The results of both of the above are presented in Table 14.6, Volume 1 of the Ruth Supplemental Report.

3.11.8.3 Sediment

Sediment samples were collected at two locations on the Dry Fork of the Powder River (Figure 14.1, Volume 2 of the Ruth Supplemental Report). One sample was collected at SWS-U (upstream of the Ruth Remote Satellite) and four samples were collected at SWS-L (downstream of the Ruth Remote Satellite). Table 14.3, Volume 1 of the Ruth Supplemental Report lists the analytical results of the pre-operational

radiological sediment samples and Table 14.4, Volume 1 of the Ruth Supplemental Report lists the analytical results of the R&D pre-operational discharge point sediment samples.

3.11.8.4 Gamma Survey

A gamma survey was completed on a 60 meter (18 foot) grid overlying the ore body. Two μR/hr meters were used in the survey; a digital meter took readings at fixed points on the grid, and an analog meter took continuous readings both at grid points and between. At each fixed point on the grid three readings were collected and averaged. The analog meter recorded anomalies over the ore body. Both continuous and fixed point readings ranged from 9 to 14 μR/hour with an average of 10.6 μR/hour and a standard deviation of 0.7 μR/hour. The results of the gamma survey are listed in Table 14.5, Volume 1 of the Ruth Supplemental Report.

Gamma readings were taken at upwind and downwind sampling sites on the Ruth Remote Satellite but away from the known ore body. The results of this gamma survey are listed in Table 14.2, Volume 1 of the Ruth Supplemental Report.

3.11.8.5 Thermoluminescent Dosimetry

Readings were taken at seven locations on the Ruth Remote Satellite with TLDs as shown on Figure 14.1, Volume 2 of the Ruth Supplemental Report. TLDs were changed quarterly. The results are listed in Table 14.7, Volume 1 of the Ruth Supplemental Report.

3.11.8.6 Atmospheric Rn-222

Radon-222 was continuously monitored at the TLD stations with Trak-Etch radon monitors that were changed quarterly. The seven TLD monitoring stations are shown on Figure 14.1, Volume 2 of the Ruth Supplemental Report. The results are listed in Table 14.8, Volume 1 of the Ruth Supplemental Report.

3.11.8.7 Groundwater Radium-226

Radium-226 values from groundwater samples collected ranges from <0.06 to 175 pCi/Liter with an average of 16.4 pCi/Liter. It is typical to see elevated Ra-226 in groundwater in which the aquifer shows significant uranium mineralization as it creates a complex geochemical environment. The analytical results of groundwater sampling are described in Section 10.1.6, Volume 1 of the Ruth Supplemental Report.

3.11.8.8 Surface Water Radium-226

Surface water quality samples were collected at two locations on the Dry Fork of the Powder River (Figure 14.1, Volume 2 of the Ruth Supplemental Report). One sample was collected at location SWS-U (upstream of the Ruth Remote Satellite) and four samples were collected at location SWS-L (downstream of the Ruth Remote Satellite). A total of 18 samples were collected at SWS-L and 14 at SWS-U. The results are listed in Table 10.17, Volume 1 of the Ruth Supplemental Report.

3.11.9 References

National Research Council of the National Academies. 2006. Health Risks from Exposure to Low Levels of Ionizing Radiation – BEIR VII Phase 2. The National Academies Press.

3.12 Waste Management

ISR facilities generate several types of liquid and solid wastes. This section describes the existing sources and types of waste generated by SUA-1548 activities as well as Cameco's current waste management practices.

Liquid wastes include:

1. 11e.(2) Liquids: Refers to all byproduct material liquid wastes resulting from Cameco's ISR processes.
2. Non-11e.(2) Liquids: Refers to all non-byproduct material liquid wastes and includes sanitary waste water and well development and testing water.

Solid wastes include:

1. 11e.(2) Solids: Refers to all solid wastes resulting from Cameco's ISR activities that exceed the NRC limits for unrestricted release.
2. Non-11e.(2) Liquids: Refers to all non-hazardous solid waste including domestic trash, construction demolition debris, septic solids, and solid byproduct material that has been determined to meet NRC criteria for unrestricted release; and Resource Conservation and Recovery Act (RCRA) or state-defined hazardous waste that is non-11e.(2) and includes universal hazardous wastes and used oil.

3.12.1 Smith Ranch – Liquid Wastes

Liquid waste streams presently being generated at SUA-1548 facilities include those associated with the operation of the CPP and on-site satellites in addition to the production of domestic (non-11e.(2)) wastes. Domestic wastes may include septage and any liquids which do not contact process fluids or the processing portion of the uranium extraction operations. The following sections describe the current waste streams at Smith Ranch in addition to current waste management practices.

3.12.1.1 Central Processing Plant and Central Processing Facility

There are five primary process waste water streams (all 11e.(2)) for the Smith Ranch CPP and the proposed CPF:

1. Well field bleed, averaging up to 1.5% of production flow rates;
2. Groundwater restoration waste water;
3. Excess water from elution and precipitation circuit;
4. Well work-over water; and
5. Wash down water.

All of these waste streams will be combined and treated at the CPP or CPF as follows:

1. Filtration to remove suspended solids;
2. Disposal via a Class I UIC injection well(s).

3.12.1.1.1 Class I UIC Injection Wells

Smith Ranch is permitted for 10 Class I UIC injection wells to dispose of excess water generated by both IX and yellowcake processing operations. Table 3-7 (in Section 3.6.1.3 of the TR) lists the well ID's, permits, authorized injection rates and analysis requirements for these disposal facilities. The locations of these wells are shown on WDEQ Plates OP-1-1 through OP-1-6. Cameco will comply with permit conditions identified within the individual UIC permits. **Table 3.12-1, Deep Disposal Well Rates** lists the volume of fluids disposed at each functioning deep disposal wells.

3.12.1.1.2 Waste Water Storage Ponds

Two small, lined storage ponds are in operation at the CPP. These ponds were initially constructed in 1981 and authorized under the Q-Sand Pilot Project (WDEQ Permit to Mine 633 and NRC License SUA-1387). These ponds are located just to the north of the CPP, and are used for limited process effluent storage prior to transfer to the injection wells. The capacity of each pond is 962 meters3 (0.78 acre-feet) of water. Each pond is 30.5 meters x 30.5 meters and 2.4 meters (100 feet x 100 feet and 8 feet). During operations, 1 meter (3 feet) of freeboard is maintained in each pond to prevent over topping and to protect the berms from wave action damage due to wind.

Each pond is constructed with a compacted sandy clay base overlain by a 30 mil thick Hypalon liner. The bottom of each pond has a two way slope toward the center. A sand layer is placed over the bottom of the pond with the synthetic liner on top of the sand. For each pond, a perforated PVC pipe is installed in the sand layer parallel to the bottom slope. The perforated pipe is connected to a collection sump. The sumps are monitored for leaks of process solutions.

3.12.1.2 *Smith Ranch Satellites*

There are five primary process waste water streams (all 11e.(2)) at all Smith Ranch satellites:

1. Well field bleed, averaging up to 1% of production flow rates;
2. Groundwater restoration waste water;
3. Well work-over water;
4. Reverse osmosis reject concentrate;
5. Wash down water; and

All of these liquid waste streams will be combined and treated in the satellite as follows:

1. Filtration to remove suspended solids;
2. Treatment to remove Ra-226 and selenium;
3. Disposal via a Class I UIC injection well(s) or land application.

In addition to the disposal wells radium settling basins, purge storage reservoirs, and a selenium treatment facility have been installed to assist in the waste water disposal. WDEQ Figure OP-4 provides a schematic describing waste water treatment at the satellites.

3.12.1.2.1 Class I UIC Injection Wells

During 2009, Class I UIC Permit 09-054 was approved by WQD authorizing the use of seven additional disposal wells; Morton 1-20, Vollman 33-27, and SRHUP #6 through SRHUP #10. The Morton 1-20 is located in NW¼ NW¼, Section 20, T36N, R72W; the Vollman 33-27 is located in NW¼ SE¼ Section 27, T36N, R73W (see SR Plates OP-1-1 through OP-1-5). Both the existing Morton 1-20 well and the Vollman 33-27 are completed in a deep injection zone within intervals from 2,446 to 2,785 meters (8,024 to 9,138 feet) below the surface and are permitted for injection into the Teckla, Teapot and Parkman formations. **Table 3.12-1, Deep Disposal Well Rates** lists the volume of fluids disposed at each functioning deep disposal wells.

3.12.1.2.2 Satellite 1 Radium Settling Basins

The radium settling basins were constructed in 1987 to settle residual radium-barium sulfate out of the Satellite 1 waste water after filtration and prior to land application. The area consisted of two 3,700 meter (3 acre-foot) lined ponds located east of Satellite 1. Water that passed through these basins then went to the Purge Storage Reservoir 1 (PSR-1) where it was stored prior to periodic land application. The

radium settling basins were originally permitted by WQD under Permit 87-042R prior to being amended into the LQD Permit to Mine 603.

Cameco has initiated the decommissioning and reclamation of the radium settling basins. The synthetic upper liner, leak detection system and most of the underlying clay liner have been removed and disposed at a NRC-licensed disposal site. A small amount of clay liner remains containing low levels of uranium and Ra-226. Assessments are currently being made to complete final reclamation and decommissioning of the basins. Any additional liner material that does not meet unrestricted release requirements will be disposed of at a NRC-licensed disposal facility.

3.12.1.2.3 Purge Storage Reservoir No. 1

PSR-1 is located east of Satellite 1 and was used to store treated mine unit purge water and treated water from Mine Units A and B restoration activities. The reservoir contains 6.6 hectare-meter (54 acre-feet) of water when at full capacity. Water stored in the reservoir was periodically land applied by a center pivot irrigation system on a 23.5 hectare (58 acre) irrigation area when weather conditions permitted. PSR-1 was originally permitted by WQD under Permit No. 93-178, and later by Permit 95-156R. The PSR-1 and associated leakage pump back system are permitted under the LQD Permit to Mine 603. PSR-1 is currently in an interim stabilization status and contains no water. There is an on-going investigation at the PSR-1 and associated land application area, including annual sampling of soils and vegetation, to assist in determining the best management of the facilities in the future as well as the reclamation and surety requirements.

The reservoir is underlain by a natural clay soil that contains an average permeability of approximately 1.8E-8 centimeters/second. Use of the reservoir began in January 1988 with the start of production from the Satellite 1 area. The reservoir performed as designed until August 1994, at which time a small amount of leakage was discovered at the two ephemeral drainages located immediately east and south of the reservoir. A Corrective Action Plan (CAP), which addressed the conditions at the reservoir and corrective measures to be implemented, including the installation of two pump back sumps (north and south pump back sumps), was submitted to the NRC and LQD in correspondence dated October 3, 1994. It was determined that the seepage resulted from erosion of the natural clay liner along the eastern most portion of the reservoir. The erosion was caused mostly by wave action. Erosion of the clay liner exposed an underlying sandstone which allowed seepage to move out of the reservoir, to the south and east, where the sandstone outcropped in the ephemeral draws.

On November 9, 1994, the treated excess water was diverted to Purge Storage Reservoir No. 2 (PSR-2) in order that PSR-1 could be dried out and repairs to the liner accomplished. Due to the abnormally wet spring of 1995, construction activities, which included repair of the clay liner and the addition of a geotextile fabric along the eastern side of the reservoir to protect against erosion, were not completed until August 1995. The CAP also included the construction of a 242 meter (800 foot) long interceptor trench approximately 91 meters (300 feet) south of PSR-1 in August 1996. The trench captures subsurface seepage from the south side of PSR-1 and pumps it back into the reservoir. The pumping system is fully automatic and continuously operates. The interceptor trench has been very effective in preventing seepage from PSR-1 from surfacing and entering the drainage south of the system. After the interceptor trench went into service, it was no longer necessary to operate the south pump back sump. Both the interceptor trench and north pump back sump are currently on standby as PSR-1 is not currently in use and contains no water. The system is monitored in accordance with requirements of the WDEQ permit. As part of the CAP, visual inspections, sampling of the seepage water, vegetation monitoring, and soil monitoring are conducted.

WDEQ Figure SR OP-15 shows the details of the interceptor trench and associated pumpback sump. The trench is approximately 2 to 6 meters (6 to 12 feet) deep depending on the topography. The bottom of the trench intercepts the fractured sandstone unit which transmitted the seepage. Approximately 46 to 61 centimeters (18 to 24 inches) of 2 centimeters (0.75 inch) gravel was placed in the bottom of the trench and surrounded the 10 centimeter (4 inch) polyvinyl chloride (PVC) drain pipe. A plastic liner was installed along the down gradient side of the trench to assist in capturing any seepage. The drain pipe drained seepage to the concrete sump which contains a submersible pump capable of pumping approximately 76 liters/minute (20 gallons/minute). When operational, the pump activates automatically by a float switch, and seepage is pumped back to PSR-1 through a buried 5 centimeter (2 inch) high density polyethylene (HDPE) pipe. Although the reservoir has not held water for several years, minor seepage continues to enter the pump back system. Therefore, this part of the system remains operational.

3.12.1.2.4 PSR-1 Land Application

The PSR-1 Land Application Areas 1A and 1B are located east of Satellite 1 near PSR-1. Area 1B has never been used for land application. Area 1A consists of a center pivot irrigation system which covers 23 hectares (58 acres). There has been no land application for several years at this site.

The PSR-1 Land Application Area was originally permitted together with PSR-1 by the WDEQ WQD under Permit No. 92-077 and later by Permit No. 95-156R and was incorporated into WDEQ LQD Permit to Mine No. 603. Monitoring requirements for vegetation, soils, etc. are included in **Table 3-8** in the TR.

3.12.1.2.5 PSR-2 and Associated Land Application Area

The PSR-2 Land Application Area is used for the disposal of well field purge and groundwater restoration fluids from mine units served by Satellites 2 and 3. During months of land application, monthly samples are collected and analyzed for the parameters listed in **Table 3-9** in the TR.

PSR-2 has a capacity of approximately 395,948 meters3 (321 acre-feet) of water. The land application area comprises approximately 47 hectares (116 acres). The locations of Satellite 2, PSR-2, land application area and the 10 centimeter (4 inch) HDPE pipeline used to transport treated water from Satellite 3 to Satellite 2 and PSR-2 are shown on WDEQ Plate OP-1. PSR-2 and its associated land application facility were originally permitted by WQD under Permit 93-410 prior to being amended into the LQD Permit to Mine 603. Similar to PSR-1, PSR-2 is underlain by several low permeability clay units.

The bleed from Satellite 2 to PSR-2 totals 9.1 hectare-meters (74 acre-feet) from June 1, 2010 to April 30, 2011. The bleed from Satellite 3 to PSR-2 totals 6.3 hectare-meters (51 acre-feet) from June 1, 2010 to April 30, 2011. A total of 7.1 hectare-meters (57.3 acre-feet) were moved from PSR-2 and land applied via Irrigator 2 during July and August 2010.

3.12.1.2.6 Selenium Treatment Facility

A selenium treatment facility has been constructed and is operating at a location approximately 13 meters (30 feet) southwest of Satellite 2. The facility is connected to Satellite 2 through buried pipelines and houses the selenium treatment circuit. After selenium treatment the water is returned to Satellite 2 for disposal.

Satellite 2 and the selenium treatment facility both process waste water currently being discharged into PSR-2 for subsequent land application. The selenium treatment facility provides selenium removal to a target concentration not to exceed average selenium levels of 0.1 mg/L. The average selenium concentration of all samples taken from the PSR-2 compositor during the entire operating season (approximately March-October) must not exceed 0.1 mg/L selenium. The treatment facility includes a

radium removal circuit that may potentially replace radium removal currently being done at Satellites 2 and 3.

Waste/remediation water is first treated for radium removal using a barium chloride solution that precipitates radium. The radium compound precipitate is allowed to gravity settle and is then concentrated by a filter press. The filtered solids are disposed at an NRC-licensed disposal facility.

Following radium removal, the remediation stream is processed in selenium removal columns. The spent media of the columns is cleaned in sand washing equipment. The resulting precipitate is allowed to gravity settle and is then concentrated in a filter press. The filtered solids are also disposed at an NRC-licensed disposal facility.

The washed sand media is recharged with iron to reestablish the 5:1 volume ratio and put back into the selenium removal columns for further processing.

3.12.1.3 Non-11e.(2) Domestic Liquid Wastes

Domestic liquid wastes from the restrooms and lunchrooms are disposed in an approved septic system that meets the requirements of the State of Wyoming and Converse County. These systems are in common use throughout the United States and the effect of the system on the environment is known to be minimal. Liquid waste from the facility laboratories are disposed at the deep disposal wells. The septic system designs for all SUA-1548 facilities meet all state and/or county requirements.

3.12.1.4 Non-11e.(2) Well Development and Testing Waters

Well development and testing waste waters reflect wastewater generated during well development and pumping tests. These tests generally occur following well installation or during hydrologic unit testing programs that precede well field development. This water is non-hazardous, non-byproduct material waste water and does not require treatment before disposal.

3.12.2 Smith Ranch - Solid Waste

Solid waste currently generated at Smith Ranch includes uncontaminated waste material, 11e.(2) or byproduct solid wastes and hazardous waste.

3.12.2.1 Non-11e.(2) Solid Waste

Waste which is not contaminated with radioactive material or which can be decontaminated and re-classified as uncontaminated waste (non-byproduct) includes piping, valves, instrumentation, and any other items that are not contaminated or which may be successfully decontaminated. If decontamination of waste material is possible, surveys for residual surface contamination are made before releasing the material for unrestricted release. Decontaminated materials must have activity levels lower than those specified in 10 CFR Part 20 for unrestricted release. Methods for decontamination and release of contaminated equipment are discussed in further detail in Section 4.3 of the TR.

Cameco estimates that Smith Ranch produces 2.7 metric tons (3 tons) of non-11e.(2) waste each month. Uncontaminated solid wastes are collected on the respective site and disposed of in the Converse County Landfill. A total of approximately 150 light bulbs, 30 of which are mercury halide are recycled annually by a company named DEC. One 5-gallon bucket of batteries is recycled off site each year by a company named Grainger. No pesticides or antifreeze are stored on site. Used oil is burned for heat and surplus is recycled off site. In 2010, two (500-gallon) barrels of oil were recycled off site. All waste electronics are being stored on site until an adequate recycling vendor is contracted. Tires are periodically picked up from Smith Ranch and recycled at Colorado Tire Recycling. In 2010, approximately

350 tires were recycled. A total of 150 metric tons (165 tons) of barium sludge waste are disposed of annually off site in Blanding, Utah. Domestic solid wastes (septage) from the restrooms and lunchrooms are disposed in the above described septic systems and the effect of the systems on the environment is minimal.

The potential exists for any industrial facility to generate hazardous waste as defined by RCRA. In the State of Wyoming, hazardous waste is governed by WDEQ Hazardous Waste Rules and Regulations. Based on preliminary waste determinations conducted by Cameco in consideration of the processes and materials that are used on the project, Cameco will likely continue to be classified as a Conditionally Exempt Small Quantity Generator, defined as a generator that produces less than 100 kilograms (220 pounds) of hazardous waste in a calendar month and that complies with all applicable hazardous waste program requirements. Cameco's experience to date is that only used waste oil and universal hazardous wastes such as spent batteries, fluorescent light bulbs, etc. will be generated at SUA-1548 properties. Cameco is committed to recycling universal wastes whenever possible.

3.12.2.2 11e.(2) Solid Waste

Solid wastes that have become contaminated with uranium and uranium daughter products as a result of recovering uranium are called 11e.(2) byproduct material. These types of wastes may include: tanks, vessels, IX resin, filter media, pond liners, decommissioning debris, process piping and equipment, etc. It could also include the solids remaining as a byproduct of the selenium treatment plant or in the surge or evaporation ponds at the end of the project.

All contaminated items that cannot be decontaminated to meet release criteria are properly packaged, transported, and disposed at a disposal site licensed to accept 11e.(2) material. It is estimated that between 38 and 329 meters^3 (50 and 300 yards^3) of solid 11e.(2) material will be generated each year at the Smith Ranch CPP and its associated contiguous satellite facilities. Those materials which cannot be decontaminated (thereby allowing unrestricted release) will be stored in appropriately labeled and covered containers and will be periodically transported to an NRC-licensed disposal facility. Cameco currently has a contract disposal agreement with Denison Mines (USA) Corp. for disposal at the White Mesa Mill in Blanding, Utah.

3.12.3 Remote Satellites

All three remote satellites covered under SUA-1548 (North Butte, Gas Hills and Ruth) are not currently in commercial production. The current primary waste generating activities at and adjacent to these remote satellites include livestock grazing, adjacent land uses including residential homes, CBM operations and exploratory uranium drilling.

Agricultural operations at the three remote satellites produce very limited quantities of miscellaneous trash. Some of this may be disposed off-site in small landfills near the proposed project area. No such landfills have been identified at or near any of the remote satellites. Typically each respective ranch house has a septic system to handle their domestic requirements and often have local municipal landfills to handle their solid wastes. There are no ranch houses within or adjacent to the Gas Hills Remote Satellite.

Nearby and adjacent to the North Butte and Ruth Remote Satellites, CBM production generates large volumes of waste water. All waste water from these CBM operations is fully contained and is piped away from the producing wells and is discharged to a surface stream (Salt Creek) in accordance with each company's NPDES requirements. Surface disposal of CBM water is not occurring in the vicinity of

either the North Butte or Ruth Remote Satellites. There are no CBM operations in the vicinity of the Gas Hills Remote Satellite.

Cameco is conducting exploratory uranium drilling at the North Butte and Gas Hills Remote Satellites. Exploratory drilling results in wastes, including drill cuttings and drilling wastes. Drilling wastes, as defined by EPA (2008) for ISR facilities, include drill muds, other drilling fluids, sludges, or evaporation products collected in excavated pits from waste water produced during drilling.

These are classified as TENORM, the definition of which is provided by EPA (2008):

> *"Naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing."*

Drill cuttings and drilling wastes are typically disposed on site in mud pits pursuant to EPA TENORM regulations. The BLM is the land management agency at the Gas Hills and Ruth Remote Satellites. Exploratory drilling is also governed by the BLM Plan of Operations (Gas Hills) that is filed with that agency. Prior to any exploratory drilling at Ruth, Cameco will coordinate this effort with the BLM as well as the LQD.

3.12.4 References

U.S. Environmental Protection Agency. 2008. Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining, Volume 1: Mining and Reclamation Background, USEPA Office of Radiation and Indoor Air Radiation Protection Division, EPA 402-R-08-005, April 2008.

4.0 Site Characterization and Description

4.1 Potential Land Use Impacts

4.1.1 Proposed Action

As discussed in Sections 2.2 and 3.1, the primary land uses at all sites covered under SUA-1548 are energy development and agriculture. While some land is used for wildlife habitat and recreation it is such a small proportion that these functions are not expected to be impacted from ISR development. ISR production will be compatible with local energy development including oil and gas, coal, CBM, and wind. Surface disturbances and exclusionary fencing will reduce grazing capacity within all SUA-1548 license areas, but the loss will be relatively small compared to the available surrounding rangeland. The maximum area expected to be impacted by approval of this LRA is approximately 1,520 hectares (3,755 acres). Approximately 40% (624 hectares or 1,542 acres) of the expected surface disturbances have already taken place as of September 2011 (see Section 3.3 for a complete discussion of existing surface disturbances). The additional potential land impacts expected from ISR operations will be less than 5% of the total SUA-1548 license areas and cumulative disturbances will be less than 8%. Disturbance estimates have remained similar since the last LRA and there is no anticipated change in the percent of disturbed area. Because only a small percentage of surface disturbances are anticipated, land use will likely continue to remain largely unaffected from ISR operations.

Potential impacts to land use are intrinsically tied to both the spatial and temporal extent of surface disturbances. ISR operations will include both long-term (more than one year) and short-term (less than one year) surface disturbances. Surface reclamation and revegetation occur concurrently with wellfield construction in order to minimize potential land use impacts. After reclamation, revegetated areas will be available for grazing and wildlife habitat for the remaining life of the project. Once production, restoration and reclamation are complete, all areas covered under SUA-1548 will be returned to the pre-ISR mining land use of livestock grazing and wildlife habitat for unrestricted use. Mitigation measures for the loss of agricultural production over the course of the project are discussed in Section 5.1. The following sections identify the specific potential impacts to land use within SUA-1548 and potential cumulative land use effects.

4.1.1.1 Smith Ranch

The Smith Ranch license area totals approximately 16,187 hectares (40,000 acres). The estimated total surface disturbances for the life of the project are expected to be approximately 761 hectares (1,880 acres), or less than 5 % of the total area (Reynolds Plan of Operations, BLM, 2011). Currently, approximately 570 hectares (1,410 acres) are already disturbed. The proposed increase in surface disturbance will be approximately 191 hectares (472 acres), or approximately 1% of the total Smith Ranch license area.

The majority of the long-term disturbances (more than one year) in the Smith Ranch license area has been constructed and includes: the Smith Ranch CPP and Highland CPF, uranium recovery satellite facilities, mine unit header houses, pump stations, powerline corridors and most access roads. Additional access roads and mine units are planned for the Reynolds Ranch Satellite but will be less than 1% of the Smith Ranch license area. Short-term disturbances (one year or less) from construction of monitor wells, pipelines and utility trench areas will be reclaimed and revegetated as soon as possible after construction has been completed. Individual mine units will be temporarily fenced during the period of production and restoration and will not be available for grazing. Cameco incorporates WDEQ and BLM guidelines into their fencing programs to ensure wildlife friendly fencing. Not only is the

estimated loss of grazing and wildlife habitat less than 5 % of the total area at Smith Ranch, but the exclusions associated with ISR development will be temporary.

Other identified land uses at Smith Ranch include the development of other natural resources, including uranium, coal, oil and gas, and wind energy. Currently all of these land uses are present within or adjacent to the license area and approval of the proposed action will not affect these land uses.

4.1.1.2 North Butte Remote Satellite

The primary land use at the North Butte Remote Satellite is rangeland and grazing. The North Butte Remote Satellite consists of approximately 409 hectares (1,010 acres). It is anticipated that a total of approximately 162 hectares (400 acres) will be disturbed during the life of the project. Current surface disturbances total about 12 hectares (30.5 acres), primarily from boreholes and monitor wells. Additional short- and long-term surface disturbances will include mine unit pattern areas during well field construction, surge ponds, IX recovery and water treatment facilities, mine unit piping distribution centers, pipelines, booster pump stations and access roads. The proposed development is expected to disturb at most approximately 150 hectares (370 acres). Mine unit pattern areas will be temporarily fenced during the period of production and restoration and will not be available for grazing. As for Smith Ranch, Cameco will incorporate WDEQ and BLM guidelines into their fencing to ensure wildlife friendly fencing. Since restoration, final reclamation and interim surface stabilization occur contemporaneously with development and production, the total disturbed area will not be more than approximately 162 hectares (400 acres) at any single point in time. In reality, this number will be even smaller since revegetation will immediately follow mine unit pattern establishment. Past experience at Smith Ranch suggests that vegetation will become well established within 3 years of initial disturbance. The production areas within each mine unit will be fenced to limit access by livestock but the surrounding license area will be open and available for grazing. The potential impacts to land use are in all cases temporary and reversible by returning the land to its former grazing use through post-ISR surface reclamation. There will be no potential long-term impacts or institutional controls following site decommissioning.

Other land uses in the North Butte Remote Satellite area include the development of other natural resources such as oil, gas, uranium, and CBM. Currently all of these land uses are adjacent to the license area and approval of the proposed action will not affect these land uses.

4.1.1.3 Gas Hills Remote Satellite

The Gas Hills Remote Satellite is predominately on public lands administered by the BLM, and is leased for sheep and cattle grazing. The license area is approximately 3,440 hectares (8,500 acres), but less than 20 % (607 hectares or 1,500 acres) of the license area is expected to be disturbed throughout the lifespan of the project. Existing buildings, drill holes and access roads are present within the license area and currently account for approximately 40 hectares (98 acres) of the expected total disturbances. Surface disturbances will be similar to other satellite locations and will include mine unit pattern areas during well field construction, evaporation ponds, IX recovery and water treatment facilities, mine unit piping distribution centers, pipelines, booster pump stations, UIC Class I disposal wells and roads. Mine unit pattern areas will be temporarily fenced during the period of production and restoration and will not be available for grazing habitat. Fencing will be wildlife friendly in accordance with WDEQ and BLM guidelines. Because construction and development is done in stages and reclamation follows each construction project, the disturbed area at any given time will be less than the projected total of approximately 516 hectares (1,275 acres). All land disturbances can be reclaimed and returned to unrestricted pre-ISR uses when mining ceases.

Other identified land uses at Gas Hills Remote Satellite include the development of other natural resources, including uranium, and oil and gas, as well as recreational usage of BLM land for hunting. Currently all of these land uses are present within or adjacent to the license area and approval of the proposed action will not affect these land uses.

4.1.1.4 Ruth Remote Satellite

The Ruth Remote Satellite is predominantly located on private grasslands. The license area is approximately 572 hectares (1,414 acres), although only a portion of this area will be disturbed similar to the other satellite locations. Surface disturbances will include mine unit pattern areas during well field construction, surge ponds, IX recovery and water treatment facilities, mine unit piping distribution centers, pipelines, booster pump stations and roads. Current disturbances at this site cover approximately 1.7 hectares (4.3 acres). Reclamation will follow all development projects and ensure that the disturbed area at any given time is kept to a minimum.

Other land uses within and adjacent to the Ruth Remote Satellite include the development of other natural resources such as oil, gas, uranium, and CBM. Currently all of these land uses are present adjacent to the license area and approval of the proposed action will not affect these land uses.

4.1.2 Potential Impacts of the No-Action Alternative

The no-action alternative would result in no additional potential land use impacts within SUA-1548. All current ISR production at Smith Ranch would cease and the current, though minimal potential land use impacts (fencing and restricted grazing) would slowly decrease as decommissioning, reclamation and restoration continue. The additional existing surface disturbances at the remote satellites will also need to be reclaimed. The total area within SUA-1548 that will need to be restored and reclaimed is approximately 624 hectares (1,542 acres). These lands will return to grazing and other energy development land uses.

4.1.3 Potential Impacts of the Alternative Action

Conventional underground and/or open pit mining represent the two available alternatives to ISR for the uranium deposits at SUA-1548. Both of these alternatives involve significantly greater potential short- and long-term impacts to land use and have historically taken place within the license area. As compared to ISR, conventional mining practices include large areas of mining, especially open pit mining, large stockpile areas, roads, processing facilities and large tailings disposal areas. Compared to the proposed action, conventional open pit mining could increase the acreage of disturbance by a factor of 100. Such lands disturbed by conventional mining would be removed from grazing for the life of the mine and often 10 years or more past reclamation. Conventional underground mining would result in an increase in land disturbance over ISR operations, but not as significant as conventional open pit mining. While the shaft and mill associated with underground mining is a smaller land disturbance, evaporation ponds and/or heap leach footprints can be substantial. In either case, the impact on land use would be far more significant if conventional mining methods were employed when compared to the proposed action.

4.1.4 Cumulative Effects of the Proposed Action

As discussed in Sections 2.2 and 3.1, the primary land use within and adjacent to SUA-1548 is energy development (oil and gas, coal, CBM, ISR and wind) and agriculture (cattle and sheep grazing). No major changes in land use are expected in the foreseeable future. Cameco's ISR operations have been and will continue to be compatible with energy development in the region and will only minimally disturb land surfaces and agricultural uses. It is estimated that less than 8% of the total SUA-1548 licensed acreage

will be disturbed throughout the life of the project, and ongoing efforts to minimize potential land use impacts will be taken (see Section 5.1). Cattle and sheep grazing will be temporarily limited as a result of construction and operation, but all land within SUA-1548 will be reclaimed and restored to its original use. Potential impacts to wildlife habitat and recreation will also be small because of the limited disturbance to the land. As a result, potential cumulative land use impacts from SUA-1548 are expected to be minimal in the Powder River Basin and Wind River Basin (see Section 2.2). Additional information regarding environmental effects of land use are discussed in Sections 7.1.2 and 7.2.3 of the TR.

4.2 Potential Transportation Impacts

4.2.1 Proposed Action

Selection of the proposed action will result in negligible potential impacts to transportation based on current traffic loading estimates (WYDOT, 2010) and transportation accidents impacts. Transportation activities associated with SUA-1548 include employee commuting, supply shipments, waste transportation, IX resin transport, and yellowcake transportation. ISR operations will increase local traffic volumes, but the change will be relatively small compared to local traffic volumes in the region. To reduce the potential impacts from a traffic accident, materials and supplies will be transported according to NRC and DOT regulations. Specific and quantifiable estimates of the potential impacts of the proposed action on local and regional transportation corridors are provided below. Mitigative measures, including emergency response plans and procedures, implemented to decrease potential impacts to transportation are discussed in Section 5.2.

4.2.1.1 Smith Ranch

Most of the Smith Ranch license area is currently in operation so no major changes in workforce vehicle traffic are expected. There will be an increase in workforce at the remote satellites ranging from 50 to 60 people at North Butte to 75 people at Gas Hills. Yellowcake slurry from the remote satellite facilities to the CPF and/or the CPP will increase as well as dried yellowcake shipments from Smith Ranch to the conversion facility in Port Hope, Ontario. North Butte is expected to ship 170 truckloads of uranium-laden resin to Smith Ranch each year while Gas Hills is expected to ship 447 truckloads of uranium-laden resin or yellowcake slurry to Smith Ranch each year. The number of shipments from these remote satellites is relatively small, with North Butte having an average daily truckload of 0.45 and Gas Hills having an average daily truckload of 1.2 relative to traffic loading estimates (WYDOT, 2010 and ER Section 3.2). The Ruth Remote Satellite would likely be similar to North Butte and ship less than one truckload per day to Smith Ranch. The addition of 2-3 truckloads between the remote satellites and Smith Ranch will not increase traffic rates on local roads by more than 1% and will likely be negligible. Specific traffic routes are discussed in further detail in Section 3.2.

4.2.1.2 North Butte

In the Powder River Basin, the primary potential traffic impacts from resin transfers between the North Butte Remote Satellite and Smith Ranch CPP or CPF will be realized on State Highway 387 between State Highway 50 and Highway 259. The increase in traffic will be less than 0.25%. Project-related traffic will be greatest from the operations and construction workforce which will be housed in surrounding communities. This workforce will commute to and from worksites and travel within worksites during work hours. A total of 33 vehicles are expected to commute to the North Butte Remote Satellite each day with approximately 75% coming from Gillette and 25% coming from Casper. Both, the percent increase on State Highway 50 coming from Gillette and the percent increase on State Highway 259 and 387 from Casper would be less than 3% and less than 1%, respectively.

4.2.1.3 Gas Hills

The Gas Hills Remote Satellite will increase traffic along: State Highway 136 between Riverton and the Gas Hills; Gas Hills Road from the satellite to State Highway 20 at Waltman; State Highway 26 north of Riverton to Shoshoni; and State Highway 20/26 from Shoshoni to Casper. Cameco estimates that ISR operations will increase travel to and from the Gas Hills Remote Satellite each day by approximately twenty to thirty vehicles and its greatest impact will be on traffic counts on the Gas Hills Road. Eighty percent are expected to travel from Riverton and twenty percent from Casper for the lifespan of the Gas Hills Remote Satellite. The percent increase on State Highway 136 would be 23 % and the increase on State Highway 20/26 east of Casper would be less than 2% (WYDOT, 2010). Although the relative increase in traffic along State Highway 136 is large, the road capacity of this state highway can easily accommodate this increase. At one time Wyoming 136 (Gas Hills Road) had the transportation capacity to accommodate workers for three to four simultaneously operating conventional mines and mills (Pathfinder, Umetco, Energy Fuels and American Nuclear). This transportation capacity remains and has been significantly underutilized since the mid-1980s.

4.2.1.4 Ruth

Similar to North Butte, Ruth will likely have their workforce come from either Gillette or Casper. Increases in traffic are likely to be similar to North Butte and will not likely increase traffic from either Gillette or Casper by more than 3%. If both satellites operate simultaneously the net increase in traffic on Highway 50 could be approximately 5%.

4.2.2 Potential Transportation Accident Impacts

Resin, yellowcake slurry, dried yellowcake and 11e.(2) byproduct material shipments are made in accordance with DOT, NRC, and Transport Canada (when applicable) regulations. Transportation of hazardous materials to and from SUA-1548 can be classified as follows:

- Shipments of uranium-laden resin and/or yellowcake slurry from SUA-1548 satellites to the CPP or CPF for processing.
- Shipments of process chemicals or fuel from suppliers to any SUA-1548 facility.
- Shipment of dried yellowcake from the CPP or CPF to a conversion facility.
- Shipments of 11e.(2) byproduct material from the CPP or CPF and satellites to a NRC licensed disposal facility.

SUA-1548 is an operating license and approval of the proposed action will allow transportation of the above types of materials to continue. Transportation accident risks may increase as the number of shipments increase, but mitigation measures such as transportation training, compliance with current and future transportation regulations and hazardous waste clean-up preparedness and training will reduce this accident risk and impact of any accidents. Accident risks involving potential transportation occurrences are discussed in the following sections. Mitigation and control measures to eliminate or minimize potential environmental impacts due to transportation accidents are discussed in Section 5.2.

4.2.2.1 Potential Accidents Involving Ion Exchange Resin or Slurry Shipments

IX resin or yellowcake slurry is transported to and from the CPP or CPF in 15 m3 (4,000 gallon) capacity tanker trailers. As many as four loads of uranium-laden resin may be transported for elution and up to four loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county, and state roads. For shipments of IX resin to a CPP, NRC determined that the probability of an accident involving such a truck was 0.009 in any year (NRC, 2009).

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium-laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the potential radiological and environmental impacts of such a spill are minimized. The radiological and environmental impact of a similar accident with barren, eluted resin would be less significant. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be refilled, graded and revegetated.

4.2.2.2 Potential Accidents Involving Shipments of Process Chemicals and Fuel

It is estimated that approximately four bulk chemical, fuel, and supply deliveries are made per working day throughout the operational life of SUA-1548. Types of deliveries include carbon dioxide, oxygen, salt, soda ash, hydrogen peroxide, sulfuric acid, hydrochloric acid and fuel. All shipments are made in accordance with the applicable DOT hazardous materials shipping provisions.

4.2.2.3 Potential Accidents Involving 11e.(2) Byproduct Material

11e.(2) byproduct material, including unusable contaminated equipment generated during operations, will be transported to a NRC licensed disposal site. Because of the low levels of radioactive concentrations involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable NRC and DOT hazardous materials shipping provisions.

4.2.2.4 Potential Accidents involving Yellowcake Transportation

NRC and others have previously analyzed the hazards associated with dried yellowcake transportation for both the generic case (Mackin, et al., 2001; NRC, 1980, NRC, 1977) and in site-specific environmental assessments (e.g., in NRC, 1997). These analyses are conservative and tend to overestimate potential impacts (e.g., release model, accident rates, dosimetry selections, exposed population density); however, they are appropriate for screening-level calculations. The NRC concluded that the risk analyses combined with past experience show estimated and actual consequences of such accidents are small, due in part to the appropriate use of safety controls and emergency response protocols on the part of the Licensee (NRC, 2009). An accident involving yellowcake slurry would actually present less of a risk since the material is wet and can easily be removed from the surface with minimal potential for residual surface or air quality impacts.

4.2.3 No-Action Alternative

The selection of the no-action alternative would result in a short term increase in 11e.(2) byproduct material transportation, but in general and over the long term a reduction in overall potential transportation impacts would occur as the workforce and shipments decrease. There may be some yellowcake shipments during restoration activities; however, overall construction activities, employee access and transportation of ISR-related fuels and supplies to the licensed facilities or waste materials away from facilities will cease following reclamation of existing SUA-1548 disturbances. Access roads, buildings and existing wells and well fields at Smith Ranch (approximately 570 hectares or 1,409 acres), North Butte (12 hectares or 30 acres), Gas Hills (39 hectares or 97acres) and Ruth (1 hectares or 4 acres) will all need to be reclaimed. This will result in a temporary increase in construction traffic over current levels, but will result in overall reduction in potential transportation impacts as the workforce decreases.

4.2.4 Alternative Action

The alternative action would include a conventional underground or surface uranium mine. The selection of this alternative would result in a significant increase in potential transportation impacts. A conventional mine may include processing facilities such as a new plant, tailings ponds or a conventional heap leach. A conventional open pit mine would include a significantly greater work force given the size of the operation and potential labor needs. Whereas ISR facilities require drilling rigs (2-3 men per rig) and facility operating staff travelling to the header houses, satellites and inspection of pipelines, a conventional mine requires either contract or company labor to drive scrapers, dozers, trucks and shovels. To strip 7,646 meters (10,000 yards) per day, an operation would likely require eight scrapers, four trucks, and two shovels as well as management and supervisory staff. Geologic and mine planning conditions would dictate the acreage stripped to meet production goals. Additionally, for any operation, ISR or conventional, personnel are required to meet needs at the plant, including engineers, chemists, environmental and safety staff, etc. For an equivalent conventional operation, one might anticipate two to three times the impact on roads that one would see with an ISR operation. A conventional mine will also require hazardous materials to be transported to customers or to an off-site location for processing. For the purposes of this analysis and assuming production goals are the same, it is assumed that shipping hazardous materials would be equivalent for both ISR and conventional mine operations.

4.2.5 Cumulative Effects of the Proposed Action

Cumulative effects from transportation at SUA-1548 are not anticipated to be significant. The existing and additional ISR operations during the renewal period will only minimally impact local road traffic within and adjacent to SUA-1548 license areas and when considered on a cumulative basis with regional energy development will have a negligible impact. ISR recovery at SUA-1548 will contribute a proportionally small portion of additional traffic to area roads as compared to other energy development and agricultural activities. The SUA-1548 sites are remote and local transportation networks include agricultural traffic, and the workers associated with other ISR operations, CBM, conventional oil and gas as well as wind development. Smith Ranch is an ongoing operation and approval of this LRA will result in an increase of the number of personnel to 170. The remote satellites will require additional personnel during initial construction, but this number will be reduced during operational periods. The majority of roads utilized by ISR operations are already built and additional roads will have relatively low rates of traffic so potential impacts to agriculture, recreation and wildlife are expected to remain small.

4.2.6 References

Nuclear Regulatory Commission. 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (NUREG-1910). Page last reviewed/updated Sunday, March 13, 2011.

Wyoming Department of Transportation (WYDOT). 2010. Automatic Traffic Recorder Report – 2010. Prepared in cooperation with U.S. Department of Transportation, Federal Highway Administration.

4.3 Potential Geology and Soils Impacts

4.3.1 Proposed Action

Potential geologic and soil impacts associated with ISR operations are significantly less than conventional underground or open pit mining. SUA-1548 geologic impacts have been in the past and are anticipated to continue to be negligible, and soil impacts will be minimal as well. The following sections describe the potential impacts to geology and soils associated with the proposed action.

4.3.1.1 Potential Geologic Impacts

Smith Ranch and the North Butte and Ruth Remote Satellites

Potential geologic impacts at Smith Ranch and the North Butte and Ruth Remote Satellites are expected to be minimal, if any. Unlike conventional uranium mining, ISR does not remove formation material from the aquifer, minimizing the chance of subsidence. No significant matrix compression or ground subsidence has been observed during 25 years of ISR operations at Smith Ranch, nor is it expected to result in the future from the proposed action.

Historical seismic activity within and around SUA-1548 are summarized by county in Section 3.3, and have been reviewed and evaluated by the NRC Staff during previous licensing actions for Cameco and other licensees operating in the region. While seismic activity has occurred, the earthquakes have been relatively small with minimal impacts. Additionally, no active faults with a surficial expression have been documented at Smith Ranch or the North Butte and Ruth Remote Satellites. As a result, potential environmental impacts from seismic activity are expected to be minimal. Mitigation measures to reduce potential impacts from seismic activity are discussed in Section 5.3.

Gas Hills Remote Satellite

Potential geologic impacts from subsidence are expected to be minimal at the Gas Hills Remote Satellite for the same reasons as cited above for Smith Ranch, North Butte and Ruth Remote Satellites. Because ISR does not remove formation material from the aquifer, no subsidence or matrix compression is anticipated.

Section 3.3 summarizes historical seismic activity within and around the Gas Hills Remote Satellite. In general, there has been minimal expression of regional earthquakes. The closest fault, the Green Mountain segment of the South Granite Mountain Fault System, is located about 45 kilometers (28 miles) from the Gas Hills Remote Satellite. This fault was analyzed deterministically to estimate ground motion at the Gas Hills Remote Satellite. Results from this study indicated that horizontal ground acceleration at Gas Hills would be approximately 6%g for a magnitude 6.75 earthquake (see Section 3.3). With seismic activity anticipated to be small, potential impacts at the Gas Hills Remote Satellite are also anticipated to be minimal. Mitigation measures, as described in Section 5.3 will minimize potential impacts from seismic activity at the Gas Hills Remote Satellite.

4.3.1.2 Potential Soils Impacts

The principal impact to at SUA-1548 will be from earthmoving activities associated with construction of ISR facilities. Earthmoving activities include:

- Clearing of ground or topsoil and preparing surfaces for the satellite facilities, pump houses, access roads, drilling sites, and associated structures;
- Excavating and backfilling trenches for pipelines and electrical cables;
- Excavating evaporation ponds and developing evaporation pond embankments; and
- Removal of potentially contaminated soils, if present, from casing or pipeline leaks, surface spills from wells or header houses, and leakage from lined ponds or land application facilities.

Construction activities may increase the potential for erosion from both wind and water due to the removal of vegetation and the physical disturbances from vehicle and heavy equipment traffic. Likewise, compaction of soils and removal of vegetation resulting from construction activities may increase the potential for surface runoff and sedimentation in local drainages and streams outside disturbed areas.

Section 3.7 of the TR describes topsoil management practices, topsoil stockpiling, erosion control methods, and the use of surface water diversions and BMP to minimize potential soil impacts associated with ISR operations.

Most soil disturbances associated with ISR are short-term. Topsoil and land recovery is initiated as soon as possible following construction. In general, soil disturbance of mine units typically lasts approximately 6 months. Compared to conventional mining practices, ISR surface disturbances are small and potential impacts are minimized by implementing appropriate mitigation measures (see Section 5.5).

Although unlikely, an unexpected spill could impact soils. The monitoring plan designed by Cameco quickly detects and responds to spills to minimize potential impacts. Should a spill occur, potential impacts are expected to be localized and short-term. Further information regarding potential spills and associated impacts are discussed as part of waste management in Section 4.13 of the ER and 4.2 of the TR. Mitigation measures to reduce the chance of a spill from occurring are presented in Section 5.0 of this ER.

Smith Ranch

It is estimated that construction and operations associated with the development of mine unit pattern areas will disturb approximately 761 hectares (1,880 acres), or less than 5% of the total Smith Ranch license area during the renewal period. Due to current operations, much of the Smith Ranch license area used for well field development has already been disturbed and subsequently reclaimed; existing disturbances cover approximately 570 hectares (1,409 acres) or 75% of the expected total. Therefore, additional potential impacts to the topsoil resource within the license area are anticipated to be minor. In the 14 years between 1996 and 2010, approximately 7 hectares (17 acres) have been disturbed by pipeline spills, well or header house leaks. Since 2008 Cameco has significantly upgraded their leak detection systems, QA/QC of pipeline construction and welds as well as header house inspection and spill control (see Section 3 of the TR). During this license period, it is anticipated that the impact of spills to the topsoil resource will be significantly less than the 7 hectares (17 acres), which has already occurred.

North Butte Remote Satellite

The North Butte license area consists of approximately 409 hectares (1,010 acres). It is anticipated that a total of approximately 162 hectares (400 acres) of soil will be disturbed during the life of the project. Current surface disturbances total about 12 hectares (30.5 acres), primarily from boreholes and monitor wells (Figure 1.10, Proposed Site Layout in the TR). Because restoration, final reclamation and interim surface stabilization occur contemporaneously with development and production, at any given time the total area disturbed will be less than the projected figures. All system upgrades mentioned above for Smith Ranch will be applied at all of the remote satellites. During this license renewal period, it is anticipated that the impact of spills to the topsoil resource will be insignificant.

Gas Hills Remote Satellite

The Gas Hills Remote Satellite license area is about 3,440 hectares (8,500 acres), but less than 20% (607 hectares or 1,500 acres) of the Gas Hills Remote Satellite license area is expected to be disturbed throughout the lifespan of the project. Existing buildings, drill holes and access roads present at the Gas Hills Remote Satellite currently account for approximately 40 hectares (98 acres) of the expected total soil disturbances. Most of the disturbances will be short-term as revegetation and reclamation will immediately follow construction activities. To reduce potential impacts, topsoil will be stockpiled and erosion control measures will be implemented (see Section 3.7 of the TR). When considering potential soil impacts, pipeline spills and header house/wellhead leaks are a potential impact. As discussed

above, Cameco will adapt updated engineered leak detection procedures and construction practices to all of their remote satellites. During this renewal period, it is anticipated that the impact of spills to the topsoil resource will be insignificant.

Ruth Remote Satellite

Similar to the other remote satellite locations, soils at the Ruth Remote Satellite will likely be minimally impacted from the planned ISR operations. The Ruth Remote Satellite license area contains 572 hectares (1,414 acres) and only a small portion of this area will be disturbed. Assuming a similar ratio as North Butte, one can assume that approximately 113 hectares (280 acres) of soils may be disturbed. Current disturbances at this site cover approximately 2 hectares (4 acres). Reclamation will follow all development projects and ensure that the disturbed area at any given time is kept to a minimum.

Although operating plans have not yet been developed for the Ruth Remote Satellite, these plans will be made available to NRC before ISR operations commence. The anticipated disturbances will likely be a small fraction of the license area, similar to development at the other remote satellite locations.

4.3.2 No-Action Alternative

The no-action alternative would not increase potential geology or soil impacts at SUA-1548. Decommissioning and reclamation would involve aquifer restoration and heavy equipment used to complete reclamation. No new areas would be disturbed and the current uranium recovery operations at Smith Ranch would be terminated. Neither the decommissioning of Smith Ranch nor the reclamation of the current surface disturbances at the remote satellites will influence potential impacts to geology. Under the no-action alternative, soils that have been impacted by the construction of the existing disturbances (buildings, roads, ponds and mine units) would be reclaimed and restored at Smith Ranch and the remote satellites (North Butte, Gas Hills and Ruth).

4.3.3 Alternative Action

Potential geologic impacts associated with conventional underground or open pit mining are more severe compared to ISR. Conventional open pit mining removes all topsoil, overburden and the rock matrix and structure where the uranium is located. By removing, stockpiling and/or processing all of these rock materials, the entire geologic strata is radically disturbed. At the end of mining, the overburden material is indiscriminately returned to the mine pit as backfilled spoils. The natural horizontal and vertical stratification is destroyed. In the event of conventional underground mining, the overlying rock strata may collapse into the mining zone resulting in subsidence of the overlying strata.

Potential soil impacts associated with conventional underground or open pit mining have a greater footprint and are more long-term than soil impacts from ISR. In open pit mining, a significant proportion of soil is disturbed because topsoil has to be removed before any overburden can be removed. The storage of the overburden and tailings piles further impacts soils. While most potential soil impacts from ISR are short-term, most soil impacts from conventional underground or open pit mining are long-term. In conventional mining the soils remain degraded throughout the life of the mining project because they cannot be reclaimed until the entire mining operation is completed. In contrast, ISR operations reduce potential soil impacts by reclaiming and restoring surface disturbances contemporaneously with development and operations throughout the project life.

4.4 Potential Water Resources Impacts

4.4.1 Proposed Action

4.4.1.1 Surface Water

Potential impacts to surface water bodies and wetlands as a result of constructing and operating the ISR facilities may include:

- Water quality degradation from temporary increases in suspended solids concentrations above background levels during the construction of roads or well fields adjacent to drainages, as well as runoff from disturbed lands. With the exception of road crossings, no construction will occur within stream channels;
- Increased sedimentation in water bodies resulting from construction of roads or well fields adjacent to drainages or construction activities on adjacent upland areas;
- Channel and bank modifications that affect channel morphology and stability;
- Reduced flow in drainages where fill has occurred;
- Water quality degradation in water bodies, impoundments, or surface water supplies from spills or leaks of fuel, lubricants, or hazardous materials during construction, operation, or transportation of such materials; and
- Filling and destruction of wetland areas (NRC, 2009).

During operations, surface water could be impacted by accidental spills from the facility or by permitted discharges. Spills from the CPP or mine unit wells, as well as spills during transportation, could impact surface waters by contaminating available surface water or by contaminating surficial aquifers that are hydraulically connected to surface waters (NRC, 2009).

There has been minimal impacts to surface water at Smith Ranch as a result of past and ongoing ISR operations. It is anticipated that impacts will continue to be minimal during the next renewal period. A SWPPP has been developed and will continue to be implemented for all construction and operations activities to protect surface waters. Cameco has and will continue to utilize BMPs to ensure that all disturbed surface runoff is contained and treated. Mine unit construction disturbances are short term, and are revegetated as soon as practicable following construction. There has been and will continue to be little to no discharge to surface drainages of sediment-laden water produced by production or construction activities. Culverts are and will continue to be used to pass surface water flow below roads and facilities, and as such, there will be no retention or impounding of surface water.

All wastewater is disposed via permitted UIC Class I disposal wells, evaporation ponds or land application facilities. During operations, surface waters could be impacted by accidental spills from the facility. Cameco has a rigorous monitoring and inspection program that allows for the monitoring of mine unit well and pipeline pressures remotely as well as daily inspections to header houses and mine unit pattern areas. This monitoring program ensures that should a leak occur, it will be contained and cleaned up immediately upon discovery. Such impacts are short term and controlled and will not likely impact surface water.

To monitor surface water impacts from ISR operations, routine sampling is has been and will continue SUA-1548 (see Sections 3.4 and 6.1, and Section 5.9 of the TR). This surface water quality sampling will ensure that residual source material from leaks or spills do not reach surface waters.

4.4.1.1.1 Smith Ranch

ISR operations are ongoing at Smith Ranch and there have been no negative impacts to area surface waters during the past 25 years of operations. Surface waters within Smith Ranch are predominately ephemeral. Streams generally flow in response to snowmelt and heavy rains. Seasonal flows, stock ponds, and impounded surface water are used for stock watering and are utilized by wildlife. Samples are routinely collected at selected surface water locations and analyzed for certain radiological constituents to ensure that surface water is not being impacted by the ISR operations (see Section 3.4). Based on the past data, and the fact that operational processes at Smith Ranch will not change within the next renewal period, it is anticipated that surface water impacts at Smith Ranch will continue minimal and insignificant.

All wastewater at Smith Ranch is disposed via permitted disposal wells or land application. From 1996 through 2010, approximately 6.7 hectares (16.5 ac) at Smith Ranch have been impacted by spills from pipeline leaks and leaks from header houses. None of these spills have affected surface water resources. Cameco has a rigorous monitoring and inspection program that allows for the monitoring of mine unit well and pipeline pressures remotely as well as daily inspections to header houses and mine unit pattern areas. This monitoring program ensures that should a leak occur, it will be contained and cleaned up immediately upon discovery. Such impacts are short term and controlled and will not likely impact the surface water. Spills from the CPP or during transportation of IX resin, yellowcake or waste materials will be closely monitored, and any spills will be cleaned up immediately (see Section 3.0 of the TR). It is anticipated that continual improvements in leak detection and alarm systems will make impacts from well field spills and leaks even less during the next renewal period.

4.4.1.1.2 Remote Satellites (North Butte, Gas Hills and Ruth)

Surface water within the remote satellite license areas for North Butte, Gas Hills and Ruth are generally ephemeral and flow in response to snowmelt or large rain events. There are two active springs that provide intermittent flow to stream courses within the Gas Hills Remote Satellite license area. All 16 surface water rights at North Butte are for reservoirs and stock reservoirs. These reservoirs contain water during a wet spring and/or following a significant rainfall/runoff event. Both the Gas Hills and Ruth Remote Satellites have all but one surface water right allocated to livestock and wildlife use, and both satellites also have one industrial allocation.

At North Butte and Ruth, all wastewater will be disposed via permitted UIC Class I disposal wells. At the Gas Hills Remote Satellite, Cameco anticipates to use a combination of evaporation ponds and UIC Class I disposal wells. Although pipeline or header house spills could impact surface water resources, it is very unlikely. Cameco will continue their rigorous monitoring and inspection program at each remote satellite. This will allow monitoring of mine unit well and pipeline pressures remotely. Daily inspections will provide additional protection against larger volume spills. This monitoring program ensures that should a leak occur, it will be contained and cleaned up immediately upon discovery. Such impacts are short term and controlled and will not likely impact the surface water.

4.4.1.2 Groundwater

Potential impacts to groundwater as a result of ISR operations may include the following:

- Consumptive use of the ore zone aquifer (lowering of the water table/potentiometric surface via "bleed") during operations and groundwater restoration ;
- Movement of lixiviant outside the mine unit monitor well ring or within aquifers above or below the production zone due to excursions;

- Inadequate groundwater restoration after ISR operations are complete; and
- Adverse effects on groundwater in shallow aquifers, if present, from casing or pipeline leaks, surface spills from wells or header houses, and leakage from lined ponds or land application facilities (NRC, 2009).

Groundwater modeling of the production zones at Smith Ranch and the North Butte and Gas Hills Remote Satellites has been completed and has determined that consumptive use of groundwater will have negligible impact on area use of groundwater resources. Since the approval of the last SUA-1548 LRA in May of 2001, there has been no defined diminution of groundwater resources to local area water users within and surrounding Smith Ranch. Based on operating history and the recent groundwater modeling, it is anticipated that impacts due to consumptive use of groundwater will continue to be negligible.

An excursion of production fluid beyond the monitor well ring or to an overlying or underlying aquifer could occur due to:

- An injection well casing failure;
- Failure to control well field pressures and/or flows;
- Uncontrolled movement of production fluids through an unidentified improperly abandoned drill hole; or
- Inadequate groundwater restoration after ISR operations are completed.

Although any of these potential impacts are possible over the life of an ISR operation, they are considered short term and local. Control of the ISR fluids and groundwater restoration is required by the regulatory agencies. Cameco is required by license condition to perform mechanical integrity testing of all Class III injection wells to ensure that the wells are constructed properly. During operations, production fluid is removed from the aquifer at a slightly greater rate than what is injected, thereby maintaining an inward flow direction. Monitoring wells are installed in a manner that allows the identification of an excursion before the excursion can migrate beyond the production zone or exempted aquifer. Prior to putting a mine unit into operation, hydrologic testing is conducted to quantify aquifer properties and injection rates, and identify any improperly abandoned drill holes. Finally, the ability to restore groundwater quality within an ISR mine unit at Smith Ranch has been demonstrated in the Q-Sand pilot restoration program, followed by the successful production and restoration of Mine Unit A. Mine Unit B groundwater restoration has been approved by the WDEQ but is still under NRC Staff evaluation. These restorations, as well as successful restorations at other ISR sites, show that groundwater can be returned to a water quality standard that is protective of public health, safety, and the environment.

Past recoveries of excursions shows that any impact from an excursion will be limited in aerial extent and to the volume of water which must be removed to restore the groundwater quality. The excursion would be short-term and controlled. The magnitude of the impact to the regional groundwater supply will be much less than impacts that have occurred during dewatering of conventional mining operations. In conclusion, long term impacts on groundwater quality are not anticipated. Excursion prevention and control measures are described in Section 6.1. Groundwater restoration of impacted groundwater to baseline conditions is required by both WDEQ and NRC regulations using best practicable technology (BPT) which will also negate any potential impacts to groundwater caused by ISR operations (see Section 6 of the TR). Finally, shallow aquifers may be adversely impacted following well casing or pipeline leaks,

surface spills from wells or header houses, and leakage from lined ponds or land application facilities. As mentioned previously, Cameco has instituted a rigorous monitoring and inspection program that allows the monitoring of injection/production well and pipeline pressures and flows remotely, as well as daily inspections to header houses and mine unit pattern areas. All evaporation ponds are double lined and contain a leak detection system. Failure of these ponds or pond liners and the ultimate release of fluids into the environment are unlikely to occur. In the event that a pond leak does occur, the leak will be immediately corrected and cleanup efforts will restore the local environment to ensure that the impacts are short term and isolated.

The operational groundwater monitoring of monitor wells and nearby domestic and stock wells will ensure that there will be no impacts to nearby groundwater users due to excursions.

4.4.1.2.1 Smith Ranch

The affected groundwater aquifers at Smith Ranch are described in Section 3.4. Cameco recognizes how important these aquifers are to the regional groundwater regieme in that they can yield sufficient fresh water for beneficial use. Based on the available data and operational experience, drawdown impacts from SUA-1548 operations are expected to be minimal.

Aqui-Ver Inc. utilized consumptive use models and conservative (Theis) assumptions to assess potential hydrologic impacts from the ISR operations at Smith Ranch and concluded that ISR operations have in the past and will continue to have minimal impact on regional groundwater resources. Results from the Smith Ranch report predict that drawdown in the shallow water-table aquifer will be less than approximately 3 meters (10 feet) in stock and domestic well locations throughout the additional 33-year projected lifespan of the project. Only one stock watering and domestic supply well is expected to exceed 3 meters (10 feet) during the 33-year model period. Drawdown in this well, Mason #3, is expected to reach a maximum of approximately 6 meters (22 feet), because it is completed in the deeper production sand aquifer and is in close proximity to the Smith Ranch license boundary. Aqui-Ver Cumulative Hydrologic Impact assessment for Smith Ranch and the Reynolds Ranch Satellite are included in **Appendix E, Cumulative Hydrologic Impact Analysis Report for Smith Ranch and North Butte.**

During ISR operation, production fluid is removed from the aquifer at a slightly greater rate than what is injected, thereby maintaining an inward flow direction. Monitoring wells exist at each well field and have the capacity to identify an excursion. Cameco has successfully recovered excursions that have gone beyond the production zone and no groundwater contamination has occurred. Finally, the ability to restore groundwater quality within an ISR mine unit has been demonstrated in the Q-Sand pilot restoration program, followed by the successful production and restoration of Mine Unit A. These restorations, as well as successful restorations at other ISR sites, show that groundwater can be returned to a water quality standard that is protective of public health, safety, and the environment.

4.4.1.2.2 Remote Satellites (North Butte, Gas Hills and Ruth)

The affected groundwater aquifers at the remote satellites are described in Section 3.4. Based on the available data and operational experience, drawdown impacts from operations at the remote satellites are expected to be minimal.

Aqui-Ver Inc. (Aqui-Ver Inc., 2011b) utilized consumptive use models and conservative (Theis) assumptions to assess hydrologic impacts from ISR at the North Butte and Gas Hills Remote Satellites and that concluded that ISR operations will have minimal impact on regional groundwater resources at both locations. At the North Butte Remote Satellite, impacts to the shallow water-table aquifer are

expected to be negligible. Stock and domestic wells in the production (B-sand) zone were found to be most likely impacted during the 16-year model period. The projected maximum drawdown will likely occur at the Pfister Ranch southeast of the North Butte Remote Satellite and is expected to be approximately 6 meters (22 feet). Wells completed in the overlying and underlying sands (C-Sand and A-Sand) at the North Butte Remote Satellite show maximum drawdowns of approximately 3 meters (10 feet). The Aqui-Ver report on the Cumulative Hydrologic Impact Assessment for North Butte is included as **Appendix E**.

Hydrologic impacts due to the Gas Hills ISR development were simulated using a three-dimensional groundwater flow model. Hydrologic impacts were evaluated over an estimated 20 year ISR development and restoration period. The drawdown impact computed by the groundwater flow model was evaluated at 45 water well and spring locations within a 16 kilometers (10-mile) radius of the Gas Hills facility.

In general, maximum drawdown impacts are predicted to occur around Development Years 8 and 9, corresponding to the period of maximum groundwater withdrawals. Maximum on-site drawdown impacts are predicted to be approximately 3 meters (10 feet) at the permit boundaries within the production sand aquifer. Impacts to all domestic and stock wells are predicted to be less than 0.3 meters (1-foot) over the life of the mine development, with no measurable decrease in spring flow. Drawdown impacts are predicted to be relatively small primarily because stock and domestic wells are installed in the shallow water-table aquifer and are hydraulically isolated from the underlying production sand aquifer by lower permeability sediments. Drawdown in the production sand aquifer is also limited by the presence of pit lakes with large storage capacity, areas of higher transmissivity across the eastern portion of the facility, and the location of the facility adjacent to the Beaver Rim groundwater recharge area. Although not simulated, the presence of abandoned underground mine workings within Mine Units 2, 3, 4 and 5 should also act to reduce drawdown impacts due to the high conductivity and storage capacity of the workings.

Hydrologic impacts analysis from ISR at the Gas Hills Remote Satellite has been completed, but the report has not been finalized. A consumptive use study will also be conducted for the Ruth Remote Satellite before operations commence. Both of these reports will be submitted to NRC for review as soon as they become available.

Based on the hydrologic modeling performed at the remote satellites plus the fact that operational controls and constraints will be the same as are used at Smith Ranch, Cameco does not anticipate impacts to private domestic wells due to aquifer drawdown during ISR operations. Should problems be identified with any domestic well within 2 kilometers (1 mile) of the license boundary, Cameco commits to providing an alternate source of water to the water user.

4.4.2 No-Action Alternative

The no-action alternative will not have any positive or negative direct, indirect, or cumulative impacts on water resources. Site reclamation and restoration activities will commence. There will be a short term surface disturbance as buildings, roads, and ponds are removed. Existing well fields at Smith Ranch will enter restoration and groundwater impacts to the extent that they have occurred will decline over time as restoration is achieved.

4.4.3 Alternative Action

Selection of the Alternative Action (conventional underground and/or open pit mining) would result in an increase in disturbance to all water resources when compared to ISR. Surface water impacts

are far more pronounced with respect to conventional open pit mining, where the footprint of the disturbed area includes the mine pit, adjacent spoil dumps, topsoil stockpiles, roads, and facilities typically requiring diversions of streams and drainages around the disturbed area. The potential for sediment runoff from conventional mining facilities is much greater and of a longer duration than what will occur with the proposed action. ISR results in significantly smaller land disturbance than conventional uranium mining and has significantly less impact on both surface and groundwater conditions.

With the alternative action, there would be a significant impact to groundwater. Both underground and open pit mining impact the groundwater by causing aquifers that were previously separated by confining layers to comingle. In an effort to mine the uranium ore, mine dewatering is necessary which results in a significant consumption of groundwater. Dewatered groundwater is often discharged to surface water and results in erosion and sediment transport downstream. During the dewatering and mining process, there is a net consumption of water and an overall drawdown of the aquifer. The volume of water permanently removed (consumed) and discharged from the aquifer is significantly greater than that associated with ISR. During the mine reclamation phase, unclassified overburden is indiscriminately backfilled into the mine pit. This results in not only a commingling of discrete sandstone aquifers, but may also result in elevated water quality parameters. Conventional mining causes the oxidation of the ore zone in air, which may result in the long term development of acid conditions in the pit or underground workings and will generally result in an overall change in groundwater and/or surface water quality. For example, oxidation of the ore zone, host rock and other mineralized areas (once groundwater recovers) will generally result in degradation of water quality due to an increase in total dissolved solids, sulfates and dissolved metals such as iron, manganese, aluminum, molybdenum, selenium, and boron. Backfilling of the mine pit may also introduce other mineral constituents associated with accidental spills and/or surface contamination.

4.4.4 Cumulative Effects of the Proposed Action

Cumulative effects on water resources associated with SUA-1548 ISR operations have been and are anticipated to continue to be small. Nominal surface water impacts are expected from ISR operations in both the Powder River and Wind River Basins, and cumulative impacts from other regional energy development (CBM, oil and gas, wind, uranium, and coal) are also expected to be insignificant. The majority of surface waters within SUA-1548 license area meet the State of Wyoming Class III standards for livestock and approval of the proposed action will not significantly impact surface water quantity or quality.

Although impacts will likely be greater for groundwater than surface water, cumulative effects on groundwater are still anticipated to be relatively small for the lifespan of the sites. The hydrologic assessments conducted at Smith Ranch and the Gas Hills and North Butte Remote Satellites examined cumulative impacts to groundwater resources. For Smith Ranch, the production of formation fracturing (frack) water associated with development of the Niobrara Shale was added to the model, and groundwater impacts were still deemed insignificant (Aqui-Ver Inc., 2011a). For the North Butte Remote Satellite, impacts from ISR operations and CBM development outside of the North Butte Remote Satellite area were also taken into consideration. Results indicated that 23 of the 81 wells studied would have cumulative drawdown over 3 meters (10 feet) and two wells would have cumulative drawdown over 6 meters (20 feet). Drawdown is expected to be greatest in wells nearest the proposed ISR operations and in wells screened across equivalent horizons to ISR production sands. Despite anticipated drawdowns in some surrounding North Butte Remote

Satellite wells, Aqui-Ver Inc. (2011b) concluded that ISR operations at the North Butte Remote Satellite will not impact planned ISR recovery at nearby ISR facilities at Willow Creek, Hank, or Nichols Ranch, nor will it interfere with containment of ISR fluids at the North Butte Remote Satellite. In addition, cumulative impacts to water resources from ISR will be significantly less than those likely to occur from conventional underground or open pit uranium mining.

4.4.5 References

Aqui-Ver Inc., 2011a. Cumulative Hydrologic Impact Assessment: Cameco Resources, Smith Ranch-Highland and Reynolds Ranch Facilities, Converse County, Wyoming. Wheat Ridge, CO.

Aqui-Ver Inc. 2011a. Cumulative Hydrologic Impact Assessment: Cameco Resources North Butte Facility, Campbell County, Wyoming. Wheat Ridge, CO.

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4.5 Potential Ecological Resources Impacts

4.5.1 Proposed Action

The type of disturbance associated with ISR operations will not result in large expanses of habitat being dramatically transformed from its original character as in conventional mining and milling operations. Additionally, all disturbed areas will be reclaimed either at the completion of construction or during decommissioning. The following sections address potential impacts to ecological resources at SUA-1548 by location.

4.5.1.1 Smith Ranch

4.5.1.1.1 Vegetation Communities and Habitat

Grasslands make up approximately 82% of the vegetation cover with some shrubs (less than 8%) and forbs (less than 5%) also present (Appendix D8 of the WDEQ Permit). ISR operations will temporarily reduce vegetation within the Smith Ranch license area. Both short- and long-term disturbances will be revegetated as soon as possible to mitigate environmental impacts. Cameco will continue to employ active revegetation measures, utilizing native grasses and forbs as soon as possible after disturbance. Revegetation seed mixes are approved by appropriate state and federal agencies and live seed (pounds of live seed) are tested and certified. In some instances, the landowner may allow rapid colonization by annual and perennial species followed or intermixed with a native seed mix. The revegetation program considers not only erosion control but also plant succession, plant density and diversity. Current and

ongoing revegetation efforts are successful and typically restore a robust vegetative cover within the first and second growing season.

Open grassland or shrub steppe communities are relatively resilient and will not be significantly impacted by ISR production (NRC, 2009). Long-term disturbances within the Smith Ranch region are expected to be small, and short-term disturbances will be quickly restored with local plant species. The total area contained within the Smith Ranch license area is approximately 16,187 hectares (40,000 acres). Currently, disturbed surfaces cover 570 hectares (1,410 acres) of the Smith Ranch license area (see Section 3.3). The proposed expansion is expected to disturb no more than an additional 191 hectares (472 acres), or less than 1.2% of the total Smith Ranch license area.

Wetland communities are a small percentage of the license area. Cameco (Hayden-Wing and Associates, LLC) identified 19 potential wetlands (**Appendix A, Wetlands Survey-2011**) and in general, wetland regions are avoided by ISR operations. If a wetland region needs to be disturbed, then Cameco will follow the appropriate measures prior to development to obtain the necessary permits to comply with Section 404 of the Clean Water Act.

4.5.1.1.2 Threatened and Endangered Plant Species

Two potential T&E plant species in Converse County are the Ute ladies'-tresses and blowout penstemon (USFWS, 2010). However, neither of these species nor any other T&E species were observed within the Smith Ranch license area during numerous field surveys. It is unlikely that any protected plant species are present on the permit area and accordingly, the impact to T&E species will be negligible.

4.5.1.1.3 Noxious Weeds

Eleven species of noxious weeds were encountered during the vegetation studies conducted at Smith Ranch including western ragweed, white-leaved ragweed, common burdock, Canada thistle, poverty weed, field bindweed, quackgrass, Russian knapweed, hounds tongue, tansy mustard and wild oat. The occurrence of these noxious species within Smith Ranch is limited, and they do not occur in such abundance or distribution as to make them a serious range management problem.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the license areas. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with surrounding undisturbed vegetation. Construction activities at Smith Ranch have not resulted in a noxious weed problem. Weed control and spraying activities occur as necessary and are conducted by licensed professionals. Mitigation measures to lessen impacts on native vegetation and control state-designated weeds are discussed in Section 5.5.

4.5.1.1.4 Wildlife

Construction activities at Smith Ranch have been ongoing for 25 years and as is typical with an ISR operation, disturbance is limited in both areal and temporal extent. Wildlife impacts are expected to be greatest in vegetative communities where clearing is required to construct wells, access roads, header houses, and pipelines from the mine units to the header houses and from the header houses to the satellite. In general, most wildlife, including the larger and more mobile animals, will disperse from the disturbed area as construction activities intensify. These displaced species will colonize in adjacent, undisturbed areas or return to their previously occupied habitats after construction ends and suitable

habitats are reestablished. Revegetation of most disturbances will generally occur within six months to one year after the initial disturbance.

Three federally listed endangered species; the bald eagle, peregrine falcon, and black-footed ferret, are potential inhabitants at Smith Ranch. While suitable nesting substrate for bald eagles and peregrine falcons is available, no known nesting has occurred in the area. As noted in previous studies, bald eagles may winter in the vicinity of the license areas but migrate to more suitable habitat in the spring. Black-footed ferrets are not expected to occur due to the absence of active prairie dog colonies. The swift fox and burrowing owl are two species that the State of Wyoming has listed as rare or high priority. These species could potentially live within the license area as suitable habitat exists. Their presence has not been recorded. Impacts to the above species are anticipated to be negligible.

Updated wildlife studies are in progress by Cameco (Grouse Mountain, and HWA). Upon completion, the results will be presented to NRC. In accordance with LQD requirements, Cameco conducts surveys for T&E, MBHFI, and other raptors from late April through May of each year to identify any new nests and to assess whether known nests are being used. The survey covers lands within and adjacent to those areas of planned activity. These surveys are primarily intended to protect against unforeseen conditions, such as the construction of a new nest in an area where construction and/or operations activities may take place. In the event that it becomes necessary to disturb a raptor nest, Cameco consults with LQD, BLM, USFWS, and WGFD to develop appropriate mitigative action plans.

4.5.1.2 North Butte Remote Satellite

4.5.1.2.1 Vegetation Communities and Habitat

According to the "Cleveland-Cliffs North Butte Vegetation Report" (Attachment D8-1 in Appendix D8 of the North Butte WDEQ Permit), vegetation cover at the North Butte Remote Satellite is approximately 62.2% sagebrush-grassland, 34.5% grassland, 2.5% bottomland and 0.8% juniper-sagebrush. Similar to the Smith Ranch license area, small portions of the vegetation cover will be disturbed during ISR development. Cameco will employ an active revegetation program following disturbance and most areas will begin to recover within six months of initial disturbance. The anticipated disturbances (operational life) to North Butte are about 150 hectares (370 acres) or 37% of the total area (409 hectares [1,010 acres]). All disturbed areas will be revegetated as soon as construction and/or production are completed to minimize ecological impacts.

Appendix D11 of the North Butte WDEQ Permit identifies two wetlands at the North Butte Remote Satellite. Sample Point 1 in Attachment D11-1 shows a small stock pond (0.02 hectares [0.05 acres]) which is the only wetland present within the proposed disturbance area. If this wetland cannot be avoided for ISR production, then Cameco will obtain the necessary permits to comply with Section 404 of the Clean Water Act before any disturbance to the wetland occurs.

4.5.1.2.2 Threatened and Endangered Plant Species

According to the most recent surveys completed at the North Butte Remote Satellite, no T&E plant species were observed; therefore, no impacts are anticipated. Updated surveys for T&E plant species will be conducted during operations and will be made available to NRC upon completion. For additional information on T&E plant species in the North Butte license area see Section 3.5.

4.5.1.2.3 Noxious Weeds

The presence of two state-designated weeds, Canada thistle and field bindweed, were observed at the North Butte Remote Satellite during the baseline surveys. Increased development at the North Butte Remote Satellite could increase the spread of noxious weeds or introduce another non-native species.

To protect the ecological integrity of the site, mitigation measures to lessen impacts on native vegetation and control state-designated weeds will be taken and are discussed in Section 5.5.

4.5.1.2.4 Wildlife

Many of the species that were identified at Smith Ranch are also present, or potentially could be present, at the North Butte Remote Satellite. T&E wildlife species as well as other species that are of conservation concern to USFWS and WGFD are black-footed ferret, swift fox, sage grouse, mountain plover, raptors, bald eagle, golden eagle, ferruginous hawk, burrowing owl, merlin, short-eared owl, and Swainson's hawk as well as the antelope, deer, bats, mice and voles, birds, and amphibians that are prevalent. Appendix D9 of the North Butte WDEQ Permit provides detailed information regarding the results of wildlife surveys and identifies the Wildlife Monitoring Plan. Similar to Smith Ranch, wildlife habitats at the North Butte Remote Satellite will be temporarily diminished. Development will cause some animals to relocate and available habitat to decline. However, this disturbance will be limited to the construction phase and will also be reversible once ISR construction is complete.

4.5.1.3 Gas Hills Remote Satellite

4.5.1.3.1 Vegetation Communities and Habitat

Approximately 86% of the Gas Hills Remote Satellite is covered with sagebrush-grassland, rough breaks, bottomland sagebrush and upland grassland (see Section 3). A small portion of these plant communities will be temporarily impacted with the onset of ISR production. Additional surface disturbances at the Gas Hills Remote Satellite are expected to be less than 20% of the total area of 607 hectares 1,500 acres) or about 476 hectares (1,177 acres) and will be reclaimed as stated in Section 4.5 post mining activity.

Potential wetlands cover no more than 0.3% of the license area (about 28 acres). Similar to other locations within SUA-1548, these wetlands will be avoided. Wetlands will be delineated and proper mitigation measures will be taken if ISR production is expected to impact these sensitive regions.

4.5.1.3.2 Threatened and Endangered Plant Species

The 2010 survey of the Gas Hills Remote Satellite did not identify any federally listed T&E plant species. Possible plants of concern within the license area are devil's gate twinpod, cedar rim thistle, and Nelson's milkvetch. Because these species are not likely present at the Gas Hills Remote Satellite, no impact to T&E plant species is anticipated from ISR operations.

4.5.1.3.3 Noxious Weeds

The noxious weeds musk thistle, Canada thistle, hairy whitetop, field bindweed, tansymustard, little blue mustard, and American licorice are present at the Gas Hills Remote Satellite (see Section 2.8.1.1 of the Gas Hills Environmental Assessment, NRC, 2004). Similar to the other SUA-1548 license locations, noxious weeds are often limited to previously disturbed sites and are controlled by Cameco. To prevent the future introduction and spread of noxious weeds at the Gas Hills Remote Satellite, Cameco will follow mitigation plans described in Section 5.5.

4.5.1.3.4 Wildlife

Wildlife species found within and adjacent to the Gas Hills Remote Satellite are similar to those found at other SUA-1548 license areas. Antelope and mule deer were the only big game species and no crucial habitat for either species is within the license boundary (see Section 2.8.1.2 of the Gas Hills Environmental Assessment, NRC, 2004). Upland bird species include Sage Grouse and Mourning Doves, but they are not very prevalent at the site. Raptors are known to nest within the project boundary.

No T&E or other sensitive species were found inhabiting the Gas Hills Remote Satellite. Although the black-footed ferret, bald eagle, peregrine falcon, mountain plover, and swift fox could all potentially live within the license area, habitat for these species is lacking in the Gas Hills. There is no roosting habitat for the bald eagle and no prairie dog colonies for the black-footed ferret. Habitat may be suitable for the mountain plover and swift fox; however, no evidence for either species has been documented in the area.

Although wildlife habitat may see limited impact from ISR activities, reclamation and revegetation of disturbed sites will mitigate the temporary loss of wildlife habitat. Animal species may relocate during construction activities, but can return to the land during operations and following reclamation. No T&E or sensitive species are anticipated to be adversely affected and overall impacts to wildlife are expected to be minimal.

4.5.1.4 Ruth Remote Satellite

4.5.1.4.1 Vegetation Communities and Habitat

According to Section 12, Volume 1 of the Ruth Supplemental Report, sprayed sagebrush-grassland and sagebrush-grassland accounted for 81.5% or about 466 hectares (1,152 acres) of the satellite area. Drainage bottomland and grassland made up the remaining 14.6% and 3.9%, respectively. These vegetation communities will be temporarily disrupted with the onset of construction. However, Cameco is not actively pursuing development of the Ruth Remote Satellite at the time of this LRA (January 2012). Prior to commencement of ISR activities, supplemental baseline data will be collected and compared with the original information for inclusion in an amendment proposal to the NRC.

4.5.1.4.2 Threatened and Endangered Plant Species

No studies have identified T&E plant species at the Ruth Remote Satellite location to date. Prior to ISR activities, vegetation studies identifying local T&E species along with other sensitive species will be conducted and the results will be presented to NRC for review and approval. The lack of T&E species at nearby locations (Smith Ranch and the North Butte Remote Satellite) suggest that potential future impacts to T&E species will be negligible. Additional surveys will be performed prior to the initiation of ISR operations at the Ruth Remote Satellite.

4.5.1.4.3 Noxious Weeds

Four noxious weed species were identified within the Ruth license area in 1989 including Canada thistle, quackgrass, perennial ragweed and wild licorice. Before ISR operations commence at the Ruth Remote Satellite, a vegetation study will be conducted to obtain current information about noxious weeds. Noxious weed study results will be presented to NRC and mitigation methods will parallel those used at other sites within the SUA-1548 license area.

4.5.1.4.4 Wildlife

According to the 1989 Ruth Supplemental Report, no big game migration routes or critical habitat were known to occur on the Ruth Remote Satellite area. Additionally, no T&E species were found living on or adjacent to the site. The bald eagle, peregrine falcon and the black-footed ferret could potentially live within the license area. To determine if any T&E or other sensitive species reside within the license area, a wildlife survey update will be conducted before pursuing ISR operations at the Ruth Remote Satellite. Cameco will amend the Ruth environmental impact analysis and provide an updated mitigation plan as required.

4.5.2 No-Action Alternative

The no-action alternative would prevent additional land from being disturbed. Reclamation of existing facilities would be required and may have a temporary impact on ecological resources. Developed sites such as Smith Ranch, will enter well field restoration and site reclamation, and as such, there will be a small but temporary additional impact to ecological resources. This impact will be mitigated when all ISR operations cease and land is reclaimed to support both native vegetation and wildlife.

4.5.3 Alternative Action

Adverse impacts to both vegetation and wildlife resources are directly related to the degree of disturbance to the land surface. Either open pit or underground mining would require a significant increase in the amount of land disturbance needed to mine the uranium deposits. The additional disturbance to the land surface would inevitably increase the impacts to ecological resources. Both underground and open pit mining would require the removal of large acreages of topsoil, including long term stockpiles of topsoil and overburden. The degree of disturbance to ecological resources under this alternative action will be significantly greater. A large open pit would remain for the life of the mine and possibly for many years after and as such vegetation, wildlife and wetlands will remain disturbed for upwards of 20 to 25 years or more.

4.5.4 References

Nuclear Regulatory Commission. 2004. Environmental Assessment for the Operation of Gas Hills Project Satellite In Situ Leach Uranium Recovery Facility.

Nuclear Regulatory Commission. 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (NUREG-1910). Page last reviewed/updated Sunday, March 13, 2011.

4.6 Potential Air Quality Impacts

4.6.1 Proposed Action

4.6.1.1 Gaseous and Airborne Particulates

The selection of the proposed action will result in continued operations at Smith Ranch and continued ISR development at the remote satellites. The current release of gaseous and airborne particulates from ISR operations at Smith Ranch are below the allowable limits for the State of Wyoming. As a result, environmental impacts from these air emissions are minimal. The primary source of gaseous emissions and airborne particulates from ISR operations are from the process plant satellites and associated equipment and traffic. The most significant radioactive airborne effluent is Rn-222, which is released from the CPP, CPF, satellites, header houses, and the wellfields (see 7.3 of the TR). The IX vessels are pressurized downflow IX columns which keep the Rn-222 in solution so as not to be released to the atmosphere. There will be minor releases of Rn-222 during the air blow down prior to resin transfer to the resin trailer. The air blow down and the gas released from the vent during column filling are vented to the sumps and then to the atmosphere. The RO units used to treat restoration fluids also may emit Rn-222 during membrane maintenance or other activities that require opening the membrane chambers. At the CPP and the CPF, uranium particulate effluents are limited to the yellowcake drying and packaging unit. Because of the vacuum dryers, minimal uranium particulate emissions occur during the drying process. For additional details on the potential impacts associated with gaseous and airborne particulates and mitigative measures, please see Section 4.1 of the TR.

Non-radiological particulates, particularly fugitive dust, are the major air quality concern at SUA-1548. Unpaved roads are the largest contributor to fugitive dust in the United States, and the construction of

new roads and an overall increase in traffic will increase the amount of fugitive dust produced. Calculations of estimated fugitive dust from SUA-1548 indicate that emissions have been and will remain below the State of Wyoming standards. To mitigate the potential release of fugitive dust, mitigation measures such as watering the roads or applying chemical treatments will be implemented as needed as stated in Section 5.6.

4.6.1.2 Construction

The NRC evaluated potential air quality impacts from ISR facilities in NUREG-1910 (NRC 2009), and concluded that construction air quality impacts of ISR facilities are small. Construction activities at SUA-1548 have and will continue to cause minimal short-term effects on local air quality. Construction activities will cause an increase in suspended particulates from vehicular traffic on unpaved roads, fugitive dust from wind erosion of areas cleared of vegetation, and diesel emissions from construction equipment. However, once construction is finished, topsoil will be replaced on disturbed sites and revegetation will take place. Each disturbed site will be reclaimed to reduce the potential for long-term air quality impacts. Surface disturbances and construction traffic will decline once construction ends and operations begin. Therefore, the anticipated air quality impacts from construction at SUA-1548 license areas are expected to be small.

4.6.1.3 Operations

Operations (including restoration activities) at Smith Ranch currently result in minimal air quality emissions, and emissions at the North Butte, Gas Hills and Ruth Remote Satellites will also likely be minimal. Because the majority of air quality emissions from ISR operations are small and occur outdoors, impacts are considered to be minimal and temporary. Similar to the construction phase, fugitive dust is the primary source of air quality emissions during operations. Emissions such as Rn-222 and NOx are also possible from ISR operations and although small, are discussed below.

As described above, small concentrations of Rn-222 are released from the CPP, satellites and mine unit header houses during operations (see Section 4.1 of the TR). Impacts from gaseous Rn-222 are minimal. Because the vacuum dryers are designed to have zero emissions, no particulate emissions are generated, and only a small amount of water vapor is produced. Current gaseous emissions at Smith Ranch are approximately 0.58 metric tons (0.64 tons) per year and are below allowable limits for the State of Wyoming. Gaseous emissions monitoring and mitigation measures are taken to ensure Rn-222 emissions are minimal, as discussed in Section 5.13. Exhaust from drilling equipment and vehicular traffic causes some emissions such as NOx, but these emissions are small and do not have any significant impacts. For additional information about NOx emissions, see Section 7.2 of the TR. As discussed above, the primary source of emissions is fugitive dust from vehicular traffic on un-paved access roads and in the wellfield areas. Fugitive dust calculations were performed in Section 3.6 according to the EPA AP-42 methodology. Current ISR operations at Smith Ranch produce approximately 71 tonnes (78 tons) per year. With the addition of the Reynolds Ranch Satellite, fugitive dust is expected to increase to 141 tonnes (156 tons) per year when Smith Ranch is operating at full capacity. Estimates for fugitive dust emissions from the North Butte and Gas Hills Remote Satellites are approximately 95 and 130 tonnes (95 and 143 tons) per year, respectively. Cameco has not developed an operating plan for the Ruth Remote Satellite at the time of this LRA (January 2012). Once this plan has been developed, fugitive dust emissions will be calculated for this site as well. Fugitive dust emissions for all SUA-1548 license areas are well below allowable limits for the State of Wyoming, and therefore do not pose a significant environmental risk. In addition, the release of fugitive dust from operations will be significantly reduced by periodic watering or by chemically treating unpaved roads. Mitigation methods such as these will be used as necessary to reduce fugitive dust (see Section 5.6).

Approval of the proposed action will not result in adverse impacts to air quality. Anticipated emissions are all below state of Wyoming regulations and will likely be minimal and temporary.

4.6.2 No-Action Alternative

Approval of the no-action alternative would not cause any additional impacts on air quality at SUA-1548. Emissions associated with the current ISR operations would slowly decrease as ground water restoration and reclamation nears completion. Construction activities would continue as facilities and wellfields are reclaimed and restored. Fugitive dust at the remote satellites may temporarily increase as reclamation activities commence and then return to below current conditions. Air pollution from traffic related activity would continue until SUA-1548 was restored and reclaimed.

4.6.3 Alternative Action

Approval of the Alternative Action would result in a significant increase in fugitive dust and air quality impacts relative to the approval of the proposed action. Air quality impacts associated with conventional underground or open pit uranium mining are significantly greater than those associated with ISR (NRC 2009). Topsoil stripping and overburden removal are ongoing processes throughout the development of a conventional mine. Conventional mining employs a significantly larger fleet of construction equipment (dozers, scrapers, loaders, haul trucks) as well as a significantly larger work force to operate the mine. Air quality impacts caused by wind erosion of ore stockpiles, overburden stockpiles, tailings disposal facilities, and crushing and grinding operations associated with conventional mining, can cause high concentrations of particulate matter as well as Rn-222 to be released into the atmosphere. Tailings piles from underground or conventional open pit uranium mining are considered long-term hazards since they continually emit Rn-222. By utilizing ISR recovery methods, the need for stockpiles and tailings is omitted which greatly reduces impacts on air quality.

4.6.4 Cumulative Effects of the Preferred Action Alternative

Cumulative effects from airborne gaseous and particulate emissions are expected to be minimal. SUA-1548 operations will contribute a proportionally small portion of additional traffic to area roads as compared to other energy development and agricultural activities. The SUA-1548 sites are remote and air quality contributions include agricultural traffic, other ISR project emissions, CBM continued development, conventional oil and gas and wind energy development. Smith Ranch is an ongoing operation and approval of the proposed action will result in an increase of the number of personnel to 170. The remote satellites will provide additional personnel during construction but this number will be reduced during operational periods. Air quality may be impacted during construction, but these impacts are localized and short-term as all disturbances are revegetated and reclaimed once construction ends.

According to the PRB Coal Review, the existing regional air quality conditions generally are very good. Modeling completed in 2002 (base year for the Power River Basin (PRB) Coal Review analysis) showed that there was a concern about some impacts of particulate matter with an aerodynamic diameter of 10 microns or less (PM10) emissions within the near-field receptors of both Montana and Wyoming. Air quality at SUA-1548 is within ambient air quality standards, and the analysis presented above indicates that continued ISR operations at Smith Ranch and the remote satellites will not adversely impact air quality. The primary potential impact will be fugitive dust from construction activities and traffic on local gravel roads.

Table 5.3-2 of NUREG-1910 (NRC, 2009) lists 15 coal mining projects in the Wyoming PRB. All have intensive air quality monitoring programs and all are deemed "in compliance" with all applicable standards by WDEQ/AQD. The regional mines are not expected to cause cumulative air quality impacts

on the SUA-1548 sites in the PRB given the minimal air quality impacts associated with ISR operations. Section 4.6 presents the anticipated quantifiable air quality impact associated with SUA-1548 and its relative contribution to state wide particulate emissions. More than 99% (99.7%) of the total impact to air quality is from estimated fugitive dust emissions, calculated as worst case without any dust control measures applied. SUA-1548 is anticipated to contribute less 0.1% to statewide particulate estimates. Cumulative effects from the proposed action will be much less than those expected from conventional underground or open pit mining.

4.6.5 References

Bureau of Land Management (BLM). 2009. Update of the Task 2 Report for the Powder River Basin Coal Review Past and Present and Reasonably Foreseeable Development Activities. Prepared by AECOM, Inc. BLM High Plains District Office and Wyoming State Office. December 2009.

U.S. Nuclear Regulatory Commission (NRC). 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (NUREG-1910). Page last reviewed/updated Sunday, March 13, 2011.

4.7 Noise Impacts

4.7.1 Proposed Action

4.7.1.1 Smith Ranch

ISR, conventional mining, rangeland, pasture, and wildlife habitat have been the primary land uses within the surrounding 3 kilometer (2 mile) radius of the Smith Ranch license area. Other land uses include oil and gas exploration, CBM development, and wind farming. The noise impacts associated with these other uses include increased construction traffic and equipment noises such as drilling, generators and pumps. The closest residence to Smith Ranch is the Vollman Ranch, which is located within the license boundary and is occupied year-round. As a result of the remote location of the project, its historic and current uranium recovery operations, and the low population density of the surrounding area, impacts from noise or congestion within the project area or in the surrounding 3 kilometer (2 mile) area have not created problems in the past and are not anticipated to cause problems in the future. Additionally, since the maximum increase of new workers associated with the proposed action is anticipated to be insignificant, noise and congestion impacts are not anticipated in Converse or any neighboring counties.

Cameco conducted tests in 2010 at Smith Ranch to determine the level of noise (in dBA) that is produced ISR activities from six different locations throughout the license area. The loudest instrument was identified by these tests, and the level of noise at each testing site was recorded. These six locations included: Satellite No. 1, the selenium treatment facility, header house 2-2 in Mine Unit 2, a vacuum-truck, a wood or PVC chipper, and personnel sampling (transfer truck). **Table 4.7-1, Peak Noise Levels for Equipment Used at the SUA-1548 Project Sites and the Noise Levels at the Six Smith Ranch Testing Sites** describes the peak decibel levels determined for each of these test sites. Because the highest noise level determined from these tests was 125 dBA, produced by the wood (PVC) chipper at the PVC chipper test site, this noise level was examined further to determine the maximum noise impact from within the 3 kilometers (2 mile) surrounding area to determine the effect it would have on the nearest resident at Vollman Ranch (Cameco, 2010). According to Table 14-16 in the US Department of the Interior, Bureau of Reclamation and Freeport Regional Water Authority, when the distance of the reference sound level is approximately 50 feet the basic sound level drop-off is 6 dBA per doubling distance (US Department of

the Interior, 2003). Therefore, up to 3 kilometers (2 miles) away from the site boundary, the highest level of noise created by ISR activities at Smith Ranch is approximately 77 dBA. This implies that ISR activities can be heard from 3 kilometers (2 miles) away, as well as beyond this point up to a certain distance. However, a noise level of 77 dBA can be likened to the same noise level as a dishwasher, barking dog, or a vacuum cleaner, and therefore the noise impact is not considered extreme (NetWell, 2011). Furthermore the typical noise levels are significantly less than 125 dBA at the source, so the proportionate decrease in noise levels will be less than that described above.

4.7.1.2 North Butte Remote Satellite

Rangeland, pasture and wildlife habitat have been the primary land uses within the surrounding 3 kilometers (2 mile) radius of the North Butte Remote Satellite. Other land uses within the general area include uranium ISR recovery (16 kilometers [10 miles]) away, oil and gas exploration (5 to 10 kilometers [3 to 6 miles]), and CBNG development (adjacent to and within the license boundary). The noise impacts associated with these other uses include increased construction traffic, heavy machinery involved in either well field construction or reclamation of well fields as well as drilling and pipeline construction activities. Approval of the preferred action alternative will present similar types of impacts as described above.

Within close proximity of the North Butte Remote Satellite is one occupied unit, the Pfister Ranch house, located approximately 1 kilometer (0.5 mile) south of the site boundary and is occupied year-round. Any noise created by the North Butte Remote Satellite is expected to increase with increased uranium recovery and processing activity, and noise levels would indeed be higher for those individuals living near the North Butte Remote Satellite area, such as at the Pfister Ranch. However, the noise levels will decrease further away from the noise source. According to the tests conducted by Cameco and assuming the worst case noise generator (PVC chipper), the calculated noise level at a location 3 kilometers (2 miles) from the noise source would be 77 dBA. Because of the low population (very few noise receptors) within the 3 kilometers (2 mile) surrounding area and the low population that exists beyond that area, noise impacts will be insignificant. Additionally, since the maximum increase of new workers associated with the proposed action is anticipated to be relatively low, noise and congestion impacts are not anticipated in Campbell or any neighboring counties.

4.7.1.3 Gas Hills Remote Satellite

Approximately 19 kilometers (12 miles) northeast of the Gas Hills Remote Satellite boundary is the JE Ranch. The Gas Hills Remote Satellite will be using the same type of equipment as Smith Ranch and North Butte during the construction, operations and reclamation/decommissioning phases of the project. Using similar noise source assumptions as above (PVC chipper) and ideal noise propagating meteorological conditions, the nearest occupied housing unit (distance of approximately 19 kilometers [12 miles] from the site boundary) may hear noise from the ISR activities at a level of approximately 35 dBA or less (US Department of the Interior, 2003). This level of noise can be likened to the typical noise level of a humming refrigerator (NetWell, 2011). Furthermore the JE Ranch lies within a protected valley and is isolated topographically from any construction activities within the Gas Hills Remote Satellite. As a result of the remote location of the Gas Hills Remote Satellite and the low population density of the surrounding area, impacts to noise or congestion within the satellite area or in the surrounding 3 kilometers (2 mile) are not anticipated. Additionally, since the maximum increase of new workers associated with the proposed action is anticipated to be relatively low, noise and congestion impacts are not anticipated in Fremont or Natrona Counties.

4.7.1.4 Ruth Remote Satellite

There are no occupied housing units within 3 kilometers (2 mile) of the Ruth Remote Satellite. However, located approximately 10 kilometers (6 miles) west of Ruth is the town of Linch which had a population of approximately 40 people according to the 2000 U.S. Census. Based on the Bureau of Reclamation (US Department of Interior, 2003) calculations on sound drop off, noise level contribution of the site will be negligible within 5 kilometers (3 miles) of the site and will be insignificant at the town of Linch. As a result of the remote location of the Ruth Remote Satellite and the low population density of the surrounding area, impacts to noise or congestion within the satellite area or in the surrounding 3 kilometers (2 mile) are not anticipated. Additionally, since the maximum increase of new workers associated with the preferred action alternative is anticipated to be relatively low, noise and congestion impacts are not anticipated in Johnson or Campbell Counties.

4.7.2 No-Action Alternative

Under the no-action alternative, the licensee would be required to reclaim all existing ISR disturbances at Smith Ranch and the remote satellites. All facilities under SUA-1548 are considered to be remotely located with relatively low ambient noise levels. Any increase in construction activities, even the no-action alternative, would result in an increase in noise levels. Construction activity under the no-action alternative would include reclamation of any existing buildings, restoration of operating mine units, well abandonment and reclamation of well fields, and removal of all ponds, treatment plants and roads. In every case, heavy construction equipment such as bulldozers, scrapers, loaders, drill rigs, PVC chippers, and seeding equipment will be required.

The greatest noise levels will occur at Smith Ranch where the existing condition disturbance is greatest. At this location the no-action alternative would result in the shutdown of an operating mine, the immediate restoration of all operating wellfields and the reclamation of all disturbed lands. Some of these disturbances include the existing 18 buildings (e.g. the CPP, the CPF, satellite buildings, the yellowcake warehouse, deep disposal well buildings, and several others), access roads, a parking area, over 11,000 wells (i.e., monitoring wells, production wells, and injection wells), underground pipelines, storage ponds, and a salvage/boneyard area. These facilities would need to be decommissioned and effectively demolished. The disturbed ground underneath would need to be decontaminated if necessary with topsoil and seeded. The wells would need to be plugged and covered with soil, then seeded. Road surfaces would be dozer-ripped, gravel material salvaged, covered with topsoil and seeded. Where miles of pipeline exist within the ground, these areas would need to be reopened with trenching equipment and pipelines removed, then the trenches backfilled and reclaimed. All storage ponds would undergo natural or enhanced evaporation; all solid 11e.(2) byproduct materials would be removed and transported to a NRC licensed disposal facility. In each case, liners would have to be removed and similarly transported to the licensed disposal facility. Following clean up and decommissioning, these ponds would need to be refilled with subsoil and spread with topsoil, leveled, and seeded as well as other reclamation processes necessary to bring the existing landscape back to its original condition. These reclamation methods require equipment such as scrapers, dozers and graders (to tear up the access roads and spread out the soil), dozers and farm discs (to loosen the packed soil), bulldozers, loaders and dump trucks (for filling reservoirs with dirt and to push topsoil into place), drill rigs (to plug up the monitoring wells), jack hammers (to break up the concrete foundations for the warehouses/shops), backhoes and PVC chippers (to break up the PVC pipe into smaller, manageable pieces), pickup trucks (to help remove the fences within the project site), cranes (to help tear down the building structures, such as the satellite buildings, CPP, CPF, etc.), pipe trailers (to remove the pipeline pieces), pull trucks (to take down the power lines), flatbed trucks (for hauling), and dump trucks (to remove the rubble). Overall, the equipment noise level ranges from approximately 74 to 125 dBA, the

loudest being the PVC or wood chipper at 125 dBA. **Table 4.7-1, Peak Noise Levels for Equipment Used at the SUA-1548 Project Sites and the Noise Levels at the Six Smith Ranch Testing Sites** provides the related noise levels for the other pieces of equipment used at SUA-1548, according to the U.S. Department of Transportation.

In the event that the no-action alternative is chosen, reclamation and decommissioning of the ISR facilities at Smith Ranch will result in noise levels of up to 125 dBA. Because of the concentrated activities of bulldozers, jack hammers and other heavy equipment, noise levels will increase over existing conditions. At a distance of 3 kilometers (2 miles) away, the noise levels will be dampened to approximately 77 dBA. As noted above, a noise level of 77 dBA can be likened to the same noise level as a dishwasher, barking dog, or a vacuum cleaner, and therefore the noise impact is not considered extreme (NetWell, 2011).

Implementation of the no-action alternative at the remote satellite sites will also result in the reclamation of existing disturbances. At each remote satellite facility, there are buildings, monitor wells and roads which will require reclamation. At the Ruth Remote Satellite there are also lined ponds which will need to be decommissioned. Since none of these remote satellites are operational, groundwater restoration of wellfields will not be required. In the event that the no-action alternative is chosen, reclamation and decommissioning of the current facilities will result in noise levels of up to 125 dBA. Because there are not as many buildings, roads and existing wells at these remote satellite facilities, the duration of the increased noise levels will be less than what might be anticipated at Smith Ranch.

4.7.3 Alternative Action

Under the alternative action, the licensee would mine uranium ore using either conventional underground or conventional open pit mining. Within SUA-1548, a conventional mining approach would result in significantly higher noise levels and would extend for a greater period of time. Because of the depth of the ore, it is possible both surface and underground methods would need to be employed. Such mining methods historically occurred at Smith Ranch and the Gas Hills Remote Satellite.

From a noise perspective, conventional mining will require the use of a diverse assemblage of heavy equipment including scrapers, loaders, haul trucks, drill rigs, draglines, bulldozers, road graders, generators, fans, compressors and a diverse number and types of support vehicles. Construction and ultimately reclamation of buildings and processing plants will still be required. Blasting may also be required and would result in the largest instantaneous decibel levels. Overall, the individual equipment noise level for a conventional mine ranges from approximately 74 to 125 dBA. Because of the large concentration of equipment within the operating mine pit, the combined noise may achieve levels of 135 dBA at peak periods of construction and if all equipment was operating at maximum power at the same time. A more reasonable noise level for the alternative action would be 90 to 100 dBA. Given the remoteness of SUA-1548 and the distance to occupied residences, noise levels will vary across the sites depending on the location of specific mine features: mine pits; mine shafts; operating plants; and, waste dumps. In general at a distance of 3 kilometers (2 miles) away, the noise levels (assuming 135 dBA at the source) will be dampened to approximately 87 dBA. Because there are not as many buildings, roads and existing wells at these remote facilities, the duration of the increased noise levels will be less than what might be anticipated at Smith Ranch. A noise level of 87 dBA can be likened to the same noise level as a snow blower or lawn mower (NetWell, 2011).

4.7.4 Cumulative Impacts

Rangeland, pasture, oil and gas exploration, CBM development, and wildlife habitat have been the primary land uses within the surrounding 3 kilometers (2 mile) of SUA-1548. Specific to Smith Ranch, ISR is ongoing and wind farming is a recent development. The noise impacts associated with these land uses include intermittent use of heavy equipment during initial phases of construction or reclamation as well as the ongoing noise associated with increased construction traffic and ongoing equipment noises such as drilling, generators and pumps. As a result of the remote locations associated with the SUA-1548 license area and the low population density of the surrounding area, the cumulative impact related to noise within the surrounding 3 kilometers (2 mile) is not anticipated to be significant. Using worst case assumptions on increased traffic loading and ongoing construction, cumulative noise levels at the source will likely be in the 50 to 70 dBA levels. At a 3 kilometer (2 mile) distance the cumulative noise level increase would be negligible. If a PVC chipper was operating at the same time as the cumulative level of increased traffic and drilling, the individual chipper would dominate the noise calculation. In this case the cumulative impact with an operating PVC chipper would likely remain at 125 dBA.

Additionally, since the maximum increase of new workers associated with the preferred action alternative is anticipated to be relatively low, noise and congestion impacts are not anticipated to affect any of the surrounding counties including: Converse, Campbell, Johnson, Fremont or Natrona.

4.7.5 References

Cameco Resources Smith Ranch-Highland Operation: *Hearing Conservation Hazard Assessment Report.* July 2010.

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US Department of Transportation: Federal Highway Administration-Office of Planning, Environment, & Realty (HEP). *Highway Traffic Noise: Construction Noise Handbook*. Sect. 9.0: Construction Equipment Noise Level and Ranges. 2001. Locate at: www.fwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

4.8 Potential Historic and Cultural Resources Impacts

4.8.1 Proposed Action

Cameco has reviewed and updated historical and cultural resource surveys at SUA-1548, with the exception of the Ruth Remote Satellite, in accordance with the requirements of WSHPO (see Section 3.8). Because of the localized nature of land-disturbing activities for ISR operations and the fact that ISR activities will avoid historic and cultural resources whenever possible, impacts to these resources are expected to be minimal. Overall impacts to cultural and historical resources during operations are expected to be less than those during construction, as operations are generally limited to previously disturbed areas (e.g., access roads, CPF, satellites and well fields).

4.8.1.1 Smith Ranch

A description of the existing historic and cultural resources present at Smith Ranch is presented in Section 3.8. The Holdup Hollow segment of the Bozeman Trail, listed in the NRHP, was within the original Reynolds Ranch Satellite License boundary. In general, it was recommended that no ground-disturbing activity of any kind take place within the recognized boundaries of the Holdup Hollow segment of the Bozeman Trail. Accordingly, the sections of land associated with the Holdup Hollow segment were removed from the northern portion of the Reynolds Ranch Satellite license area. Therefore, there have not been and will not be any adverse 36 CFR 800 impacts to the Bozeman Trail by SUA-1548 operations. All of the other sites under question were determined ineligible for inclusion into the NHRP.

If any previously unidentified historical or archaeological finds are discovered on the property, they will be protected and the appropriate state and/or federal office notified. Cultural and historical resource mitigation procedures used at all SUA-1548 facilities are provided in Section 5.8.

4.8.1.2 North Butte Remote Satellite

Section 3.8 provides a description of the existing cultural resources present at the North Butte Remote Satellite. There are two sites at the North Butte Remote Satellite that have been determined eligible for the National Register of Historic Places. One site is a diffuse scatter of chipped artifacts, suggesting that this site has the potential to yield significant scientific information. As a result, Cameco will not disrupt the ground surface near or within the site. The second site, Pumpkin Buttes, is an extremely large, discontinuous historic property that takes in the tops and sides of the physiographic features making up the Pumpkin Buttes (Dome Butte, North Butte, North Middle Butte, South Middle Butte, Indian Butte, and South Butte). All lands above the 1,609 meter (5,280 foot) contour line are included in the North Butte historical site, which has also been designated a TCP. Cameco will address this TCP in consultation with the NRC, WSHPO and various Native American tribes during NRC's Section 106 consultation process to determine an appropriate course of action related to this site. Cameco has developed a plan for gathering Section 106 information about properties of religious and cultural significance to federally recognized Indian tribes that may be affected by ISR activities at the North Butte Remote Satellite. This plan is provided as **Appendix E, North Butte Section 106 Plan**.

The WSHPO has recommended that Cameco contact the appropriate state and federal agencies if subsurface cultural remains are found during construction. Cameco has agreed to this stipulation for all of its SUA-1548 sites and will also be following mitigation measures outlined in Section 5.8.

4.8.1.3 Gas Hills Remote Satellite

A review of the historic and cultural resources at the Gas Hills Remote Satellite is provided in Section 3.8. Two sites within the Gas Hills Remote Satellite were determined eligible for the NRHP. No disturbance is expected at one of the sites as it will be avoided during construction and operations. However, the other site is located within a wellfield area and will need to be addressed or mitigated (see Plate D3-2 in Appendix D3 of the WDEQ Gas Hills Permit). Mine Unit V may require a Class III inventory before construction commences to ensure minimal impacts to historic and cultural resources. However, the majority (approximately 70% of Mine Unit 5) was previously disturbed by conventional mining and reclamation activities.

As is the case for Smith Ranch and the North Butte Remote Satellite, should subsurface cultural remains be found during any construction activities, all activities within the area will halt and the appropriate state and federal agencies will be contacted immediately. See Section 5.8 for Cameco's mitigative measures used to protect cultural and historic resources.

4.8.1.4 Ruth Remote Satellite

As stated in Section 3.8, no cultural resources were located within the Ruth Remote Satellite during the 1980 survey and archeological clearance was given with the stipulation that if any cultural remains were found, the appropriate state and federal agencies would be contacted immediately. Because cultural studies conducted prior to 1981 are generally not accepted today, an updated historic and cultural survey will be conducted and submitted to NRC, LQD and WSHPO prior to commencing ISR operations at the Ruth Remote Satellite.

4.8.2 No-Action Alternative

The no-action alternative will not have any additional impacts on historical or cultural resources within SUA-1548 as new construction and operations activities will not take place. At Smith Ranch, construction of new mine units would cease and only restoration and reclamation activities would continue. Therefore, additional impacts on cultural and historical resources would be minimal.

4.8.3 Alternative Action

Underground and open pit mining would disturb much larger areas of land compared to ISR methods. Such conventional mining disturbances would include open pits, spoil piles, topsoil piles and construction of buildings. The increase in ground disturbance would undoubtedly increase the risk of adverse impacts to historical and cultural resources over the proposed action.

4.9 Potential Visual and Scenic Resources Impacts

4.9.1 Proposed Action

During ISR operations, there are temporary, short-term and long-term visual effects. The temporary and short-term visual effects occur during the construction phase of mine unit wellfield development which includes header house construction, well installation, wellfield access road construction, pipe and power line installation, etc. Following completion of wellfield installation, the temporarily disturbed areas are reclaimed (Photo 4.9-1, Wellfield Area at Smith Ranch). Only the long-term visual effects associated with operations and maintenance will remain during operations and are described below. SUA-1548 is an ongoing ISR operation and approval of the proposed action will continue the operations at Smith Ranch and allow new operations to commence at the remote satellites.

Long-term visual effects result from the addition of structures to the landscape that will exist over the life of the project. Within the SUA-1548 license areas, long-term visual disturbances consist of buildings, wellfield areas, access roads, and related ancillary infrastructure such as storage ponds, salvage areas, and pipe and power line corridors. The visual disturbances at Smith Ranch include 18 buildings (e.g., the CPP, the CPF, satellite buildings, warehouse, maintenance/construction shop, selenium treatment facility, and deep disposal well buildings), individual wellfields (mine units) and header houses, access roads, a parking area, storage ponds, and a salvage/boneyard area. Additional wellfields, monitoring wells, UIC Class I disposal wells and a Reynolds Ranch Satellite building will be constructed during the license renewal period. License approval of the proposed action would allow these visual disturbances to remain on the landscape for the license period. At the end of ISR operations, all of these facilities will be removed and the land surface reclaimed.

The existing visual disturbances described above range in size from large building structures to wells within the wellfield areas. The Smith Ranch CPP (Photo 4.9-2, Central Processing Plant at Smith Ranch) is the largest building structure at approximately 122 by 30 meters (400 by 100 feet) in size followed by the Highland CPF facility at approximately 86 by 54 meters (288 by 176 feet. The satellite IX buildings

average approximately 15 by 30 meters (50 by 100 feet) each. The wellfield areas comprise the similar visual disturbances including booster station buildings, header houses, wells, power and pipe line corridors, and access roads. The booster station buildings, deep disposal well buildings, and header houses are the largest building structures in the wellfield. These larger structures are accompanied by smaller metal buildings, which are less than 15 by 30 meters (50 by 100 feet) in size. The booster station houses pumps necessary to move water from the wellfields to the processing facilities. The header houses contain electrical components and injection and production headers connecting the wells to the pipelines. Each building is connected by an access road and is characterized by a small disturbance area to provide adequate access for operations and maintenance activities. Electric power lines connect these buildings to the main electric distribution poles. The electric distribution poles represent the tallest structure in the wellfield and are approximately 6 meters (20 feet) high. The smallest visual disturbance in the wellfield area is the well. Each operational well is encased in a weatherproof cover which is approximately 1 by 0.6 meters (3 by 2 feet) in size and come in a variety of shapes from cylindrical to pyramid. Under the proposed action, Cameco will maintain the same design for any new facilities that are constructed at Smith Ranch or any of the remote satellites.

At the North Butte Remote Satellite, Cameco will initially construct three buildings (one satellite building, two UIC Class I injection well buildings, two surge ponds, additional monitoring wells, wellfield areas and header houses, electrical distribution lines, and access roads. Approval of the proposed action would allow these visual disturbances to be constructed during the license renewal period. At the end of ISR operations, all of these facilities will be removed and the land surface will be reclaimed.

At the Gas Hills Remote Satellite, the Carol Shop, approximately 40 monitoring wells, the radium treatment building, a settling basin and several miles of roads and drilling-related disturbances and site reclamation exist. Additionally, disturbances associated with historical conventional mining (both underground and surface) and reclamation exist and represent the affected environment for the assessment of long-term visual impacts. Under the proposed action, Cameco will construct five mine units and associated wellfields, header houses, upgrade and construct new roads, four to six evaporation ponds, UIC Class I injection wells and possibly an additional satellite facility. Approval of the proposed action would allow existing long-term visual disturbances to remain and these additional visual disturbances to be constructed during the license period. At the end of ISR operations, all of these facilities will be removed and the land surface reclaimed.

At the Ruth Remote Satellite, there are three existing buildings (the processing plant, one warehouse, and a generator building), three monitoring wells, one two-celled evaporation pond and one access road. A detailed operations plan has not yet been completed for the Ruth Remote Satellite, so it is yet to be determined whether Cameco will remove and reclaim several of these existing visual disturbances and replace them with new facilities. Cameco anticipates starting development of the Ruth Remote Satellite near the end of the renewal period and will provide an updated operating plan and environmental analysis at that time.

With the approval of the proposed action, Cameco will continue to mitigate the visual impacts by ensuring that these structures blend in with their surroundings as much as possible, including painting them a neutral color to mask their presence. During final decommissioning and reclamation, all structures will be removed thereby removing any visual impacts created by these structures. Any structures built for the purpose of the ISR operation are expected to have very little impact on the overall visual quality of the surrounding area. Photo 4.9-2, Central Processing Plant at Smith Ranch, demonstrates a potential worst case visual impact (largest building complex) within SUA-1548.

4.9.2 No-Action Alternative

The no-action alternative for Smith Ranch would require the reclamation of all visible structures that currently exist at the site. Construction activity under the no-action alternative would include reclamation of any existing buildings, restoration of operating mine units, well abandonment and reclamation of wellfields, and removal of all ponds, treatment plants and roads. The buildings would need to be decommissioned and effectively demolished. The disturbed ground underneath would need to be covered with topsoil and seeded. The wells would need to be plugged and covered with soil, then seeded. Road surface would need to be dozer-ripped, gravel material salvaged, covered with topsoil, and seeded. Buried pipelines would need to be removed using trenching equipment and the trenches backfilled and reclaimed. All storage ponds would undergo natural and enhanced evaporation, and regulated solids would be removed and transported to a NRC-licensed disposal facility. In each case, liners would have to be removed and disposed at a NRC-licensed disposal facility. Following clean up and decommissioning, these ponds would need to be backfilled with subsoil, leveled, spread with topsoil and seeded. At the North Butte Remote Satellite, there is currently (January 2012) no structures, wellfields, and limited access roads. Under the no-action alternative, no new structures would be constructed and all existing ISR disturbance (e.g., monitor wells and access roads) would be removed and reclaimed. At the Gas Hills Remote Satellite, the visual structures include the Carol Shop, more than 40 monitoring wells, the radium treatment building, and existing access roads. Under the no-action alternative, no new structures would be constructed and all existing structures, monitor wells and access roads would be removed and reclaimed. At the Ruth Remote Satellite, the visible structures include three buildings (the processing plant, one warehouse, and a generator building), three monitoring wells, one two-celled evaporation pond and one access road. Under the no-action alternative, no new structures would be constructed and all existing structures, access roads, the pond, monitor wells and a small wellfield area would be decommissioned and reclaimed.

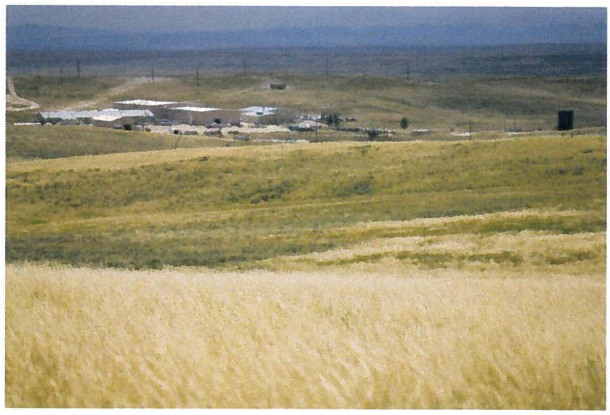
4.9.3 Alternative Action

The visual and scenic resource impacts of the alternative action would be greater than those of the proposed action. Under the alternative action, the overall land disturbance would be significantly greater and will include large conventional open pit and/or underground mine facilities. The long-term visual disturbance would include large mine dumps, topsoil stockpiles, multiple roads, multiple buildings, dewatering wells and facilities as well as conventional milling and tailings facilities. Open pit mining would remove and stockpile hundreds of cubic yards of overburden before reaching the ore zone. Underground mines would also have hoist house structures that would be taller than any of the proposed project buildings. The larger size of a conventional mill will have greater long-term visual impact relative to the proposed action.

4.9.4 Cumulative Impacts

The cumulative impacts to the visual/scenic resources of SUA-1548 are not expected to be significant. The project sites are located in remote areas that are primarily on private and BLM-administered lands and a small amount of state-owned land, with limited or no access. This restricts the number of people that will be able to see the operations. On a cumulative basis, the adjacent existing landscape includes features associated with other energy development enterprises including wind energy generators, CBM wellfields, conventional oil and gas drilling pads and ponds, as well as ancillary roads and buildings. The cumulative impact of an ISR operation within these remote areas will be insignificant. Cameco proposes certain mitigation measures that include painting processing facilities, office and maintenance buildings, well casing covers, and any other visible structures with neutral colors to blend in with the natural landscape. Power lines will be laid underground whenever possible to limit the number of poles and

overhead lines. Wellfield revegetation will alleviate any potential visual/scenic impact that may temporarily occur due to wellfield construction and installation.

Photo 4.9-1 Wellfield Area at Smith Ranch	Photo 4.9-2 Central Processing Plant at Smith Ranch
	

4.10 Potential Socioeconomic Impacts

4.10.1 Proposed Action

The construction and operating workforce for the proposed action will come from the region surrounding each site; primarily Converse, Campbell, Fremont, and Johnson Counties. Smith Ranch is located in Converse County and is an ongoing operation. Much of the current and ongoing effects to housing, public and other community services, recreation, county and municipal finances, crime, and the local transportation network occur within Converse and Natrona Counties. With respect to the remote satellite operations at North Butte, Gas Hills, and Ruth; Campbell County, Fremont County, and Johnson County would likely experience similar, but to a lesser extent socioeconomic impacts.

It is anticipated that the overall effect of the proposed action on the local and regional economy for these counties and the state as a whole would be beneficial. Purchases of goods and services by the project and project employees would contribute directly to the economy. Local, state, and federal governments would benefit from taxes paid by the ISR operations and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. These economic effects would further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the ISR operation would continue for the life of SUA-1548, which, if the proposed action is approved, may result in an additional 36 years for Smith Ranch, 20 years for the North Butte Remote Satellite, 20 to 25 years for the Gas Hills Remote Satellite, and 10 years for the Ruth Remote Satellite. Economic impacts of the proposed action are discussed in further detail in Section 7.6 of the TR.

4.10.1.1 Construction

The construction phase of an ISR project causes a temporary, moderate impact on the local economy resulting from the purchases of goods and services directly related to construction activities. Impacts to community services in Converse, Campbell, Fremont, and Johnson Counties, such as roads, housing, schools, and energy costs, would be minor to non-existent.

An estimated 50 to 75% (approximately 150 to 225 workers) of the construction workforce for Smith Ranch is based in Converse and Natrona Counties. When construction commences at the North Butte and Ruth Remote Satellites, it is anticipated that the majority of the workers will be hired from communities located within Campbell and Johnson Counties; and when construction commences at the Gas Hills Remote Satellite, it is anticipated that the majority of workers will be hired from communities located within Fremont County.

Most construction work available to the local construction labor pool consists of temporary contract work that varies in duration, depending on the scope of each construction project. The number of unemployed construction workers does not represent the number of workers that would be available to the project from the local construction labor pool. The "unemployed" number is an annual average that does not take into account monthly variations in the available construction labor pool from construction start-ups and completions. Cameco will likely hire from the local construction labor pool. The actual number of construction workers available for SUA-1548 draws from the entire construction labor pool of approximately 7,100 (2010 estimate). This pool will fluctuate as construction activities from some active projects conclude and new workers become available for construction activities under the proposed action.

4.10.1.2 Operations Workforce

An estimated 153 full-time employees are currently employed at Smith Ranch for operations and restoration activities. This number is expected to increase to 170 full time employees under the proposed action. It is estimated that an additional 50 to 60 people will be required to operate the North Butte Remote Satellite facility, an additional 75 workers for the Gas Hills Remote Satellite facility, and an additional 20 for the Ruth Remote Satellite facility. It is not known how many of the required operations workforce would be hired from outside of Converse, Campbell, Fremont, Natrona and Johnson Counties. In the event that the entire operations workforce and their families relocated to the counties within which the projects are located, the population increase would be a maximum of 360 in Converse County, 144 in Campbell County, 180 in Fremont County, and 48 in Johnson County based on the 2010 average Wyoming household size of approximately two people. This increase would account for less than 1% of the population of Converse, Campbell, and Johnson Counties, and approximately 1% for Fremont County. These increases are smaller than the projected annual growth rate. Therefore, there would be little to no effect on the vacancy rates of any type of housing in the affected counties.

4.10.1.3 Effects to Housing

Smith Ranch is within commuting distance of Glenrock and Douglas in Converse County, and Casper in Natrona County. The North Butte and Ruth Remote Satellites are within commuting distance of Gillette and Wright in Campbell County; Midwest, Edgerton and Casper in Natrona County; and, Kaycee in Johnson County. The Gas Hills Remote Satellite is within commuting distance of Riverton and Shoshoni in Fremont County and Casper in Natrona County. Therefore, workers from these counties would likely commute from their homes. There would be no impact on temporary housing located within commuting distance (approximately 1 to 2 hours) of the license areas.

In the event that temporary workers from other states are hired for construction at SUA-1548, temporary housing such as motel/hotel rooms and RV sites located within commuting distance would be required, as no on-site housing is available or planned. The available stock of motel/hotel rooms for Smith Ranch and the remote satellites would accommodate relocating workers.

It is recognized, however, that the coal, CBM, oil and gas, and other uranium projects in the area are presently a dominant influence on temporary housing, and the workforce employed in these industries

occupy much of the temporary housing that is currently available. Wyoming counties are often faced with a shortage of temporary housing and have adapted to this shortage by the construction of new temporary facilities.

It is anticipated that only a few members of the construction workforce would purchase or rent housing of any type. Therefore, there would be no effects on the costs of any type of housing in the affected counties. Because rental housing usually requires a long-term lease (generally a minimum of six months), only long-term employees would likely enter into this type of lease agreement. Under a hiring scenario that assumes all of the proposed operations workforce would need to relocate to the area, approximately 210 housing units would be required over the life of the project for Smith Ranch, approximately 144 for the North Butte Remote Satellite project, approximately 180 for the Gas Hills Remote Satellite project, and approximately 28 for the Ruth Remote Satellite project. Since Smith Ranch is an operating uranium ISR facility, the need for 210 housing units is unrealistic. In 2010, there were a total of 2,513 vacant housing units in Converse and Campbell Counties combined, and 3,112 vacant housing units in Fremont and Johnson Counties. When combined and assuming the above worst case assumptions, this would meet the future demand for housing in these four counties from anticipated population growth. There would be little to no effect to the rental rates of any type of housing in the affected counties.

4.10.1.4 *Effects to Services*

It is likely that both the construction and operating workforce for the project would be from Converse, Campbell, Fremont, and Johnson Counties, or other nearby communities, and would not require permanent or temporary housing. In the event that up to 50% of the construction and operating workforce are non-local workers, it is anticipated that there would be less than a 1% increase in the population of the affected counties from the permanent relocation of the workers and their families. Most non-local workers are anticipated to utilize temporary housing. Because existing mobile home and RV parks will be used for a majority of the temporary housing, the project will not require new water, sewer, electrical lines, or other infrastructure. There will be no additional demands or increases in service levels for local infrastructure, such as police, fire, water, or utilities. In addition, there would be little measurable increase in non-basic employment, as these jobs are generated from ongoing employment of the existing base of construction workers, and would be maintained through the continued employment of local construction workers. Therefore, construction and operation of SUA-1548 during the renewal period would not significantly affect the various public and non-public facilities and services described above from the influx of workers for non-basic employment opportunities.

Families moving into the affected county school districts as a result of SUA-1548 operations would not stress the current school system because it is presently under capacity in each of the affected counties.

4.10.1.5 *Economic Impact Summary*

Economic impacts are discussed in detail in the benefit-cost analysis in Section 7.0.

4.10.2 No-Action Alternative

The no-action alternative would result in a negative economic impact to local towns and counties by reducing the sales tax revenue for goods and services in Converse, Campbell, Fremont, and Johnson Counties. Selection of this alternative would impede any chance of further boost to the economy for the towns that would provide housing and services for works associated with SUA-1548. The no-action alternative overall would create no additional jobs and would inhibit any positive effects that the project has and would have continued to have on the economy at the local, state, and federal level.

The no-action alternative would; however, increase the number of available housing units (temporary or permanent) in the cities and towns that are within commuting distance of the SUA-1548 license areas since they would not be occupied by the Cameco employees. Also, the no-action alternative would prevent an increase in the number of students that would occupy the local schools, and would increase the vacancy levels at nearby mobile home communities and RV parks. However, based on the number of workers anticipated for each of the SUA-1548 license areas, the no-action alternative is unlikely to have a positive effect on local housing or the local school system.

4.10.3 Alternative Action

The socioeconomic impacts of conventional mining would be similar, though possibly greater than those associated with the proposed action. In particular, the labor force associated with a conventional mine and the upfront capital requirements would be greater. Because of the increase in labor, the overall demand for housing and school will be higher and additional housing may need to be created. Tax revenue from a conventional mine is likely to be greater, both in the number of employee's spending money locally as well as the significantly larger capital investment in equipment, materials, fuel and supplies. Additionally, more out-of-area/state workers may be required to fill all of the open positions of an open pit or underground mining operation.

4.10.4 Cumulative Impacts

The proposed action will provide an overall positive contribution to cumulative socioeconomic impacts in the region. The affected counties are all "energy affected counties" and the energy specialized workforce is in place. The cumulative jobs associated with approval of the proposed action are all high paying jobs and will likely be similar to those associated with conventional oil and gas, wind energy, shale fracking, other uranium ISR operations, coal, and CBM. The proportion of new jobs associated with the NRC approval of the proposed action will be insignificant relative to the cumulative nature of energy development within the region. On a cumulative basis, the energy development within these counties has provided jobs, wages, and tax revenues to the state and surrounding communities without adverse impacts to local infrastructures like hospitals, schools, and community services. In fact, the cumulative taxes associated with mineral and resource recovery has provided funding for capital improvements, including critical infrastructure improvements on a statewide basis. If the proposed action is approved by the NRC Staff, the positive socioeconomic effects will be accentuated.

4.11 Potential Environmental Justice Impacts

4.11.1 Proposed Action

Based on the data provided in this section, no large populations of minorities or people living below the poverty level are located near any of the SUA-1548 license areas. Therefore, it is concluded that the ISR operations are not now nor will they in the future create any adverse environmental justice impacts on either of these populations. Except for scattered ranches, the majority of the population nearest to Smith Ranch and its contiguous satellites live in Casper, Glenrock, Rolling Hills, Douglas and other smaller communities along the I-25 corridor. Similarly, the majority of the population near the North Butte and Ruth Remote Satellites reside in Gillette, Wright and other smaller communities along Highways 387, 50 and 59. The majority of the population near the Gas Hills Remote Satellite resides in Riverton, Lander and Casper. These cities, towns, and communities also possess a low percentage of minority and low-income populations compared to the state as a whole (U.S. Department of Commerce, 2000c).

4.11.1.1 Smith Ranch

The 2000 U.S. Census Decennial Population program provides race and poverty characteristics on a census tract basis. Based on an 80 kilometer (50 mile) radius, Smith Ranch consists of a total of seven potentially-impacted census tracts which encompass portions of Campbell, Converse, Johnson and Natrona Counties.

As summarized in **Table 4.11-1, 2010 Race Characteristics of the Population for the Census Tracts Included in the 80 Kilometer Radius Surrounding Smith Ranch**, the combined population of the surrounding census tracts was approximately 29,000, according to the 2010 U.S. Census (U.S. Department of Commerce, 2010b). The State of Wyoming minority and low-income housing data was compared to the combined census tract totals to demonstrate how the overall minority and low-income populations directly compare to each other. There are approximately 2,700 minorities (approximately 9% of the total state population) living within the seven census tracts, whereas there are approximately 80,000 minorities (approximately 14% of the total state population) living in the entire state of Wyoming (U.S Department of Commerce, 2010b).

The following census tracts exhibit a smaller percentage of the population living below the poverty level than the state as a whole: Campbell County Tract 1, Converse County Tract 9566, and Natrona County Tract 18. Their approximate poverty level populations respectively are 8%, 5%, and 6%, whereas the state overall has a poverty level average of approximately 11%. **Table 4.11-2, 2000 Poverty Level Characteristics of the Population for the Census Tracts Included in the 80 Kilometer Radius Surrounding Smith Ranch** summarizes the median household income, per capita income, and population below the poverty level for each of the impacted census tracts as well as the state as a whole. No disproportionate adverse Environmental Justice impacts have been identified for low-income populations within the census tracts due to the operations at Smith Ranch.

4.11.1.2 North Butte and Ruth Remote Satellites

Because of their close proximity to one another (Ruth is approximately 13 to 16 kilometers (8 to 10 miles) southwest of North Butte), the Environmental Justice impacts of these two facilities have been analyzed together. Based on an 80 kilometer (50 mile) radius, the North Butte and Ruth Remote Satellites consist of a total of six census tracts which encompass portions of Campbell, Converse, Johnson, and Natrona Counties. Because of its location, the North Butte Remote Satellite 80 kilometer radius also includes a small portion of Platte County.

As summarized in **Table 4.11-3, 2010 Race Characteristics of the Population for the Census Tracts Included in the 80 Kilometer Radius Surrounding North Butte** and **Table 4.11-4, 2010 Race Characteristics of the Population for the Census Tracts Included in the 80 Kilometer Radius Surrounding Ruth**, the combined population of the surrounding census tracts of these two remote satellite facilities is approximately 33,100, according to the 2010 U.S. Census (U.S. Department of Commerce, 2010b). Of that population total, there are approximately 3,400 minorities (approximately 10% of the combined census tract population) living within the six census tracts, whereas there are approximately 80,000 minorities (approximately 14% of the state population) living in the state of Wyoming (U.S Department of Commerce, 2010b).

The following census tracts exhibit a smaller percentage of the population living below the poverty level than the state as a whole: Campbell County Tract 1, Campbell County Tract 7, Converse County Tract 9566, and Natrona County Tract 18. Their approximate poverty level populations, respectively, are 8%, 8%, 5%, and 6%, whereas the state has an overall poverty level population of approximately 11%. **Table 4.11-5,2000 Poverty Level Characteristics of the Population for the Census Tracts Included in the 80**

Kilometer Radius Surrounding North Butte and **Table 4.11-6, 2000 Poverty Level Characteristics of the Population for the Census Tracts Included in the 80 Kilometer Radius Surrounding Ruth** summarize the median household income, per capita income, and population below the poverty level for each of the impacted census tracts as well as the state of Wyoming.

4.11.1.3 Gas Hills Remote Satellite

Based on an 80 kilometer (50 mile) radius, the Gas Hills Remote Satellite consists of a total of seven census tracts that encompass portions of Carbon, Fremont, Johnson, Natrona, and Sweetwater Counties.

According to the 2010 U.S. Census, and summarized in **Table 4.11-7, 2010 Race Characteristics of the Population for the Census Tracts Included in the 80 Kilometer Radius Surrounding Gas Hills**, the combined approximate population of the surrounding census tracts was 25,800 (U.S. Department of Commerce, 2010b). Of that total, there are approximately 5,900 minorities (approximately 23% of the total census tract population) living within the seven census tracts, whereas there are approximately 80,000 minorities (approximately 14% of the state population) living in the entire state of Wyoming (U.S Department of Commerce, 2010b).

The percentage of the population residing within the following census tracts exhibit fewer people living below the poverty level than the rest of the state: Fremont County Tract 3, Natrona County Tract 18, and Sweetwater County Tract 9716. Their approximate poverty level populations are, respectively, 8%, 6%, and 9%. **Table [2000 Poverty Level Characteristics of the Population for the Census Tracts Included in the 80 Kilometer Radius Surrounding Gas Hills]** summarizes the median household income, per capita income, and population below the poverty level for each of the impacted census tracts and the entire state.

4.11.2 No-Action Alternative

Under the no-action alternative, a number of workers would be required to decommission (including groundwater restoration) and reclaim the SUA-1548 license areas back to their original pre-ISR condition. At Smith Ranch, approximately 75 employees would be necessary to successfully carry this out. At the North Butte Remote Satellite, approximately 30 employees would be needed to complete decommissioning and reclamation activities. At the Gas Hills Remote Satellite, approximately 38 employees would be needed; and at the Ruth Remote Satellite, approximately 10 workers would be necessary. During the decommissioning and reclamation process, the number of required workers at each of the SUA-1548 license areas will decrease as the process progresses and tasks are completed. As demonstrated with the proposed action (see Section 4.11.1), there is not now, nor will there be in the future, any disproportionate potential adverse impacts to minority and low-income populations from the operation of SUA-1548. Therefore, the number of employees and activities necessary to successfully decommission and reclaim each of the four sites would exhibit less of an impact on the minority and low-income populations than the proposed action.

4.11.3 Alternative Action

Under the alternative action, Cameco would mine the uranium ore using conventional underground or open pit mining methods. A conventional mining approach would result in a significantly larger work force. The greater number of employees and contract labor workers required for each of the SUA-1548 license areas would likely reside in the same cities and towns described for the proposed action. Housing is somewhat limited in these communities (see Section 4.10) and additional housing may need to be created. The increased demand in housing may result in higher rents and/or availability of housing to the minority and poverty level populations. This increased stress on the community housing and

infrastructure could cause potential adverse impacts on the minority and poverty level populations that would not exist with the proposed action.

4.11.4 Cumulative Impacts

The SUA-1548 license areas are located in remote areas of the state surrounded by rural populations with no significant minority or low-income populations. The average salary, including salaries of the proposed action, for the areas within 80 kilometers (50 miles) of each of the SUA-1548 license areas, is significantly higher than the poverty level. This fact alone indicates that the proposed action will have a positive impact on any minority and low-income individuals living in communities surrounding the SUA-1548 license areas by making available additional high salary jobs to the people of Wyoming. Therefore, based on an analysis of the impacts caused by the existing Smith Ranch operation and publicly available statistics, it is not anticipated that the proposed action will result in any adverse Environmental Justice impacts on the surrounding local communities or the State of Wyoming.

4.12 Potential Public and Occupational Health Impacts

4.12.1 Proposed Action

ISR operations under the proposed action pose a low risk to public and occupational health. To ensure risk levels from non-radiological and radiological impacts remain low, Cameco has instituted standard operating procedures for handling, processing, storing, transporting or disposing of source and byproduct and hazardous materials. Approval of the proposed action will not result in significant risk to public and occupational health.

4.12.1.1 Smith Ranch

Non-Radiological Impacts

The proposed action includes continued operations at Smith Ranch and expansion to the Reynolds Ranch Satellite. Non-radioactive airborne effluents at Smith Ranch are limited to fugitive dust from access roads and mine unit activities and non-radioactive NOx particulate emissions from the CPP yellowcake vacuum dryer and packaging room scrubber system. Non-radioactive particulates from the CPP have been negligible in the past and are anticipated to continue to be so. During construction, non-radiological impacts are those associated with fugitive dust from access roads and mine unit activities along with gasoline and diesel emissions from construction equipment and field vehicles. Fugitive dust would result from land disturbance activities associated with construction as well as vehicular traffic. Impacts from these emissions is expected to remain small due to both the short duration of the release and the fact that emissions are readily dispersed into the atmosphere (NRC, 2009). A summary of the estimated annual fugitive dust emissions is provided in Section 7.2.1 of the TR and indicates that the fugitive dust emission estimates are well below the allowable limits of the State of Wyoming. For additional information on the non-radiological impacts associated with Smith Ranch please see Section 4.6 of this ER and 7.4 of the TR.

No highly hazardous chemicals, toxics, or reactives listed in Appendix A to 29 CFR 1910.119 are used at Smith Ranch. While some hazardous chemicals are used at ISR facilities, small risks are expected in the use and handling of these chemicals during normal operations (NRC, 2009). However, accidental releases of these hazardous chemicals can produce significant consequences and impact public and occupational health and safety. Mitigation measures as described in Section 5.12 are used by Cameco to reduce the chance of such an accident. If an accident did occur, Cameco has established emergency response plans and procedures that will minimize the risks and impacts. For additional information on

the non-radiological impacts associated with hazardous materials at Smith Ranch, please see Section 7.5 of the TR.

Non- 1e.(2) liquid and solid wastes will be properly disposed to prevent any significant impacts to public and occupational health. The different types of wastes are characterized as follows:

Non-11 e.(2) Liquid Wastes

- Liquid wastes not affected or contaminated by uranium processing. Reagents and fuels stored outside and near the facilities are placed within bermed areas to provide secondary containment and meet requirements of the Spill Prevention Control and Countermeasures (SPCC) regulations. Contained spills are then removed for appropriate disposal.
- Domestic liquid wastes from restrooms and lunchrooms are disposed in an approved septic system that meets the requirements of the State of Wyoming. Liquid wastes from the facility laboratories are disposed at UIC Class I disposal wells.
- Storm water management is controlled under Wyoming Pollution Discharge Elimination System (WYPDES) permits issued by the WDEQ/WQD. Facility drainage is designed to route storm water away or around buildings, ancillary buildings and parking areas, chemical and fuel storage areas. Refer to Section 4.0 of the TR for more information on Non-11-e.(2) liquid wastes.

Non-11 e.(2) Solid Wastes

Solid materials which are not contaminated with radioactive material or which can be decontaminated to unrestricted release criteria. To be released for unrestricted use, decontaminated materials must have activity levels lower than those specified in NRC guidance titled "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials", September 1984.

Waste management and potential impacts related to these materials are provided in greater detail in Section 4.2 of the TR and 4.13 of this ER.

Radiological Impacts

During typical ISR operations, there is a small potential for radionuclides to be released to the environment. Rn-222 can be emitted from IX facilities, the CPP and the mine unit header houses during operations. However, ISR activities do not release significant amounts of gaseous or airborne particulates (see Section 4.6). Specific information relating to the radiological impacts associated with Smith Ranch, including all MILDOS modeling, pathway assessment, and public and occupational exposure information can be found in Section 7.3 of the TR. Information related to the radiological impacts associated with spills at Smith Ranch can be found in Section 7.5 of the TR.

Under the proposed action, yellowcake processing will be performed at the Smith Ranch CPP and CPF facilities. The primary potential source of airborne uranium occurs during yellowcake packaging. Packaging of the yellowcake will be confined to the dryer room, which will be closed and posted as an airborne radioactivity area. Within the yellowcake drying and packaging areas at the CPP and CPF, the potential exists for exposure to yellowcake dust. However, airborne particulate levels at ISR plants that employ vacuum dryers are very low since there are no radionuclide emissions from the dryer. Cameco utilizes vacuum dryers rather than calciner type dryers (yellowcake roasted at 800 °C [1,472 °F] in a gas fired furnace) to reduce migration of air particulates from the drying process. Drying takes place in a

vacuum. Material is sucked into the canister so particulates are not allowed to escape into the environment.

In the slurry unloading area, the potential for exposure to airborne uranium is considerably less than in the drying and packaging areas as slurry unloading will be performed on an infrequent basis. Dryer operators are required to wear precautionary respiratory protection during yellowcake packaging operations to provide another layer of protection from the potential release of airborne uranium during this procedure.

Cameco uses downflow pressurized IX columns instead of open columns to minimize exposure to Rn-222. All facilities have ventilation systems that remove released radon from building units to the atmosphere. These and other measures ensure impacts to public and occupational health from yellowcake processing are ALARA.

Cameco performs extensive monitoring to reduce the potential for radiological impacts to public and occupational health. External gamma radiation surveys are regularly performed at worker occupied stations and areas of potential gamma source exposure such as tanks and filters at Smith Ranch. Area samples are collected and analyzed at specified sample locations (see Figure 3.19, CPP Floor Plan and Figure 3.21 Highland CPF Floor Plan in the TR) in accordance with standard operating procedures. Workers are also monitored to ensure they receive less than 10% of the dose limits for internal or external radiation. Lastly, occupational airborne radioactivity concentrations at Smith Ranch are monitored daily, weekly and monthly to allow for timely investigations and corrective actions, if needed, to respond to conditions or practices resulting in airborne radioactivity concentrations above the action level of 25% of the DAC. For additional information about current activities and mitigation measures, see Sections 3.12 and 5.13 of this ER and Sections 5.8 and 5.10 of the TR.

4.12.1.2 Remote Satellites (North Butte, Gas Hills, and Ruth)

Non-Radiological Impacts

Approval of the proposed action (at the remote satellites will allow in the commencement of uranium recovery operations at these facilities. Construction and operations at the remote satellites will have similar safeguards as those utilized at Smith Ranch. There, potential impacts on public and occupation health at the remote satellite locations are expected to be small. Increases in fugitive dust levels as construction and operation activities commence are anticipated, but impacts on local air quality will be minimal (see Section 4.6). Measures to reduce dust from vehicular traffic include applying water or chemically treating unpaved roads. Estimated fugitive dust emissions during construction of ISR facilities are less than 2% of the National Ambient Air Quality Standards (NAAQS) for PM2.5 and less than 1% for PM10 (NRC 2009).

Hazardous materials use will be kept to a minimum and handling of these materials will be according to standard operating procedures. Should an accident or spill occur, emergency response plans will be followed to minimize potential health impacts. Non-radiological impacts are discussed in further detail in Section 7.5 of the TR.

Waste management procedures are in place at Smith Ranch, and reflect those approved in the 2001 license renewal, to reduce public and occupational health impacts from liquid and solid wastes. Monitoring and sampling of waste effluent show that management measures are successful as levels are within acceptable values. These management and sampling procedures will also be used at the remote satellites. Information regarding potential impacts from waste management is discussed in Section 4.2 of the TR and 4.13 of this ER. At this time, site planning and proposed construction activities for the Ruth

Remote Satellite have not been finalized. Consequently, impacts from construction and operations will not be experienced at the Ruth Remote Satellite until future operational details are finalized.

Radiological Impacts

Airborne effluents from ISR operations at the remote satellites are anticipated, but constituent concentrations will likely be minimal. In particular, Rn-222 is the main potential radioactive effluent expected during operations. Potential sources include plant buildings evaporation ponds (if utilized) and well field locations. Although these sources do provide a transfer mechanism to the atmosphere, anticipated levels of airborne Rn-222 is small and will immediately be dispersed in the atmosphere further reducing any potential concentrations.

Similar to Smith Ranch, once construction and operations begin at the remote satellites, Cameco will closely monitor radiological levels of its workers, site locations and air quality to reduce potential impacts to public and occupational health. Conversely, upon completion of ISR activities, equal attention will be given to decommissioning and restoration efforts. Section 5.13 provides detailed information regarding mitigation measures. Measures include cleanup criteria for structures, which includes radiological surveys and sampling of all facilities, equipment, materials, and soils to determine the level of contamination and resultant mitigation efforts. As part of this process, appropriate safety measures will be initiated to protect both workers and the environment through the decommissioning process.

4.12.2 No-Action Alternative

Under the no-action alternative there would be no significant impacts on public and occupational health at SUA-1548. Both non-radiological and radiological public and occupational health impacts at Smith Ranch would remain at current levels and diminish over time as decommissioning and restoration activities were completed. There would be construction activities at the remote satellites as existing disturbances are reclaimed and, as such, there may be a temporary increase in fugitive dust or other non-radiological emissions.

4.12.3 Alternative Action

Non-radiological impacts to public and occupational health are significantly less at an ISR operation than conventional underground or open pit uranium mining. The larger work force and scale of conventional underground and open pit mining would cause a major increase in the amount of gaseous and airborne particulates, particularly from fugitive dust. In addition, the structure and design of an ISR facility also decreases potential public and occupational health hazards that are present in conventional mining operations. Hazardous structures exist not only with underground, but also open pit mining and increase the potential for health impacts. In contrast, ISR recovery has no open pits, shafts or other potentially hazardous structures reducing the chance of injuries.

Radiological exposure is also greater from conventional uranium mining than ISR. At an ISR facility, operating personnel are not exposed to the radionuclides present in and emanating from the ore and tailings. Conventional mill tailings can contain all of the Ra-226 originally present in the ore, whereas ISR operations may have less than 5% of the original Ra-222 in the ore zone (Energy Metals Corporation, 2007). The alternative action will result in greater public and human health impacts than the proposed action.

4.12.4 References

Crow Butte Resources, Inc. "License Renewal Application: SUA-1534." Crawford Nebraska: Crow Butte Resources, Inc. 2007.

Energy Metals Corporation, U.S. "Application for NRC Source Material License Moore Ranch Uranium Project, Campbell County, Wyoming: Environmental Report." Casper, Wyoming: Energy Metals Corporation, U.S. [ADAMS Accession Number: ML072851249]. September 2007.

NRC. 2006. "Environmental Assessment for the Addition of the Reynolds Ranch Mining Area to Power Resources, Inc.'s Smith Ranch/Highlands Uranium Project Converse County, Wyoming." Source Material License No. SUA–1548. Docket No. 40-8964. Washington, DC: NRC.

NRC. 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (NUREG-1910). Page Last Reviewed/Updated Sunday, March 13, 2011.

5.0 Mitigation Measures

In accordance with the guidance provided in NUREG-1748, this section describes those mitigation measures that Cameco uses and will continue to use to reduce potential adverse impacts from operations at SUA-1548. An analysis of the anticipated effectiveness of the mitigation measures and any residual potential impacts or unavoidable potential impacts caused by the mitigation measures is also provided. Finally, the technical feasibility and cost-benefit of applying the mitigation measures is discussed.

In 40 CFR 1508.20, the CEQ defines mitigation as:

1. Avoiding the potential impact altogether by not taking a certain action or parts of an action.
2. Minimizing potential impacts by limiting the degree or magnitude of the action and its implementation.
3. Rectifying the potential impact by repairing, rehabilitating, or restoring the affected environment.
4. Reducing or eliminating the potential impact over time by preservation and maintenance operations during the life of the action.
5. Compensating for the potential impact by replacing or providing substitute resources or environments.

Mitigation measures can take the form of both general BMP and more site-specific management actions. A BMP, in the most general terms, is a method or technique found to be the most effective and practical means in achieving an objective (in this case preventing or minimizing potential adverse impacts to the environment) while optimizing resource use. Cameco is committed to meeting the highest standards in health and environmental performance. The following sections describe the mitigation measures that will be or already are implemented at all locations covered under SUA-1548.

5.1 Land Use

This section addresses the final decommissioning methods of disturbed lands including mine unit well fields, satellite facility areas and the central processing facilities at Smith Ranch and the remote satellite facilities. The section also discusses general procedures to be used during final decommissioning as well as the decommissioning of a particular wellfield area.

NRC regulations at 10 CFR 40.42(h)1 and 2 state that decommissioning of the site or a portion of the site is required within 2 years following the commencement of decommissioning activities. Similarly, when decommissioning involves the entire site, a request for license termination is required within 2 years following the initiation of decommissioning activities, unless an extension or exemption has been applied for and approved by NRC Staff.

Following is a list of general decommissioning activities:

- Plugging and abandonment of all wells.
- Determination of appropriate cleanup criteria for structures.
- Radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.

- Decontamination of items to be released for unrestricted use to levels consistent with NRC requirements.
- Surveying of excavated areas for contamination and decontamination or removal of the contaminated materials to another operational portion of SUA-1548, or removal to another NRC-licensed facility for reuse or disposal.
- Performance of final site soil radiation surveys.
- Replacement of topsoil and recontouring of the surface, as needed.
- Establishment of permanent revegetation on all disturbed areas.

5.1.1 Surface Reclamation and Decommissioning

NRC regulations at 10 CFR 40.42(d)1 - 4 state that upon termination of the license, permanent ceasing of principal activities or in the absence of principal activities for a 2-year period, Cameco is required to provide written notification of decommissioning to the NRC. "Decommissioning" includes ground water restoration. It is the goal of surface reclamation to return all disturbed areas to its pre-operational land use of livestock grazing and wildlife habitat (unrestricted use) unless an alternative use is justified, in concurrence with the landowner desires and approved by the WDEQ and NRC. For example, if the landowner desires to retain certain roads or buildings, this will be addressed with the regulatory agencies. Interim and final reclamation mitigates the initial disturbance to land use. For complete information on surface reclamation and decommissioning including well plugging and abandonment, surface disturbances, and surface reclamation, please see Section 6.2 of the TR.

5.2 Transportation

5.2.1 Traffic

The highest levels of project-related traffic are from the operations and construction workforce which are housed in surrounding communities and limited to travel to and from the sites and on site during the work shift. As stated in Section 4.2 traffic rates on all adjacent and regional roadways are anticipated to increase by less than 5% as the result of SUA-1548 activities. No mitigation measures have been necessary in the past and are not anticipated to be necessary in the future.

5.2.2 Transportation Accidents

Transportation of hazardous materials associated with SUA-1548 can be classified as follows:

- Shipments of uranium-laden resin from SUA-1548 satellites to the CPP or CPF for processing.
- Shipments of process chemicals or fuel from suppliers to any of the SUA-1548 sites.
- Shipment of processed yellowcake from the CPP or CPF to a conversion facility.
- Shipments of 11e.(2) byproduct material from the CPP or CPF and satellites to a NRC-licensed disposal facility.

Resin, yellowcake slurry, dried yellowcake and 11e.(2) byproduct material shipments are made in accordance with DOT and NRC regulations. Shipments will be handled as low specific activity (LSA) material. General shipping procedures are outlined as follows:

- The materials described above are shipped as "Exclusive Use Only". This requires the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs.
- A bill of lading is included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified are the shipping name, ID

number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number.

- Before each shipment of LSA material, the exterior surfaces of the trailer will be surveyed for alpha contamination. In addition, gamma exposure rates will be obtained from the surface of the trailer and inside the cab of the tractor. All of the survey results will appear on the bill of lading.
- Properly licensed and trained drivers transport the material between SUA-1548 satellites and the CPP or CPF. Dried yellowcake and 11e.(2) byproduct material is shipped by contract carrier.

Cameco has developed an emergency response plan for yellowcake and other transportation accidents to or from all SUA-1548 license areas, which has been in place since the initial license was approved. Cameco personnel receive initial and annual refresher training for responding to a transportation accident.

In the event of a transportation accident involving resin or yellowcake slurry transportation between SUA-1548 sites, Cameco will implement its emergency response plan for transportation accidents. Additionally, to reduce the risk of a potential accident and to minimize potential impacts from such an accident, the following procedures are followed:

- Each truck is equipped with a communication device that allows the driver to communicate with either the shipper (i.e., satellite) or receiver (i.e., CPP or CPF). In the event of an accident and spill, the driver is able to communicate with either site to obtain help.
- A check-in and check-out procedure is required where the driver notifies the receiving facility prior to departure from his location. If the resin or slurry shipment fails to appear within a set time, an emergency response team will respond and search for the vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.
- Each transport vehicle is equipped with an emergency spill kit which the driver can use to begin containment of any spilled material. The kit includes plastic sheeting to cover spilled material until cleanup operations can begin.
- Both the shipping and receiving facilities are equipped with emergency response kits to quickly respond to a transportation accident.
- Personnel and truck drivers receive specialized training to handle an emergency response to a transportation accident.

5.3 Geology and Soils

5.3.1 Geology

Potential geologic impacts from the proposed action license areas have been in the past and are anticipated to continue to be minimal, if any. No significant matrix compression or ground subsidence has been observed from existing ISR operations and none are anticipated. Further, once production and restoration operations are completed, groundwater levels return to near original conditions under a natural gradient and exist at their pre-mining water quality. Potential impacts to deep geologic structures from disposal of fluids via UIC Class I disposal wells have not created any potential geologic impacts to the receiver formations in the last 25 years of operating experience at Smith Ranch. Injection rates are limited by regulatory and permit requirements so that formation fracture pressures that could cause geologic instability are not exceeded. Based on past operating history, it is not anticipated that

potential geologic impacts will occur in the next renewal period due to continued operation of existing UIC wells or additional wells that may be installed and operated during the renewal period.

5.3.2 Soils

The Smith Ranch is operational whereas the Reynolds Ranch Satellite, North Butte, Gas Hills, and Ruth Remote Satellites are not. The topsoil management and erosion control methods employed at each facility are similar. Section 3.8 of the TR details the most current BMP being employed at SUA-1548 in the areas of: topsoil management, erosion control methods, surface water diversions, and the construction quality assurance plan.

Potential soil impacts will occur as topsoil is removed from drill pads, roads, building footprints, ponds and similar ISR operations. Potential impacts to soils will be mitigated by the temporary nature of the disturbance, proper stockpiling and protection of topsoil resources and careful replacement and reseeding of topsoil on the reclaimed land surface. The majority of topsoil disturbances at an ISR facility are generally short term and include the six month period of wellfield development or the near simultaneous trenching and reclamation of pipeline trenches. In both cases, reclamation occurs shortly after the disturbance.

Although unlikely, an unexpected spill could potentially impact soils. The monitoring plan designed by Cameco quickly detects and responds to spills to minimize potential impacts. Should a spill occur, potential impacts are expected to be localized and short term. Information regarding potential spills and associated potential impacts are discussed as part of waste management in Section 4.12 of the ER and 4.2 of the TR. Cameco has demonstrated, through existing operations at Smith Ranch, both prompt and efficient methods for addressing spills. Furthermore, Cameco's Spill Committee review process has proven effective investigating causes of spills and recommending and implementing engineering and operational changes to eliminate or reduce the risk of spills occurring in the future. Section 3.10 of the TR provides additional information on potential impacts of historical spills at Smith Ranch.

5.4 Water Resources

5.4.1 Surface Water

There will be minimal potential impacts to surface waters at all SUA-1548 license areas as a result of the planned or ongoing ISR operations. A Storm Water Pollution and Prevention Plan has been implemented for all construction and operational activities. Cameco has and will continue to utilize BMP to ensure that all disturbed land runoff is contained and treated. Well field construction disturbances are revegetated as soon as practicable following the end of construction. There has been and will continue to be little to no discharge of sediment laden water produced by production or construction activities to surface drainages. Properly designed culverts are used to pass surface water flow below roads and facilities, and as such, there is minimal retention or impounding of surface water.

All process related wastewater generated at SUA-1548 is disposed via permitted UIC Class I disposal wells, land application or solar and enhanced evaporation. During operations, surface waters could be potentially impacted by accidental spills from the facility. Cameco has a rigorous monitoring and inspection program that allows for the monitoring of production and recovery wells and pipeline pressures remotely as well as daily inspections of header houses and wellfield pattern areas. This monitoring program ensures that should a leak occur, it will be contained and cleaned up immediately upon discovery. Such potential impacts are short term and controlled and will not likely impact surface water. Spills from the CPP, CPF, satellites or during transportation of resin, slurry, dried yellowcake or 11e.(2) byproduct materials are closely monitored, and any spills are cleaned up before they can contact

surface water. With the exception of isolated spring-fed reaches of West Canyon Creek, there are no perennial or intermittent surface waters within SUA-1548 license areas.

5.4.2 Groundwater

Cameco has operated SUA-1548 in a manner to limit the number of excursions to a very small number relative to the number of mine units operated and the number of wells monitored. As discussed in the NRC's *"Staff Assessment of Groundwater Impacts from Previously Licensed In-Situ Uranium Recovery Facilities"* (Miller, 2009), the number of excursions reported and the duration of the excursions at the Smith Ranch constitute a small percentage of the total number of samples analyzed. For example, at the Smith Ranch site, approximately 1,000 wells have been sampled and analyzed twice a month for excursion parameters since the previous license renewal in 1999, compared to confirmed excursions of 12 wells (1% of the wells). Approximately 240,000 monitor well samples have been analyzed for excursion parameters, of which 12 wells have been confirmed to be on excursion status. Only five of the 16 mine units that are operational, or in restoration, have had excursions during the license renewal period. Detailed information on the location and extent of excursions can be found in Section 3.9.2 of the TR. Additionally, the above mentioned NRC Staff assessment report on groundwater impacts states that for most excursion events, the licensees were able to control and reverse the excursions through pumping and extraction at nearby wells. The excursions have not resulted in environmental impacts. This has been true at Smith Ranch in that Cameco has been able to successfully mitigate the impact of the limited number of excursions through corrective actions such as rebalancing flow throughput of nearby wells.

Following detection of an excursion, actions are immediately taken to mitigate potential migration of production fluids. These actions include immediately shutting off the injection wells in the vicinity of the excursion, thereby drawing in production fluids and creating a negative hydraulic gradient. The negative hydraulic gradient, or cone of depression, prevents further migration of production fluids. Excursion mitigation practices like these have proven to bring a well on excursion status back to non-excursion status in a timely fashion.

5.5 Ecological Resources

5.5.1 Vegetation

Mitigation of potential vegetation impacts consist of temporary and permanent surface revegetation of disturbed areas. Revegetation practices will be conducted in accordance with applicable state and federal requirements with agency approved seed mixes. Disturbed areas will be seeded to establish a vegetative cover to minimize wind and water erosion and the invasion of undesired plant species. For complete information on revegetation efforts see Section 6.2 of the TR.

5.5.2 Wildlife

Potential impacts to wildlife are described in detail in Section 4.5.2. Construction activities in ISR wellfields will result in a temporary and limited loss of wildlife habitat. This loss of habitat is minimized as disturbed areas are reseeded when construction is completed in that area. Furthermore, Cameco employs wildlife friendly fencing wherever fences are required.

The likelihood for the impacts resulting in injury or mortality for wildlife is greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Traffic will persist during production, but should occur at a reduced, and possibly more predictable level. Speed

limits are enforced during all construction, operation and maintenance activities to reduce potential impacts to wildlife throughout the year, but particularly during the breeding season.

In accordance with state and federal requirements, Cameco conducts surveys for T&E species, MBHFI or other raptors from late April through May of each year to identify any new nests and to assess whether known nests are being used. The survey covers all areas of planned activity for the life of the Project and a 1-mile area around the proposed area of activity. These surveys are primarily intended to protect against unforeseen conditions, such as the construction of a new nest in an area where construction and/or operations activities may take place. Results of wildlife surveys conducted within the last 10 years have shown little to no changes in wildlife population or of individual species within or near any operational area of SUA-1548. In the event that it becomes necessary to disturb a T&E or MBHFI nest, Cameco will consult with LQD, BLM, USFWS and WGFD to develop an appropriate mitigation action plan.

Cameco takes various precautions to limit potential adverse impacts to wildlife at all SUA-1548 license areas. Impacts to wildlife as a result of SUA-1548 operations are insignificant for the following reasons:

1. No unique or critical habitats are present within the permit areas.
2. No important wildlife migration routes are contained within the permit area.
3. ISR activities disturb relatively minor amounts of land surface compared to conventional open pit mining methods.
4. Areas disturbed by wellfield activities are quickly revegetated after wellfield construction and are used by wildlife throughout production activities.
5. Restrictive fencing is limited to isolated areas which do not significantly impede wildlife movements.
6. Vehicular traffic is limited and reduced speed limits are utilized for safety purposes and to decrease the potential for vehicle-wildlife collisions.

Observations over the 25 years of operation show that wildlife are not impacted, and both deer and pronghorn readily utilize the operating areas. It is likely that wildlife are attracted to the fenced wellfield areas due to the abundant vegetative growth which offers food and cover.

5.6 Air Quality

The primary source of emissions from SUA-1549 is fugitive dust from vehicular traffic on unpaved access roads and in the wellfield areas. Fugitive dust calculations provided in Section 3.6 were performed in accordance with the EPA AP-42 methodology. Current ISR operations at Smith Ranch produce approximately 71 tonnes (78 tons) per year of fugitive dust. With the proposed expansion at Smith Ranch, fugitive dust is expected to increase to 141 tonnes (156 tons) per year when Smith Ranch is operating at full capacity. Estimates for fugitive dust emissions from the North Butte and Gas Hills Remote Satellites are approximately 95 and 130 tonnes (95 and 143 tons) per year, respectively. Although operational plans for the Ruth Remote Satellite have not yet been developed, it is anticipated that fugitive dust emissions from this site will be less than what is anticipated for the North Butte Remote Satellite.

Construction and operational activities within SUA-1548 cause a minimal increase in fugitive dust emissions. Radiation measurements from soils at Smith Ranch show low levels of radionuclides (NRC, 2006). Accordingly, the inhalation of fugitive dust will not result in any significant radiological dose. Fugitive dust emissions are minimized by adherence to site speed limits. Vehicle speed has a linear effect on the production of total suspended particulates (Crow Butte, 2010). Speed limits at the current

operation are 25 mph or less and will remain as such at all new satellite and remote satellite locations. Fugitive dust releases during operations can be reduced by at least half by periodic watering or chemical treatment of the unpaved roads which is implemented as needed at all SUA-1548 license areas. If possible, dust-producing activities are coordinated in a manner that reduces maximum fugitive dust exposure. As mentioned in Section 5.1, disturbed areas are reclaimed and revegetated as soon as is possible. Less exposed ground means less fugitive dust created by wind.

The potential impacts associated with vehicle and construction equipment exhaust are also minimal. There are also several mitigation measures in place to reduce vehicle exhaust impacts even further. All fossil fuel vehicles will meet applicable emission standards, all diesel-powered construction equipment will be properly tuned and maintained, and Cameco avoids leaving equipment unnecessarily idling or operating.

5.7 Noise

As a result of the remote location of the project and the low population density of the surrounding area, potential impacts from noise or congestion within the project area or in the surrounding 3 kilometers (2 miles) area are not anticipated. The highest levels of project-related traffic are from the operations and construction workforce which are housed in surrounding communities and limited to travel to and from the sites and on site during the work shift. The projected increase in traffic levels is minor (Section 4.2). Potential noise and congestion impacts are not anticipated in any of the counties where SUA-1548 facilities are located. No mitigation measures have been necessary in the past and are not anticipated to be necessary in the next renewal period.

5.8 Historical and Cultural Resources

Construction, and particularly operation, land disturbing activities are localized in nature. This, in combination with the fact that construction activities will not take place on a known resource, potential impacts to historical and cultural resources are expected to be small. Even though the potential impacts to historical and cultural resources are predicted to be minimal, the following cultural resource mitigation measures apply to all SUA-1548 license areas.

- Cameco will not conduct any surface disturbing activities in areas that have not been previously inventoried and cleared for cultural resources
- If Cameco determines that it must conduct surface disturbing activities within the boundaries of an eligible site, Cameco will notify NRC, SHPO, and LQD, and will prepare an appropriate cultural resource mitigation plan for submittal to the agencies for review and approval. Once approved, the mitigation plan will be implemented prior to any surface disturbing activities being undertaken. Any such approved mitigation plan(s) will be subsequently incorporated into the permit and license documents.
- If any unanticipated cultural resources are discovered during operations, Cameco will immediately halt activities in the area of the discovery and notify LQD, NRC, and the SHPO. The LQD, NRC, and SHPO will evaluate or have evaluated any discovered cultural resources and will determine if any action may be required to protect or preserve such discoveries. Land disturbance by construction or operational activities will not occur until authorization has been received from the NRC.
- All discovered cultural resources will remain under the jurisdiction of the private landowner or the United States government depending on where the cultural resource(s) were discovered.

- Cameco will instruct all employees, contractors, subcontractors and any additional parties involved with the project to avoid potential impacts to cultural resource sites and the TCP at the North Butte Remote Satellite, and to not search for archaeological materials (i.e., arrow head hunting).
- If Native American human remains, funerary objects, or objects of cultural patrimony are encountered, Cameco will stop all work in the immediate area and will immediately notify NRC, SHPO and LQD, and the NRC will comply with Section 3 of the Native American Graves Protection and Repatriation Act and its implementing regulations at 43 CFR Part 10. If Native American human remains, funerary objects, or objects of cultural patrimony are encountered as a result of a NRC undertaking on private surface, the remains will be evaluated as a historic property. Existing state and local laws will be followed pertaining to discovery of Native American human remains, funerary objects, sacred objects or objects of cultural patrimony on private surface.

In addition to the above listed mitigative actions, specific agreement mitigation programs for the North Butte and Gas Hills remote satellites will be adhered to. Because North Butte has been determined to be a TCP, ISR restrictions and mitigative actions for the North Butte Satellite TCP will be negotiated with interested parties during the NRC "Section 106" review process that will take place concurrently with the review of this LRA. Cameco has developed a Section 106 Plan that can be used for gathering information of religious and cultural significance to Indian tribes that may be affected by ISR activities at the North Butte Remote Satellite. This plan is included as **Appendix A, North Butte Section 106 Plan** of the TR.

The Gas Hills Remote Satellite has a negotiated Programmatic Agreement between Cameco, NRC, BLM and WSHPO that prescribes the mitigative actions for preserving historical and cultural resources at the site. This agreement has been in effect since 2003 and will expire in 2013, at which time it will need to be renewed by the signatory parties involved. The Gas Hills Programmatic Agreement document is provided in **Appendix F, Gas Hills Programmatic Agreement for Protection of Historical and Cultural Resources**.

5.9 *Visual and Scenic Resources*

Long-term effects result from the addition of structures to the landscape, such as the CPP, CPF and associated structures, satellites and associated structures, deep disposal well buildings, land application facilities, header houses, wellhead covers, access roads, and electric distribution lines. Effects from long-term activities will occur over the life of the renewal and beyond. Mitigation measures are meant to minimize adverse contrasts of project facilities with the existing landscape. The measures are applied to all facilities. Mitigation enables project facilities to harmonize with the surrounding landscape to the extent feasible.

In addition to selecting paint colors that harmonize with the surrounding landscape, several other measures would minimize adverse effects of project facilities in the landscape.

- Using existing vegetation and topographic features to screen wells, facilities, and roads;
- Avoiding straight line-of-sight road construction;
- Aligning roads with the contours of the topography rather than cutting straight across contours to header houses, although this method of aligning the roads may result in a greater area of disturbance;

- Constructing clearings to appear as natural clearings by rounding corners and feathering the vegetation interface between the clearing and the surrounding grasses and shrubs (in those areas where the existing vegetation is dense, clearings should be irregular in shape); and,
- Removing construction debris immediately because it creates undesirable textural contrasts with the landscape.

5.10 Socioeconomic

As is discussed in Section 7.0, the potential socioeconomic impacts associated with this LRA are and will continue to be beneficial. The operation will continue to accrue monetary benefits to the surrounding communities from local expenditures and state and local taxes paid by the project. Continuing operation at Smith Ranch and developing the remote satellites as ISR facilities will add employment to the local communities. Effects on housing, schools and municipal services are anticipated to be minimal (see Section 4.10). No mitigation measures have been necessary in the past and are not anticipated to be necessary during the renewal period.

5.11 Environmental Justice

Discussion presented in Section 4.11 determined that there would be no disproportionate potential adverse environmental impacts for populations living below the poverty level within the census tracts due to the LRA. No mitigation measures have been necessary in the past and are not anticipated to be necessary during the renewal period.

5.12 Public and Occupational Health

The potential impacts to public and occupational health from the LRA are described in Section 4.12 and include fugitive dust from construction activities and vehicle travel, the release of Rn-222 from IX facilities, the CPP, CPF, mine unit wellfields and header houses, and any potentially adverse impact associated with a spill or accident.

Mitigation measures to minimize the potential impacts associated with potential spills during transportation are discussed in Section 5.2. Mitigation measures to address fugitive dust from construction and operation activities are discussed in detail in Section 5.6.

5.12.1 Radiation Health and Safety: Corporate Structure

The release of Rn-222 from IX facilities, the CPP, CPF and the mine unit wellfields and header houses is being responsibly mitigated at the existing SUA-1548 facilities. Cameco has implemented procedures, training, and Management Actions designed to mitigate the risk of radiation exposure to both the public and the employees. Examples include the use of vacuum driers as opposed to calciner dryers and using down-flow pressurized IX columns instead of open columns. Additionally, all of the facilities provide ventilation systems that remove any released Rn-222 from the buildings to the atmosphere.

Cameco is committed to providing a safe work environment for visitors, contractors, and permanent employees alike. Accordingly, Cameco has implemented an ALARA Policy to keep all exposures to radioactive and other hazardous materials as low as possible and to as few personnel as possible. The ALARA Policy takes into account the state of technology and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of nuclear energy in the public interest.

Section 5.1 of the TR describes the responsibilities of management, the radiation safety officer, supervisors and employees within the framework of the ALARA Policy. The successful implementation of the ALARA Policy relies on the cooperation and dedication at all levels within Cameco. Section 5.3 of the

TR describes the successes of Cameco's ALARA Policy. The results of the annual audits exemplify the commitment to investing time and resources into continually improving safety at SUA-1548. In addition to the annual ALARA audits, inspections of radiation safety are made on a daily, weekly and monthly basis (Section 5.3 of the TR). The same standard of commitment and innovation is carried forward to all SUA-1548 facilities.

The maximum TEDEs reported for workers at Smith Ranch are well below applicable standards, are consistent with doses the NRC indicates to be representative of uranium ISR facilities, and have been stable over the 10-year period since the last license renewal submittal (RAMC, 1999). This is in part due to the efforts put forth by SERP as described in Section 5.2 of the TR.

As described in Section 5.2 of the TR specific actions taken as a result of the infrastructure described above include the development of SOP for all operational activities involving source and 11e.(2) byproduct materials that are handled, processed, stored or transported by employees or outside contractors. Radiation Work Permits are also required in the case that employees are required to conduct activities of a non-routine nature for which there is the potential for significant exposure to radioactive materials and no SOP exists. Additionally, any area, room or enclosure will be designated an "Airborne Radioactivity Area" as defined in 10 CFR 20.1003, if at any time the uranium concentration exceeds 5E-10 pCi/L for soluble uranium or 2E-11 pCi/L for insoluble uranium.

5.12.2 Radiation Health and Safety: Training

All site employees and contractor personnel at SUA-1548 facilities participate in a training program covering radiation safety, radioactive material handling, and radiological emergency procedures. The training program is administered in keeping with standard radiological protection guidelines and the guidance provided in NRC Regulatory Guide 8.29, NRC Regulatory Guide 8.31, and NRC Regulatory Guide 8.13. Additional details relating to the content of the Radiation Safety Training Program for visitors, contractors and permanent employees as well as the associated testing requirement, on the job and refresher training can be found in Section 5.5 of the TR.

5.12.3 Radiation Health and Safety: Security

Measures to secure NRC-licensed material from unauthorized access or removal is in place at all SUA-1548 facilities. The operating facilities are manned 24 hours per day, 7 days per week, and in controlled and/or unrestricted areas, surveillance is maintained through the presence of the operators and workers on site. All licensed material is stored in secured areas and clearly marked with signs. Specific details relating to the implementation of security protocols are discussed in Section 5.7 of the TR.

5.12.4 Radiation Health and Safety: Controls and Monitoring

Cameco has a strong corporate commitment to and support for the implementation of the radiological control program at all SUA-1548 facilities. This corporate commitment to maintaining personnel exposures ALARA is incorporated into the radiation safety controls and monitoring programs described in Section 5.8 of the TR. Components of the radiation safety controls and monitoring program include an external radiation exposure monitoring program, an airborne radiation monitoring program, a respiratory protection program, a bioassay program, the establishment of an administrative action level, and a contamination control program.

5.13 Waste Management

Although less than conventional mining, ISR facilities produce airborne effluents, liquid wastes, and solid wastes that must be properly handled and disposed.

5.13.1 Gaseous Airborne and Particulate Emissions

The radiological effluents of concern at ISR operations include the release or potential release of radon gas (radon-222), radionuclides in liquid process streams, and dried yellowcake particulates at the CPP and CPF.

Section 4.1 of the TR discusses the mitigation measures to control potential gaseous and airborne particulate impacts.

5.13.2 11e.(2) Liquid Waste

11e.(2) wastes produced at ISR operations include liquid process wastes from the production and restoration processes, water collected from wellfield releases, water collected from header house releases, water collected from sumps of the CPP, CPF and the satellites, and water collected at the UIC Class I disposal well sumps. Section 4.2 of the TR contains specific information regarding the handling of 11e.(2) liquid wastes.

5.13.3 Non-11e.(2) Liquid Waste

Non-11e.(2) liquid wastes include those collected from bulk reagent storage facilities, domestic liquid wastes and storm water runoff. Section 4.2 of the TR provides specific information regarding the handling of non-11e.(2) liquid wastes.

5.13.4 11e.(2) Solid Wastes

11e.(2) solid wastes (i.e., byproduct materials) may include tanks, vessels, IX resin, filter media, process piping and equipment, evaporation and surge pond solid residues or any other material or equipment that cannot be decontaminated to meet the unrestricted release criteria. All 11e.(2) solid waste materials are transported to and disposed at a NRC-licensed disposal facility (see Section 4.2 of the TR).

Production of 11e.(2) byproduct materials is primarily minimized through process design, decontamination and volume reduction. For example, filter media for production and restoration equipment is selected based on filtration efficiency so that fewer replacements are needed. Whenever possible, equipment and buildings are decontaminated so that they can be released for unrestricted use. Volume reduction is accomplished by crushing piping and other materials using a grinder or chipper.

Methods for decontamination and release of contaminated equipment and materials are discussed in further detail in Sections 5, 6.2 and 6.3 of the TR.

Additional details associated with waste management mitigation measures can be found in Sections 4, 6.3 and 6.4 of the TR.

5.13.5 Non-11e.(2) Solid Wastes

Non-11e.(2) wastes may include office wastes, domestic trash, construction debris, empty reagent containers and uncontaminated or decontaminated non-repairable equipment. These materials are typically disposed of in a municipal landfill. Section 4.2 of the TR provides additional information related to the handling and disposal of non-11e.(2) waste materials.

Potential impacts resulting from the management and disposal of non-11e.(2) solid wastes is the impact on the local landfill capacity. To date, this impact has been small. Potential waste management impacts from hazardous solid waste management and disposal include potential releases to the land surface, surface water and groundwater if not correctly stored and disposed. Potential impacts from domestic waste management and disposal include surface disturbance during construction of septic leach fields,

transportation accidents during transport of chemical toilets, and contamination of shallow groundwater from leach field effluents. These potential impacts have been minimal in the past and are anticipated to be very small during the next renewal period. Cameco will employ waste minimization and recycling to reduce the quantity of solid waste generated.

5.14 Financial Assurance

Cameco maintains NRC-approved financial surety arrangements in the form of letters of credit issued for each individual project licensed under SUA-1548. Consistent with 10 CFR 40, Appendix A, Criterion 9, which states in part: "...In order to avoid unnecessary duplication and expense, the Commission may accept financial sureties that have been consolidated with financial or surety arrangements established to meet requirements of other federal or state agencies...", the NRC has accepted and approved letters of credit issued to the WDEQ as the "beneficiary" and/or the WDEQ and the BLM, together as "co-beneficiaries". The amounts of the License Conditions are based on surety estimates that assume third-party costs and incorporate reclamation obligations for both existing operations and planned expansions within the upcoming year. The term "reclamation" encompasses all groundwater restoration, facility decommissioning and surface reclamation activities, including the off-site disposal of 11e.(2) byproduct material.

License Condition 9.5 of SUA-1548 requires submittal of a revised financial surety arrangement within three months of NRC approval of a revised closure plan (if the estimated costs exceed the amount covered in the existing License Condition(s)). It is Cameco's understanding that this condition does not apply until final decommissioning activities are performed on a project-by-project basis.

License Condition 9.5 also requires that Cameco provide annual financial surety updates consistent with the requirements of 10 CFR 40, Appendix A, Criterion 9. Proposed annual updates to the surety amounts for each project are submitted to the NRC at least 90 days prior to the anniversary dates listed in License Condition 9.5. These dates coincide with the WDEQ Permit to Mine Annual Report and Surety Estimate Update due dates and allow for coordination and submittal of the annual updates to multiple agencies (NRC, WDEQ and BLM) at one time. Cameco's License Conditions are issued on an annual auto-renewal basis to ensure that the surety arrangement is extended for one year in the event NRC has not approved a proposed surety update within 30 days of the License Condition's expiration (i.e., auto-renewal) date. Cameco's annual updates include the necessary supporting documentation and detail showing a breakdown of costs and basis for cost estimates, including adjustments for inflation (e.g., based on Consumer Price Index) and maintenance of a minimum 15% contingency (WDEQ requires 25%).

In the event of plans for expansion or operational changes that were not included in the previous year's surety update, an updated surety is submitted for NRC approval at least 90 days prior to the commencement of construction activities. In addition to coordinating submittal of the annual updates to both agencies (NRC and WDEQ), Cameco forwards copies of the WDEQ's surety review(s) and final surety arrangements upon WDEQ approval. The annual surety estimate updates identify NRC-related aspects (e.g., decontamination, decommissioning, 11e.(2) byproduct disposal, etc.) and are consistent with the groundwater restoration, facility decommissioning and surface reclamation portions of the license applications for each project. The annual estimates are also consistent with Appendix C to NUREG-1569. Section 6.5 of the TR provides additional information related to financial surety requirements.

5.15 No-Action Alternative

Smith Ranch is operational and exploratory drilling and construction is taking place at the Reynolds Ranch Satellite as well as the North Butte and Gas Hills Remote Satellites. Under the no-action

alternative, production and exploration activities would cease and all existing wellfields would enter restoration. Site reclamation of all ISR facilities would begin. The mitigation measures described above will remain in practice until all production, restoration and reclamation activities have ended.

5.16 Alternatives

In comparison with the alternatives of conventional open pit and underground mining with associated uranium mills, operations at Smith Ranch have demonstrated that an ISR facility, implementing appropriate safety checks and environmental mitigation measures has minor impact on the environment. Large evaporation and tailings ponds used in conventional mining and milling operations are not utilized at ISR facilities. Overburden removal from open pit mining and ore stockpiles associated with conventional mining operations does not occur at ISR projects. These types of activities related to conventional mining and milling result in unavoidable adverse impacts and residual impacts even after mitigation measures have been implemented. The amount of surface and subsurface disturbance at conventional mining sites is such that even after mitigation measures have been utilized, the area remains impacted. Open pits leave large scars on the land and allow intermingling of previously separated aquifer systems thereby changing the water quality. Sometimes entire local aquifer systems are destroyed due to the massive dewatering of these types of mines that is necessary to access the ore. Large tailings basins require institutional controls and legacy management by the U.S. government for an undetermined period of time, during which, the land surface cannot be utilized for domestic or industrial purposes. SUA-1548 has not in the past and will not in the future result in any major impacts to the surface or subsurface matrices, including groundwater quality and quantity.

5.17 References

Energy Metals Corporation US. 2007. Application for NRC Source Material License – Moore Ranch Uranium Project, Campbell County, Wyoming. Environmental Report.

U.S. Nuclear Regulatory Commission. 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities (NUREG-1910). Page Last Reviewed/Updated Sunday, March 13, 2011.

Wyoming Department of Environmental Quality Wyoming Department of Environmental Quality, Land Quality Division, Guideline No. 10, Fencing, August 1994.

Wyoming Department of Environmental Quality, Land Quality Division, Rules and Regulations Chapter 11. NonCoal In Situ Mining, May 2005.

Wyoming Department of Environmental Quality, Land Quality Division, Rules and Regulations, Chapter 3, Environmental Protection Performance Standards, April 2006.

6.0 Environmental Measurements and Monitoring Programs

Baseline environmental monitoring (radiological, groundwater, surface water, soil, sediment, vegetation, wildlife and air quality) is conducted to establish baseline conditions and as a precursor to operations at all SUA-1548 license areas. The results of operational environmental monitoring are provided to both the LQD and NRC Staff in various reports. A brief summary of the various environmental measurement and monitoring programs are provided below with references to specific sections of the TR where they are described in detail.

6.1 Radiation Safety Monitoring

Cameco has undertaken a sampling program to evaluate a variety of radiation protection measures at SUA-1548 license areas, such as the potential for exposure to certain uranium daughter products that have not been evaluated in the past by uranium recovery operations. NRC Staff have requested this evaluation based on their experience at other ISR facilities. The SUA-1548 baseline radiological sampling plan was initiated in early 2012 and will last for one year. At that time the data collected will be evaluated in coordination with NRC Staff to determine if additional sampling is needed or the program can be discontinued. The sampling plan is provided in **Table 6-1, 2012 Smith Ranch Radiological Sampling Plan**. The sampling plan identifies the sample type, location, equipment frequency/duration and lower limit of detection. In addition the sampling plan presents objectives and purposes, components of the dose assessment and a decision rule/path forward. The sampling plan will be updated to include the Reynolds Ranch satellite once it becomes operational. A similar sampling plan will be developed for each of the remote satellites.

In summary, the sampling plan will provide site-specific data to evaluate:

- Dose to public;
- Dose to office workers, lab workers, wellfield workers and wellfield construction personnel;
- Implications to work dose from in-growth of short-lived beta-emitting isotopes;
- Implication of short-lived beta-emitting isotopes to contamination control, for both personal contamination and for free release of objects;
- Implications of isotope mixtures in establishing the site-specific DAC; and,
- Potential to use Ra-226 concentrations in pregnant lixiviant as a component of 10 CFR 40.64 effluent reporting.

As elements of the sampling plan are completed, Cameco will provide data and propose program revisions where necessary to NRC staff. Following deliberation, appropriate license amendments will be prepared. Because the existing program will continue until the various sampling activities are complete and concurrence is reached with NRC staff as to appropriate program modifications, the program descriptions in the TR reflect current practice.

Section 5.8 of the TR presents both program descriptions and historic results of the radiation safety monitoring program. The specific components include:

- Personnel Dosimetry;
- Gamma Surveys;
- Airborne Uranium Particulate Monitoring;
- Radon Daughter Monitoring;

- Calculation of Exposure;
- Bioassay Program; and,
- Contamination Control Program.

6.1.1 Quality Assurance

Cameco has established a Quality Assurance Program for all radiological, non-radiological effluent and environmental (including groundwater) monitoring programs SUA-1548. This Quality Assurance Program addresses elements discussed in NRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) —Effluent Streams and the Environment."

Quality assurance comprises those planned and systematic actions which are necessary to provide adequate confidence in the results of a monitoring program. Quality control includes those quality assurance actions that provide a means to control and measure the characteristics of measurement equipment and processes to established requirements. Therefore, quality assurance includes quality control.

The overall objectives of the Quality Assurance program are:

- To identify deficiencies in the sampling and measurement processes to those responsible for these operations so that corrective action can be taken.
- To obtain a measure of confidence in the results of the monitoring programs to assure regulatory agencies and the public that the results are valid.

The first step of any reliable Quality Assurance Program is a formal delineation of the organization structure, management responsibilities, and training requirements for management personnel. These items are described in detail in Sections 5.1 through 5.7 of the TR.

Section 5.9 of the TR presents the quality assurance policies for the environmental monitoring programs including:

- Radiological and Environmental Monitoring Procedures;
- Duplicative Sampling and Inter and Intra Laboratory Analyses;
- Instrument Calibrations;
- In-house Laboratory QA/QC;
- Records; and,
- Audits.

6.2 Operational Monitoring

The following sections summarize the monitoring programs in place during operations. As the focus of the TR is on operational policies and protocols, the majority of the details are located in the TR and specific references to pertinent sections are provided below.

6.2.1 Air Particulate Monitoring

Cameco has a strong corporate commitment to and support for the implementation of the radiological control program at all SUA-1548 license areas as has been shown by Cameco's record of compliance over the past 25 years. To ensure compliance with 10 CFR 20.1301, 20.1302 and 20.1501, Cameco maintains a continuous ambient air particulate monitoring program at five separate locations at Smith Ranch. An additional air monitoring station is proposed for the Reynolds Ranch Satellite facility. This

station will be installed to replace the current upgradient station (AS-1, Dave's Water Well). The CPF and CPP have the greatest potential for airborne releases to the environment. Two of these stations (AS-4 and AS-5) were used to monitor downwind conditions at the CPF but are inactive as a result of the CPF being placed in standby status. Monitoring at AS-4 and AS-5 will resume once operations begin again at the CPF.

The monitoring program at Smith Ranch is effective in monitoring potential airborne effluent releases and gamma exposure rates resulting from site activities and is consistent with the recommendations contained in NRC Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills". The results of this program show that airborne releases of radionuclides are well below the ECL which are contained in 10 CFR 20 Appendix B and used for compliance purposes by Cameco. The gamma exposure levels are well below the 0.05 rem per year requirement contained in 10 CFR 20 Subpart D. To show the extent of the airborne monitoring program, Cameco has collected more than 300 samples for particulates, Rn-222 and gamma analysis. See Section 5.10.1.1 of the TR for additional details relating to sampling locations, constituents measured, sampling procedures and a summary of results from existing operations at Smith Ranch.

6.2.2 Soil and Vegetation Sampling at Air Particulate Monitoring Stations

Annual soil and vegetation sampling was performed at Smith Ranch and Highland prior to 2000. Based on an NRC inspection that stated that the license did not require annual soil and vegetation sampling (IR 40-8857/99-02), the sampling program was terminated.

6.2.3 Surface Water Sampling Programs

Surface water sampling takes place at all SUA-1548 license areas. Quarterly sampling of surface water in stock ponds, reservoirs and drainages takes place to the extent that water is available to sample. Due to the ephemeral nature of surface waters at SUA-1548 license areas, samples are not always available for collection. Surface water sampling programs are described in Section 5.10 of the TR.

6.2.4 Groundwater Monitoring Programs

A groundwater environmental monitoring program has been approved for Smith Ranch and will be implemented at the Reynolds Ranch Satellite and the North Butte, Gas Hills and Ruth Remote Satellites. All domestic livestock wells and naturally existing groundwater springs within 2 kilometers (1.2 miles) of each SUA-1548 license area are sampled quarterly. Groundwater monitoring programs are described in the TR in detail for: Smith Ranch (Section 5.10.3.1), the North Butte Remote Satellite (Section 5.10.3.2), the Gas Hills Remote Satellite (Section 5.10.3.3) and the Ruth Remote Satellite (Section 5.10.3.4).

6.2.5 Wastewater and Land Application Monitoring Program

To assist in assessing impacts of irrigating treated wastewater at the Smith Ranch-Highland Satellite No. 1 and Satellite No. 2 Wastewater Land Application Facilities (Irrigation Areas) the irrigation water, soil, and vegetation are monitored for various constituents including uranium and radium-226. This monitoring program has been in place since the start of each facility. Results of the monitoring program are reported to the NRC in the Semi-Annual Report. Specific components of the wastewater and land application monitoring program are discussed in Section 5.10 the TR.

6.2.6 Ecological Monitoring

6.2.6.1 Smith Ranch

Cameco has a strong corporate commitment to and support for the implementation of wildlife monitoring at all SUA-1548 license areas.

In consultation with state and federal agencies, Cameco developed a Wildlife Monitoring Plan for each of the sites, which is provided in WDEQ Appendix D9. The Wildlife Monitoring Plan provides the methodology and frequency of monitoring as well as the specific target species to be monitored. In accordance with state and federal requirements, the Wildlife Monitoring Plan has been designed to obtain sufficient data to allow the evaluation of the effects of the ISR operation on wildlife species of concern and to develop mitigation plans for those effects.

The entirety of the Wildlife Monitoring Plan for Smith Ranch is located in the Supplemental Information attached to Appendix D9 of the Smith Ranch WDEQ Permit.

6.2.6.2 North Butte Remote Satellite

The purpose of the North Butte Remote Satellite Wildlife Monitoring Plan is to set forth protocols and schedules for monitoring the status of wildlife species identified by the regulatory agencies as species of concern that may occur in or proximal to the North Butte Remote Satellite. The Wildlife Monitoring Plan was prepared after the 2010 wildlife survey update. This plan has been tailored to meet the specific wildlife monitoring needs of Cameco's North Butte Remote Satellite and does not address species that are unlikely to occur in the survey area.

Species-specific details, the wildlife monitoring survey schedule and a discussion of the monitoring of ISR disturbance and the effectiveness of reclamation in wildlife habitats can be found in Addendum D9-2 to Appendix D9 of the North Butte WDEQ Permit.

6.2.6.3 Gas Hills Remote Satellite

Addendum D9-E to Appendix D9 of the Gas Hills WDEQ Permit contains the wildlife monitoring plan for the Gas Hills Remote Satellite. The plan was developed after consultation with the LQD and BLM during 2009. The Plan has been reviewed and approved by WGFD and USFWS and provides the methodology and frequency of the annual monitoring as well as the specific target species to be monitored. The Plan is reviewed with BLM on an annual basis to address any necessary changes, such as reducing number of surveys or eliminating surveys altogether for those species that are not present in the permit area.

6.2.6.4 Ruth Remote Satellite

Section 13.4.1 of the Ruth Supplemental Report contains the Wildlife Management Plan developed for the Ruth Remote Satellite in 1988. Cameco is not actively pursuing development of the Ruth Remote Satellite at the time of this LRA (January 2012). Prior to commencement of ISR activities, baseline environmental data, environmental assessment and the operating plan (including a wildlife management plan) will be updated and provided to NRC Staff.

6.3 Groundwater Restoration Monitoring

Following regulatory concurrence that restoration has been achieved in a particular mine unit and, unless otherwise approved by the agency, at lease a one-year stability monitoring period is performed to demonstrate that the restoration standard has been adequately maintained. The NRC requires monitoring at all M-, MO- and MS-wells until the restoration is approved by the NRC. Section 6.1 of the TR contains detailed information on both operational monitoring and restoration stability sampling.

6.4 Reporting Procedures

6.4.1 Semi-Annual Effluent and Environmental Monitoring Report

Pursuant to 10 CFR 40.65 and SUA-1548 License Condition No. 11.1, a report is submitted to the NRC on a semi-annual basis outlining the results of the effluent and environmental monitoring programs and

any other information that may be required by license condition, including monthly averages of injection rates, recovery rates and injection trunk line pressures for each satellite.

6.4.2 Non-Routine Reports

In the event that a report of a non-routine incident becomes necessary (eg. wellfield excursion, pond leak, etc.), Cameco will follow specific reporting procedures for that incident as identified by the particular regulatory agency. In most cases, both the WDEQ and NRC are notified by telephone or e-mail within 24 hours of verified monitor well excursions, pond leakage, significant spills, tank ruptures, or any other incident that would trigger the reporting requirements provided in 10 CFR 20, Subpart M. Written reports will be provided to the NRC 30 within 30 days of the non-compliance event. Monthly reports will be provided to NRC until the non-compliance incident has been corrected.

6.5 General Records Compliance

Records maintenance and retention comply with 10 CFR 20, Subpart L. All effluent and environmental monitoring measurements and calculations records are maintained on site until license termination.

7.0 Cost Benefit Analysis

7.1 Environmental Impacts

There is a general need for uranium to supply operating nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against the related environmental costs. These incremental costs or impacts are balanced against the benefits derived from the power generation and economic growth provided to surrounding communities. Similarly, it is appropriate to review the specific site-related benefits and costs of the proposed action.

The renewal of SUA-1548 will benefit the surrounding communities through local expenditures and state and local taxes paid by Cameco. Expansion of operations at Smith Ranch in addition to the development of the remote satellites will also provide employment to local communities.

Environmental impacts are, and will continue to be, minimal. See Section 4 for an expanded discussion of the anticipated environmental impacts associated with the proposed action. Ground water will be returned to as near pre-ISR quality as possible, as has been demonstrated by Cameco at Smith Ranch and ground water restoration efforts completed to date by other operators. The radiological impacts have been and will continue to be small as the amount of solid 11e.(2) byproduct materials produced is small and such materials are transported off-site for disposal at an NRC-licensed disposal facility. The surface disturbances have been and will continue to be small relative to the disturbance footprint of a conventional mining operation, and are temporary as is the surface is reclaimed back to its pre-ISR land use. Benefits from ISR operations and the resulting power generation are considered to offset the relatively small risks associated with environmental impacts.

An analysis of the economic impacts associated with SUA-1548 was completed by the University of Wyoming, Department of Agriculture and Applied Economics. The primary focus of the analysis was the economic aspects of uranium production in Wyoming and Cameco's expansion plans (North Butte, Gas Hills and Ruth Remote Satellites) in particular. Cameco retains the right to not provide or to limit the use of any information that it considered confidential.

The analysis measured the impact of jobs, employee income, government revenues, purchases of goods and services, contractor payments, production royalties, and other economic contributions from SUA-1548 on the Wyoming economy. Where possible, benefit and cost estimates were monetized; however, reliable monetary estimates for some potential impacts were not readily available, so the narrative examines several factors in non-monetary or qualitative terms.

The analysis evaluated all of the costs and benefits associated with Smith Ranch, the North Butte Remote Satellite and the Gas Hills Remote Satellite. Cameco has not completed an operations plan for the Ruth Remote Satellite at the time of this LRA (January 2012). Prior to commencement of ISR operations, additional baseline environmental data, additional environmental impact and cost benefit analyses in addition to the operations plan will be developed and provided to NRC.

7.2 Alternatives and Assumptions

7.2.1 Proposed Action

The proposed action would result in the renewal of SUA-1548 for an additional 10 years. Development of mine units and satellite facilities at Smith Ranch (including the Reynolds Ranch Satellite) will continue during the next renewal period. The North Butte, Gas Hills and Ruth Remote Satellites will be developed

as well. These new satellite facilities will produce IX resin and/or yellowcake slurry which will be transported to the Smith Ranch CPP or Highland CPF for processing into yellowcake.

7.2.2 Impact Scope

A critical step in any Cost Benefit Analysis is establishing a viable scope of impact and thus establishing who will be affected by the operation. Cameco has a total of three separate facilities in Wyoming including: 1) Smith Ranch near Douglas, 2) an Exploration and Development Office in Casper, and 3) Cameco's U.S. Headquarters in Cheyenne. The University of Wyoming analysis described above considered the contribution of all three facilities to the Wyoming economy.

The analysis included data regarding the number of employees, employee payrolls, taxes paid, fees paid, contractor payments, rents, royalties, and other necessary company information. The year 2009 was the latest for which complete operating expenditures were available. This information was supplemented with 2009 operating expenditure for the U.S. Headquarters adjusted for the new location in Wyoming.

The operating information was disaggregated into appropriate sectors and entered into a 2008 IMPLAN model for the State of Wyoming (MIG, 2010) to estimate economic impacts in terms of direct and secondary employment, labor earnings, and industry production. IMPLAN is an economic modeling system used to create complete and detailed models of local economies for in-depth analyses of regional economies. The model considers both direct impacts and secondary impacts from re-spending by businesses and employees to provide estimates of the total economic impact of an economic activity in the region.

7.2.2.1 Non-Monetary Impacts

Conventional Cost Benefit Analysis uses monetary values to compare goods and services derived from a project or program. The values of goods and services represent their relative importance so that if the total value of the benefits is greater than the total value of the costs, the project is desirable. The standard result is a quantified benefit-cost ratio (BCR), equal to a project's total net benefits divided by its total cost. BCR's above one, have positive net economic impacts. While many inputs in the SUA-1548 BCR are goods and services (eg. skilled labor, construction materials, etc.) that are regularly traded in markets at well-known and predictable prices, others (eg. changes to land or water, aesthetic impacts, etc.) are not directly traded and are more difficult to value. Where reliable monetary values are not available, a qualitative approach based on the best available information is required.

7.2.3 Economic Benefits of Project Construction, Operation, Restoration and Decommissioning

7.2.3.1 Current Economic Benefits

Cameco's presence in Wyoming has grown substantially over time. As shown in **Table 7-1, Trends in Wyoming Expenditures by Cameco Resources**, the company's expenditures in Wyoming totaled $16M in 2005. By 2009, expenditures in Wyoming had increased by over 2.5 times to $40.3M. Approximately two-thirds of this increase was due to additional purchases from Wyoming vendors, with about 25% from increased payroll, and approximately 10% from increased Wyoming taxes and royalty payments. Wyoming taxes and royalties was the fastest growing of the expenditure category, increasing by 2.7 times between 2005 and 2009. The Wyoming taxes included in the taxes and royalty expenditure category were use taxes, ad valorem taxes, severance taxes, and property taxes. Other Wyoming taxes such as payroll and sales taxes are included in the payroll and Wyoming vendor amounts. Federal taxes paid by the company were not considered in the analysis. Total expenditures in Wyoming by Cameco over the 5-year period were $139.6M.

In 2009, the total Wyoming expenditures by Cameco were $40.3M (**Table 7-1,**). Of this total, approximately 26% ($10.5M) was payroll. This represents the wage and salary payments for 155 workers in the state. Wyoming taxes and royalties represented 9% of this total ($3.7M) and purchases from Wyoming vendors represented 65% of the total ($26M). The composition of Wyoming taxes included in this expenditure category was discussed above. Royalty payments represent production royalties paid to private landowners and the State of Wyoming. Expenditures with Wyoming vendors represent purchases of goods and services from companies and individuals located in Wyoming. This includes payments to 50 drilling contractors plus purchases from 328 other businesses located in Wyoming. The largest Wyoming expenditures were payments to drilling contractors, capital equipment purchases, payments to utility companies, and purchases of well casing and other drilling materials and supplies. In 2010, with the relocation of the U.S. Headquarters from Denver to Cheyenne, total annual operating expenditures in Wyoming for Cameo are estimated to be $42.8M.

The current total operating expenditure estimate of $42.8M was disaggregated into the appropriate sectors and entered into a statewide IMPLAN model of Wyoming in order to estimate the current economic impacts of Cameco's uranium operations in the state. The economic impact of each expenditure category will be discussed individually below, followed by an overall economic impact summary.

Cameco's current payroll in Wyoming is estimated to be $12.5M. As shown in **Table 7-2, Current Economic Impact of Cameco's Wyoming Payroll** this represents direct employment of 169 people (preliminary estimates for 2010 employment show an increase to 185 employees). Secondary employment, resulting from spending by Cameco employees with other businesses in the state, is estimated to have added an additional 69 jobs to the Wyoming economy for a total employment impact of 238 jobs. Nearly 95% of the secondary employment is in the service and trade sectors of the Wyoming economy.

The labor income associated with the 69 secondary jobs generated by the company's payroll is estimated to add $2.2M in labor income. When this amount is combined with the $12.5M in direct labor income, the total labor income impact is estimated to be $14.7M. Over 95% of the secondary labor income is from the services, trades, and transportation/information/public utilities sectors of the Wyoming economy.

The $12.5M in payroll also generates an estimated $7.8M in secondary output due to spending by Cameco employees with other businesses in Wyoming. Combined with the $12.5M in direct labor earning, which in this case is also the direct output, the total output impact is estimated to be $20.3M.

The current Wyoming taxes and royalty payments for Cameco are estimated to be $3.7M. This amount includes production royalties paid to private landowners and the State of Wyoming plus use, ad valorem, severance, and property taxes paid to state and local governments in Wyoming. As shown in **Table 7-3, Current Economic Impact of Cameco's Wyoming Taxes and Royalties**, this spending supports an estimated 26 jobs in the Wyoming economy. This employment represents only the jobs associated with the tax revenue since royalty payments do not generate any direct employment because they represent a transfer payment to households. Secondary employment, resulting from spending of royalty payments by households and by spending of tax revenue by state and local governments in Wyoming, is estimated to have added an additional 19 jobs to the Wyoming economy for a total employment impact of 45 jobs. Over 95% of the secondary employment is in the service and trade sectors of the Wyoming economy.

The labor/household income resulting from the direct employment associated with Wyoming tax revenue and royalty payments to landowners by Cameco is estimated to be $3.4M. The labor income from the 19 secondary jobs is estimated to be over $613,000. Nearly 90% of the secondary income is in the service and trade sectors of the Wyoming economy. The combined total labor/household income is estimated to be $4M.

The $3.7M in Wyoming taxes and royalty payments also generates an estimated $2.1M in secondary output in the Wyoming economy due to spending by state and local governments and landowner households in Wyoming. The combined total output impact is estimated to be $5.9M.

Currently it is estimated that Cameco purchases $26.1M from Wyoming vendors annually. This amount includes payments to 50 drilling contractors plus purchases from 328 other businesses located in Wyoming. As shown in **Table 7-4, Distribution of Cameco's Economic Impact in Wyoming**, these purchases support an estimated 105 jobs in the Wyoming economy. Secondary employment in Wyoming, resulting from spending by these vendors and their employees supports an additional 56 jobs in the Wyoming economy for a total employment impact of 162 jobs. Over 90% of the secondary employment is in the service and trade sectors of the Wyoming economy.

The labor income resulting from the direct employment associated with these vendor purchases is $6.2M. The labor income from the 56 secondary jobs is estimated to be $2.1M for a total labor income impact of $8.4M. Over 90% of the secondary labor income is in the service, trade, or transportation/information/public utilities sectors of the Wyoming economy.

The $26M in Wyoming vendor purchases by Cameco directly impacts most of the individual sectors of the Wyoming economy (**Table 7-5, Current Economic Impact of Cameco's Wyoming Vendor Purchases**). The largest purchases are from construction ($12M), trade ($9.7M), and transportation/information/public utilities ($4M). In addition, these direct expenditures also generate an estimated $6.9M in secondary output in the Wyoming economy due to spending by the vendors and their employees. The combined total output effect is estimated to be $32.9M.

Table 7-6, Current Economic Impact Summary for Cameco in Wyoming summarizes the current economic impact of Cameco's uranium operations in Wyoming. In terms of direct impacts, the company's expenditures for payroll, Wyoming taxes and royalties, and purchases from Wyoming vendors supports over 300 direct jobs, $22.1M in direct labor/household income, and $42.3M in direct economic activity in Wyoming.

The secondary impacts from Cameco's expenditures in Wyoming include 144 secondary jobs, $5M in secondary labor income, and $16.8M in secondary economic activity in the state. When both direct and secondary impacts are considered, Cameco's total economic impact in Wyoming is 445 jobs, $27.2M in labor/household income, and $59.1M in economic activity in the state.

Table 7-6, shows that employment associated with Cameco's uranium operations in Wyoming tends to be good paying jobs. For the 169 jobs directly with Cameco, the average salary per job is approximately $74,000. For the 301 direct jobs associated with Cameco's expenditures in Wyoming, the average salary per job is approximately $67,000. Because the secondary employment tends to be more service oriented, the average earnings for these jobs are somewhat lower at slightly less than $35,000. Still, the overall average for all jobs associated with Cameco's operations in Wyoming is more than $56,000. This is 25% higher than the Wyoming average ($45,106) and 12% above the U.S. average ($50,259) in 2008.

The results from this analysis indicate that for every direct uranium job in the mining sector there are 1.6 other jobs elsewhere in the Wyoming economy. The results also indicate that for every $1.00 of uranium job income in the mining sector there is $1.20 of income in other sectors of the Wyoming economy. **Table 7-4** summarizes the total distribution of economic activity from Cameco's uranium operations among the major sectors of the Wyoming economy. In terms of employment, the largest impacts are in mining (38%), service (22%), construction (19%), and trade (11%). In terms of income, the largest impacts are in mining (46%), construction (17%), government (13%), and service (12%). Finally in terms of output, the largest impacts are in mining (22%), trade (22%), construction (21%), and service (20%). As can be seen in **Table 7-4** Cameco's uranium operations in Wyoming have a positive economic impact on every major sector of the state's economy.

7.2.4 Proposed Expansion

Approval of this LRA will also approve further development of Cameco's uranium operations in Wyoming to include Reynolds Ranch, North Butte Remote Satellite, Gas Hills Remote Satellite and Ruth Remote Satellite. Two aspects of the economic impact of this further development are considered in the analysis. One is the economic impact of the construction expenditures associated with the expansions. The other is the economic impact of the increased production from facilities once the expansion is completed. The current economic impacts of Cameco's uranium operations in Wyoming were used as a basis to project what the economic impacts of operations would be with the planned expansions in the future.

In terms of construction, Cameco is planning to spend a total of $82M to expand its uranium production facilities in Wyoming over the next three years including $17M in 2011, $30M in 2012, and $35M in 2013 (**Table 7-7, Economic Impact of Construction Expenditures**). Depending on how this money is spent, it could support up to 656 job-years of total employment in Wyoming over the three-year period. The total labor income resulting from this employment could be up to $34.3M and the total economic activity could be up to $52.3M. The average salary per job would be more than $52,000. This economic impact would continue for the duration of the 3-year construction period.

With the expansion of production facilities, Cameco is planning to eventually increase uranium production from the current level of 1.9M pounds per year to 3.6M pounds per year. **Table 7-8, Economic Impact of Cameco's Expanded Production** summarizes the economic impact of 3.6M pounds of production on the Wyoming economy based on the current economic impact estimates for the company. The expanded level of production would increase expenditures in Wyoming to $80.2M per year including: $23.7M in payroll, $7.1M in Wyoming taxes and production royalties, and $49.4M in vendor purchases. The increased expenditures in Wyoming would support a total employment of 843 jobs. The labor/household income at that level of expenditure would be $51.5M and the total economic activity in the state's economy with the expansion would be $112.1M.

7.3 External Costs of Project Construction and Operation

In this section of the analysis, external costs of the SUA-1548 expansion are identified and addressed. Both short-term and long-term external costs that may affect the interest of people other than the owners and operators of SUA-1548 are also identified and described.

7.3.1 Short Term External Costs

7.3.1.1 Housing Shortages

Approximately 70% of the total construction and operating work force for SUA-1548 would likely come from Converse and Campbell Counties. The remaining workforce would likely be based in Casper

(Natrona County) or Riverton (Fremont County). The IMPLAN model results show that SUA-1548 is expected to generate 656 new jobs over the next three years. Once the expansion is completed, the increased expenditure in Wyoming would support a total employment of 843 jobs.

Since Smith Ranch lies within commuting distance of Natrona County, no impacts on the housing situation in nearby cities or towns are anticipated. In the event that workers from out-of-state are hired for the short-term construction phase of SUA-1548, the present available stock of motel/hotel rooms would accommodate the temporary workers. See Section 3.10 for additional housing information.

7.3.1.2 Impacts on Schools and Other Public Services

Smith Ranch is located within Converse County School District #2, which serves approximately half of Converse County. The nearest Converse County community that provides educational services to residents in the vicinity of Smith Ranch is Glenrock, which is located approximately 29 km (18 miles) southwest of Smith Ranch on State Highway 20. Three schools are located in Glenrock: Grant Elementary School serves K-4; Glenrock Middle School serves grades 5-8; and, Glenrock High School serves grades 9-12 (Converse County School District 2, 2011).

The North Butte Remote Satellite is located within Campbell County School District #1, which serves all of Campbell County. The nearest Campbell County community that provides educational services to residents in the vicinity of the remote satellite is Wright, which is located approximately 40 km (25 miles) east of the remote satellite on State Highway 387. Two schools are located in Wright: Cottonwood Elementary School serves K-6 and the Wright Junior & Senior High School serves grades 7-12. The Ruth Remote Satellite employees may also utilize the school system in Wright since it is only approximately 10 km (6 miles) southwest of the North Butte Remote Satellite.

The Gas Hills Remote Satellite is located in Fremont County School District #25, which serves approximately one-fifth of Fremont County. The nearest Fremont County community that provides educational services to residents in the vicinity of the remote satellite is Riverton, which is located 80 km (50 miles) northwest of the remote satellite on State Highway 136. There is one high school (Riverton High School), one middle school (Riverton Middle School), and four elementary schools (Aspen Park Elementary, Jackson Elementary, Ashgrove Elementary, and Rendezvous Elementary) located in Riverton. Riverton High School serves grades 9-12; Riverton Middle School serves grades 6-8, and the four elementary schools serve grades K-5.

The Ruth Remote Satellite is located within Johnson County School District #1, which serves all of Johnson County. The nearest Johnson County community that provides educational services to residents in the vicinity of the remote satellite is Kaycee, which is located 48 km (30 miles) northwest of the remote satellite on State Highway 1002 (Highway 192). Three schools are located in Kaycee: Kaycee Elementary School, which serves grades K-5; Kaycee Jr. High School, which serves grades 6-8; and Kaycee High School, which serves grades 9-12. Total enrollment in these three schools for the 2009-2010 school year was 54 in the elementary school, 34 in the junior high school, and 49 in the high school (School Digger, 2010).

All four SUA-1548 project sites could possibly utilize the school system in Natrona County, such as the Midwest School, which provides classes for students from preschool through grade 12. Enrollment for the 2005-2006 school year was 229 (Natrona County, 2011).

Families moving into the Natrona and Converse County school districts as a result of SUA-1548 operations would not stress the current school system because it is presently under capacity.

There is no significant change anticipated from the no-action alternative in the demand for other public services such as fire, police, water and utilities. The maximum population increase resulting from the permanent migration of workers into Wyoming represents only 0.4% of the total state population (2009).

Please refer to Section 3.10 for additional information on the aforementioned schools.

7.3.1.3 Impacts on Noise and Congestion

Smith Ranch and the North Butte Remote Satellite are the two project sites that have residents within 3 km (2 miles) from the project site. The closest residence to Smith Ranch is the Vollman Ranch, which is located within the site boundary and is occupied year-round, and for the North Butte Remote Satellite, the closest residence is the Pfister Ranch house, located approximately 1 km (0.5 mile) south of the site boundary and is also occupied year-round. As a result of the remote location of the project, its historic and current uranium recovery operations and the low population density of the surrounding area, impacts from noise or congestion within the project area or in the surrounding 3 km (2 mile) area have not created problems in the past and are not anticipated to cause problems in the future. Open rangeland is the primary land use within and in the surrounding 3 km (2 mile) area. Other land uses include oil and gas production facilities, CBM facilities, and wind farms. Please refer to Section 4.7 for more information on the impacts of anticipated noise levels on the SUA-1548 Project sites.

7.3.1.4 Impairment of Recreational and Aesthetic Values

While opportunities for developed and dispersed recreation exist throughout the regions surrounding all SUA-1548 license areas, there are limited recreational uses within the license areas or in the surrounding 3 km (2 mile) area. Private lands within the license area allow limited hunting opportunities. Public lands within and adjacent to the Gas Hills Remote Satellite are used for antelope hunting and limited other recreational interests. Section 3.1.3 describes all state and federal recreational lands within 80 km (50 miles) of all SUA-1548 sites. There have not nor will there be any significant impacts on recreational opportunities as a result of SUA-1548 operations. The physical remoteness of the sites and the lack of proximity to any well recognized federal or state site of recreational interest indicate that there are no significant long-term impairments to recreational values from expanding SUA-1548 operations.

7.3.1.5 Land Disturbance

Smith Ranch and its satellites and remote satellites have been used historically for grazing, prospecting, CBM, and oil and gas development, among other land uses described in Section 3.1. Therefore, it is unlikely that any true undisturbed land area currently exists. Pre-existing land disturbance includes grazing activities and facilities (stock tanks, fences), oil production facilities, wind farms, historic conventional uranium mining, natural gas production facilities, and infrastructures that support these activities. Oil and gas field infrastructure within the North Butte and Ruth Remote Satellites and the surrounding 3 km (2 miles) review area includes access roads, overhead electric distribution lines, and cleared rights-of-way for underground utilities, which are generally found along access roads. There would be negligible changes in land cover or land use from existing conditions outside of the 3 km (2 mile) review area. Oil and gas field infrastructure, conventional uranium mining disturbances and abandoned mine reclamation within the Gas Hills Remote Satellite are evident within the surrounding 3 km (2 mile) review area. Such disturbances include access roads, overhead electric distribution lines, acres of reclaimed lands, existing and, in several cases, reclaimed pit lakes. Development of the Gas Hills Remote Satellite would result in negligible changes in land cover or land use from the existing condition.

Smith Ranch and its satellite facilities use ISR rather than conventional mining techniques. ISR results in less land surface disturbance than any conventional resource recovery alternative. Land surface disturbance associated with mine unit development is short term as interim stabilization with native vegetation species is implemented as soon as construction activities are complete and maintained through the life of the mine unit. No tailings or waste rock are generated. The CPP, satellites and private access roads will continue to be confined to clearly delineated areas on site. While there will be some land use changes from the existing conditions, potential impacts will be minimal.

7.3.1.6 Habitat Disturbance

Currently, there are no federal- or state-designated wildlife reserves located within SUA-1548. Because of the revegetation practices at ISR sites and wildlife friendly fencing, wildlife habitats are not seriously impacted. No long-term losses to wildlife habitat relative to the existing conditions will result from the continued construction and operation at SUA-1548.

7.4 No-Action Alternative

If the NRC denies the renewal of SUA-1548, Cameco would be required to cease uranium recovery operations at Smith Ranch and complete groundwater restoration, decontamination and decommissioning, and reclamation in a timely manner, leaving a valuable mineral commodity undeveloped. This would also result in no further development at the North Butte, Gas Hills and Ruth Remote Satellites. Reclamation of existing disturbances would begin. Denial of this LRA would also result in the loss of all uranium production and the sale of uranium as fuel. Currently Cameco sells SUA-1548 uranium for use as fuel for nuclear reactors. Finally, denial of this license renewal request would result in significant adverse financial and economic growth impacts to Converse, Campbell, Fremont, and Natrona Counties due to the loss of tax revenues and jobs. Financial impact to Wyoming would likely exceed $42M per year once restoration is completed. Over a 30-year period assuming no increase in rates or costs of uranium recovery activities, NRC denial of the LRA could result in a $1.26 billion loss to the State of Wyoming.

7.5 Alternative Action

If Cameco were to employ a conventional mining alternative, uranium recovery operations would continue. However the environmental and socioeconomic impacts of this alternative action would be far greater than the proposed action. Specifically, the physical land disturbance would be greater and the number of workers required to accomplish the proposed action would be far greater. Although there would be greater payrolls, tax revenues and jobs, the sale of nuclear fuel would not likely increase and mineral royalty payments to the state would remain the same or be lower.

8.0 Summary of Environmental Consequences

The status of the affected environment of SUA-1548 has been characterized and presented in Section 3.0. SUA-1548 is an operating license, and as such, the affected environment continues to change. For that reason, and upon agreement with NRC Staff, Cameco has defined on-site conditions (the Affected Environment) effective at the end of September 2011. This is especially important when one evaluates water uses, since new wells are being drilled for adjacent energy interests (CBM, shale fracking, etc.) on a monthly basis. The potential positive and negative environmental consequences in addition to cumulative impacts to land use, transportation, water resources, air quality, noise and socioeconomics are discussed in detail in Section 4.0. Mitigation measures taken to lessen environmental impacts are discussed in Section 5.0.

Impacts to land use resulting from the renewal of SUA-1548 are limited to the loss of grazing access in impacted areas for the life of the operation. The additional land impacts expected from this renewal will be less than 5% of the total license area, and cumulative disturbances will be less than 8% of the total license area. Because only a small percentage of the land surface will be disturbed, land use will likely remain largely unaffected by the renewal of SUA-1548. Once production, restoration and reclamation are complete, all areas covered under this license will be released for unrestricted use.

Impacts to transportation resulting from the renewal of SUA-1548 are minimal compared to current traffic levels. The predicted increase in traffic volumes on all adjacent and regional roadways are anticipated to increase by less than 5% as the result of the proposed action. No mitigation measures are proposed to address transportation impacts.

Geologic impacts resulting from the renewal of SUA-1548 are expected to be minimal. ISR does not remove formation material from the aquifer, therefore no subsidence or matrix compression is anticipated. The principal impact to soils will be from earthmoving activities associated with construction of additional ISR facilities. Currently (January 2012), approximately 3% of the available soils within the licensed areas have been disturbed, and the majority of these disturbed soils have been reclaimed (i.e., mine unit wellfields). With the proposed action, an additional approximate 5% of soils will be disturbed. Most soil disturbances are short-term and reclamation and vegetation is initiated as soon as possible following construction.

There will be minimal impacts to surface waters at all SUA-1548 license areas as a result of the proposed action. A SWPPP has been implemented for all construction and operational activities. Cameco has and will continue to utilize BMP to ensure that all disturbed land runoff is minimal.

Potential impacts to groundwater include: 1) consumptive use of the ore zone aquifer; 2) contamination outside the mineralized zone or within aquifers above or below the production zone due to excursions; 3) contamination due to inadequate restoration after ISR operations are complete; and, 4) contamination of shallow aquifers, if present, from casing or pipeline leaks, surface spills from wells or header houses, and leakage from lined ponds or land application facilities. Based on groundwater modeling of the SUA-1548 license areas, consumptive use of groundwater will have a negligible impact on area use of groundwater resources. Since the last renewal of SUA-1548 (May 2001), there has been no defined diminution of groundwater resources to local area water users.

The types of disturbances associated with operations at all SUA-1548 license areas will not result in large expanses of habitat being dramatically transformed from its original character. Similar to impacts to land use resulting from the proposed action, the additional land disturbances will be minimal and will

represent less than 5% of the total licensed area. The majority of this land disturbance will be revegetated and will remain accessible to wildlife during the remaining operational period. No substantial impairment of ecological stability or species diversity is anticipated. Mitigation measures include wildlife friendly fencing and Cameco's commitment to reclaim the majority of disturbances after wellfield construction or immediately following restoration and decommissioning.

Impacts to air quality resulting from the proposed action will be negligible and will be related to a minimal impact from fugitive dust caused by construction activities and vehicle traffic on gravel roads. The expected release of gaseous and airborne particulates from SUA-1548 license areas will remain below the allowable limits for the State of Wyoming and will be less than 200 tons per year. To mitigate the release of fugitive dust and other particulates, mitigation measures such as watering the roads or applying chemical treatment will be implemented.

Noise impacts resulting from the proposed action will come from increased vehicle travel and the operation of construction equipment during the construction phase of the project. All SUA-1548 license areas are remote and noise receptors are typically far away. Noise from construction equipment could raise noise levels slightly during the construction phase of the project. According to the tests conducted by Cameco and assuming a worst case noise source (PVC chipper), the calculated noise level at a location 3 kilometers (2 miles) from the noise source would be 77 dBA. A noise level of 77 dBA can be likened to the same noise level as a dishwasher, barking dog, or a vacuum cleaner. Therefore, the noise impact is not considered extreme.

Construction and operation land-disturbing activities resulting from the proposed action will be localized. Because of this localized nature of land-disturbing activities for ISR production and the fact that ISR operations will avoid historic and cultural resources, impacts to these resources are expected to be negligible to non-existent. Overall, impacts to cultural and historical resources during operations are expected to be less than those during construction, as operations are generally limited to previously disturbed areas (e.g., access roads, CPF, and well sites). Additionally, should an unanticipated cultural resource discovery be made during construction or operational activities, License Condition 9.9 of SUA-1548 requires that work in the area cease and the artifacts be inventoried and evaluated in accordance with 36 CFR Part 800. No disturbance of the area of discovery will occur until authorization to proceed has been received from the NRC. The proposed action will continue to cause short-term and long-term visual effects. The short-term visual effects will occur during the construction phase of mine unit wellfields, which includes header house construction, well installation, access road construction, pipe and power line installation, etc. Following each wellfield installation, the temporarily disturbed areas are reclaimed and visual effects are mitigated. Long-term visual effects result from the construction and utilization of buildings to operate the ISR and process the uranium-laden IX resin and the resultant uranium products. These buildings will exist within the landscape over the life of the project, but are limited in their number and density. Buildings and well heads will be painted a color that will blend with the natural surroundings. Overhead power lines will be kept to the minimum necessary. Power lines within the wellfields will be buried, whenever possible. At the end of resource recovery, the buildings and all remaining wellfields will be removed, and the land surface will be reclaimed, thereby removing all visual impacts caused by the ISR operation.

It is anticipated that the overall effect of the proposed action on the local and regional economy and the state as a whole will be beneficial. Purchases of goods and services by the project and project employees will contribute directly to the economy. Local, state, and federal governments will benefit from taxes paid by Cameco and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, will also be beneficial. These economic effects

will further stimulate the economy, resulting in the creation of additional jobs. If this LRA is approved, these beneficial impacts to the local and regional economy provided by the continued ISR operation could continue for an additional 36 years for Smith Ranch, 20 years for the North Butte Remote Satellite, 20 to 25 years for the Gas Hills Remote Satellite, and 10 years for the Ruth Remote Satellite.

ISR operations associated with SUA-1548 are not now nor will they in the future create any adverse environmental justice impacts on large populations of minorities or people living below the poverty level. Except for scattered ranches, the majority of the population nearest to Smith Ranch and its contiguous satellites live in Casper, Glenrock, Rolling Hills, Douglas, and other smaller communities along the I-25 corridor. Similarly, the majority of the population near the North Butte and Ruth Remote Satellites reside in Gillette, Wright, and other smaller communities along Highways 387, 50, and 59. The majority of the population near the Gas Hills Remote Satellite resides in Riverton, Lander, and Casper. These cities, towns, and communities also possess a low percentage of minority and low-income populations compared to the state as a whole.

The potential impacts to public and occupational health from SUA-1548 operations are described in Section 4.12 and include fugitive dust from construction activities and vehicle travel, the release of Rn-222 from IX facilities, the CPP, the mine unit header houses, wellfields and any potentially adverse impact associated with a spill or accident. To ensure risk levels from non-radiological and radiological impacts remain low, Cameco has instituted standard operating procedures for handling, processing, storing, transporting and disposing of source and 11e.(2) byproduct materials and other potentially hazardous materials. The majority of the radioactive uranium daughter products are not removed with the uranium and remain underground. Additionally, the use of modern vacuum dryers for yellowcake production reduce the potential for radiological air particulate releases to insignificant levels

SUA-1548 operations produce airborne effluents, liquid and solid wastes that must be properly handled and disposed. Potential waste impacts from solid or liquid waste management and disposal include potential releases to the land surface, surface water, and groundwater if not correctly stored and disposed. Potential impacts from domestic waste management and disposal include surface disturbance during construction of septic leach fields, transportation accidents during transport of chemical toilets, and contamination of shallow groundwater from leach field effluents. Cameco has and will continue to employ proper waste management procedures at all SUA-1548 license areas and will also continue to properly transport, treat and dispose of 11e.(2) liquid and solid wastes and by so doing, reduce the impacts of waste generation.

All impacts are short term, meaning that the life of the impact will be less than or equal to the length of time between construction and final decommissioning of SUA-1548 license areas. No significant long-term impacts that would extend beyond the duration of the project have been identified.