Safety Evaluation Report
License Renewal for the Smith Ranch Highland Uranium Project in Various Counties in Wyoming

Materials License No. SUA-1548

Docket No. 40-8964

POWER RESOURCES INCORPORATED dba CAMECO RESOURCES

September 2018

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INTRODUCTION

By letter dated August 12, 2010, Power Resources, Inc. (PRI), doing business as Cameco Resources (Cameco), submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for renewal of source material license SUA-1548 for the Smith Ranch Highland Uranium Project. NRC License SUA-1548 authorizes uranium in-situ recovery (ISR) operations at the Smith Ranch Highland Uranium Project, which includes remote satellite facilities at Gas Hills, Ruth, and North Butte. The proposed license renewal application would allow uranium recovery operations to continue for an additional 10 years from the date of issuance of the renewed license at all locations authorized by NRC License SUA-1548. As discussed in SECY 17-0086 (NRC, 2017e), the NRC staff increased the term for uranium recovery licenses from 10 years to 20 years. Cameco submitted its license renewal request prior to the NRC staff's policy change. The NRC staff provided Cameco the opportunity to modify its application to request a 20 year license term. However, Cameco did not modify its application. Therefore, the NRC staff performed its review based on a 10 year renewal term. The Smith Ranch Highland Uranium Project is subject to the safety requirements found in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, "Domestic Licensing of Source Material" and 10 CFR Part 20, "Standards for Protection Against Radiation."

During its acceptance review of the August 2010 submittal, the NRC staff identified several items that were not consistent with regulatory requirements or did not appear to be present in the renewal application (NRC, 2011a). At that point, the NRC staff suspended its review to provide Cameco with the opportunity to revise its application. On February 1, 2012, Cameco submitted an updated application for renewal of source material license SUA-1548 that superseded its August 2010 request. Cameco's license renewal application for the Smith Ranch Highland Uranium Project consisted of a technical report and an environmental report (Cameco, 2012b). The NRC staff accepted Cameco's 2012 application on July 5, 2012 (NRC, 2012c). The NRC staff issued its request for additional information (RAI) for Cameco's license renewal request on May 2, 2013 (NRC, 2013b). The licensee responded to this request for additional information on November 18, 2014 (Cameco, 2014d) and April 21, 2015 (Cameco, 2015b). By letters dated March 7, July 30, 2018 and emails dated August 15, and August 16, 2018, Cameco provided additional responses to the NRC staff's request for additional information (Cameco, 2018d, 2018f, 2018g, and 2018h). Hereafter in this safety evaluation report (SER), the February 1, 2012 license renewal request and its supplements are referred to as the Smith Ranch Renewal Technical Report and the Smith Ranch Renewal Environmental Report (Cameco, 2012b). License condition 9.3 contains the licensee's commitments, representations, and statements incorporated by reference in the renewed license.

In the Technical Report, the licensee stated that current operations are expected to last for approximately 30 years (Cameco, 2012b). More recent projections that reflect current conditions in the uranium market and Cameco's future plans identify completion of decommissioning activities around 2045 (Cameco, 2017b). On April 2, 2018, Cameco informed the NRC of its decision to cease production at Smith Ranch Highland and the North Butte remote satellite (Cameco, 2018e). In its letter, Cameco states that it intends to maintain equipment to provide the option to resume full operations should market conditions warrant. Cameco did not request that the NRC staff cease its review of the license renewal request. Therefore, the NRC staff proceeded with its review. The NRC staff recognizes that the duration of operations under license SUA-1548 is dependent on market conditions. Additionally, the NRC staff understands that market conditions will influence the amount of uranium the licensee recovers from year to year.

The expiration date for the current performance based license was September 30, 2010. Because Cameco submitted a renewal application within the required timeframe, the existing license continues in effect until a decision is made by the NRC on the renewal application in accordance with 10 CFR 40.42(a). The renewal period begins at the time of the NRC staff's approval of the application, not the expiration date of the existing license.

The Atomic Energy Act of 1954, as amended by the Uranium Mill Tailings Radiation Control Act of 1978, authorizes the NRC to issue licenses for the possession and use of source material and byproduct material. The NRC must license facilities, including ISR operations, in accordance with NRC regulatory requirements to protect public health and safety from radiological hazards. In accordance with 10 CFR 40.43, "Renewal of licenses," an application for renewal must be filed on NRC Form 313 and in accordance with 10 CFR 40.31, "Application for specific licenses." In accordance with 10 CFR 40.44, "Amendment of licenses at request of licensee," the renewal application shall specify the respects in which the licensee desires the license to be amended and the grounds for such amendment. In accordance with 10 CFR 40.45, "Commission action on applications to renew or amend," the Commission staff applies the criteria set forth in 10 CFR 40.32, "General Requirements for Issuance of Specific Licenses," wherein the the NRC staff will approve a license renewal request if:

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

This SER documents the safety portion of the NRC staff's review of the license renewal application, and includes an analysis to determine Cameco's compliance with these and other applicable 10 CFR Part 40 requirements, and applicable requirements set forth in 10 CFR Part 40, Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content." This SER also evaluates Cameco's compliance with applicable requirements in 10 CFR Part 20, "Standards for Protection Against Radiation." An Environmental Assessment (EA) has been prepared in parallel with this SER to address environmental impacts of the proposed action in accordance with 10 CFR Part 51, which contains NRC's implementation regulations for the National Environmental Policy Act (NEPA) of 1969, as amended.

The NRC staff's safety review of the license renewal application was performed using NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications" (NRC, 2003a) (referred to as either the standard review plan or SRP in the remainder of this SER) and is a comprehensive assessment of the Smith Ranch Highland Uranium Project. The NRC staff's review, including a review of the historical aspects of site performance, is contained in

Appendix A of this SER. The NRC staff's review of the historical aspects of performance at the Smith Ranch Highland Uranium Project included reviews of: (1) NRC staff inspection reports generated since the previous license renewal; (2) a summary of amendments to license SUA-1548 since the last renewal; (3) changes made to the application made under the performance based license using the safety and environmental review panel process; (4) violations cited since the last license renewal; (5) excursions, incidents, and root cause investigations since the last renewal; (6) unplanned spills or releases that have occurred since the last renewal; (vii) leaks from storage or evaporation ponds which have occurred since the last renewal and; (7) occupational or public radiation related regulatory exceedences. As described in detail in Appendix A of this SER, the NRC staff concludes that the Smith Ranch Highland Uranium Project has been operated so as to protect health and safety and the environment. The NRC staff did identify several performance issues in Appendix A of this SER. Therefore, the NRC staff focused its review on those aspects of the Smith Ranch Renewal Technical Report and Smith Ranch Renewal Environmental Report (Cameco, 2012b) that represent changes from previous descriptions reviewed and approved by the NRC staff. For aspects of Smith Ranch Highland that have not changed since the last renewal or amendment and for which the NRC staff have not identified a performance issue, the NRC staff will verify there are no changes to regulatory requirements that would render the NRC staff's prior review invalid as part of its determination that the NRC staff's prior review remains valid. Where the NRC staff identified a performance issue related to its review in Appendix A, this SER provides an evaluation of how the licensee has addressed the issue.

License SUA-1548 covers a large area and has a complex history. To aid in the development of this SER, the NRC staff used the terminology in Table 1~~Table 1~~ when referring to different portions of the site. To the extent possible, the NRC staff used the licensee's terminology used in the Smith Ranch Renewal Technical Report and Smith Ranch Renewal Environmental Report. Note that Power Resources, Inc. (PRI) is the named licensee on NRC license SUA-1548. Since license SUA-1548 was last renewed, some of the correspondence has been submitted by PRI on PRI letterhead and some has been submitted by Cameco Resources on Cameco letterhead. In this SER, the NRC staff has cited references based on entity that submitted the document.

Table 1. SER Terminology

Word or Phrase	Staff Definition
License area	All areas covered by the license (Smith Ranch, Highland, Reynolds Ranch, Ruth, North Butte, and Gas Hills,)
Smith Ranch Highland Uranium Project	All license areas authorized by License SUA-1548. This includes activities at Smith Ranch, Highland, Reynolds Ranch, and the remote satellites at Ruth, North Butte, and Gas Hills.
Smith Ranch Highland	The portion of the facility initially licensed under License SUA-1548 (Smith Ranch) and License SUA-1511 (Highland). As Reynolds Ranch was an amendment to SUA-1548, this portion of the facility is also included here. In some sections of the SER, Smith Ranch and Highland are referred to separately to better differentiate past licensing history and site specific features.
Smith Ranch central processing plant (CPP)	Building and related equipment located off of Ross Road authorized to produce dried yellowcake.
Highland central processing facility (CPF)	Building and related equipment located off of Highland Loop Road authorized to produce dried yellowcake.
Satellite facility	Processing facility located within the existing Smith Ranch Highland license area capable of loading uranium onto ion exchange resins. Resins from satellite facilities are sent to the Smith Ranch CPP for further processing into yellowcake. Examples of satellite facilities at Smith Ranch Highland include: Sat-1, Sat-2, Sat-3, SR-1, SR-2, and Reynolds Ranch.
Remote satellite facility	Processing facility located outside the Smith Ranch Highland license area and capable of processing uranium to the ion exchange or yellowcake slurry stage of yellowcake production. Final processing of the product from a remote satellite would occur at either the Smith Ranch CPP or Highland CPF. Ruth, North Butte, and Gas Hills are examples of remote satellite facilities.
Power Resources, Inc. (PRI)	The licensee for NRC license SUA-1548.
Cameco Resources	Power Resources Inc. does business as Cameco Resources

In developing this SER, some sections were developed with specific subsections that relate to different portions of the site. The NRC staff included these subsections when they were necessary to capture a particular difference for a portion of the site. An example would be with geology. Given the distance between the Smith Ranch CPP and the remote satellites at North Butte, Ruth, and Gas Hills, the geology is different and the NRC staff has included subsections to describe the geology in more detail. Chapters of the SER that describe an activity or approach that is that same across the entire license area (including the remote satellite areas) are not broken down into subsections. An example of this would be chapter 5 of the SER relate to the overall radiation protection program that is in place across the entire license area, regardless of its location. Therefore, in Chapter 5, the NRC staff has not broken the SER down into subsections.

The NRC staff's review of Cameco's license renewal application for the Smith Ranch Highland Uranium Project identified a number of facility specific issues that require additional or modified

license conditions to ensure that the operation of the facility will be adequately protective of public health and safety. Table 2 includes the license condition language as well as the section of the SER where the regulatory need for the license condition was identified. The NRC staff will maintain the performance based aspect of the license, as described in condition 9.4. This condition allows the licensee to make changes to the facility, provided that the criteria in condition 9.4 are satisfied. The NRC staff has also used the renewal process to remove several existing conditions that have been addressed by the licensee and, therefore, are no longer necessary. Appendix B of this SER includes a justification for either making administrative changes to license SUA-1548 or for not carrying certain license conditions forward into the renewed license.

The NRC staff concludes that the findings described in succeeding sections of this SER, including the necessary license conditions, supports renewal of License SUA-1548. This SER documents the NRC staff's review based on the information in the NRC staff's possession through August 16, 2018.

Site History

This is the second license renewal request for license SUA-1548. Since the last license renewal was issued in 2001 (NRC, 2001a), several licensing actions have consolidated the Highland, Ruth, and North Butte licenses into the Smith Ranch license (NRC, 2003b) and have authorized expansions into Gas Hills (NRC, 2004b), Reynolds Ranch (NRC, 2007a), and the Southwest Area, also known as SR-2 (NRC, 2008a). The following paragraphs describe the history for each portion of the site and the major actions that resulted in the current version of license SUA-1548.

Smith Ranch

The NRC first issued license SUA-1387 to Kerr-McGee Corporation (KMC) authorizing Research and Development (R&D) ISR operations at Smith Ranch in June 1981 (46 FR 30924, NRC, 1981a). License SUA-1387 was amended in 1984 to list Sequoyah Fuels Corporation, a wholly owned subsidiary of KMC, as the licensee for the Smith Ranch R&D operation (NRC, 1984). In 1988, the NRC renewed license SUA-1387 and allowed for continued R&D operations at Smith Ranch (NRC, 1988a). The NRC staff's review of the 1988 license renewal action is documented in an SER (NRC, 1988b) and in an Environmental Assessment (NRC, 1987e). Rio Algom Mining Corp. (RAMC) acquired the Smith Ranch site in December 1988 (Quivira Mining Corp., 1988). On March 12, 1992, the NRC staff authorized expansion of the Smith Ranch R&D operations into commercial scale production (NRC, 1992b). As part of this action, the NRC staff issued license SUA-1548, which replaced the R&D license, SUA-1387. The NRC staff's review of the 1988 licensing action is documented in an SER (NRC, 1992c) and in an Environmental Assessment (NRC, 1992a). The NRC staff issued a renewal for license SUA-1548 on May 8, 2001 (NRC, 2001a). PRI acquired RAMC's Smith Ranch properties in July 2002 (Rio Algom, 2002b). Current facilities in place at Smith Ranch include: a central processing plant (CPP), mine units, header houses, piping, deep disposal wells, storage ponds, and two satellite facilities (SR-1 and SR-2). All current yellowcake production under license SUA-1548 occurs at the Smith Ranch CPP.

Highland

The NRC staff issued license SUA-1064 to Humble Oil and Refining Company authorizing R&D ISR operations at the Highland site in 1970 (AEC, 1970). The NRC staff approved a second R&D ISR project at Highland in 1978 (NRC, 1978a, 1978b). In 1987, the NRC staff authorized Everest Minerals Corporation (EMC) to conduct commercial scale operations at Highland (NRC, 1987b). The NRC staff's review was documented in a SER and an EA (NRC, 1987c), as well as a Federal Register Notice (NRC, 1987d). As part of this action, the NRC staff issued license SUA-1511, which replaced the R&D license, SUA-1064. EMC changed its name to Power Resources, Inc. in 1989 (EMC, 1989). In 1995, the NRC staff issued a renewal of license SUA-1511 for Highland (NRC, 1995a). Cameco acquired PRI and the Highland project in 1997 (PRI, 1997). Current facilities in place at Highland include: a central processing facility (CPF), mine units, header houses, piping, deep disposal wells, purge storage reservoirs, land application irrigation circles, and three satellite facilities. Ion exchange resins from the three satellite facilities at Highland are shipped to the Smith Ranch CPP for further processing. The licensee refurbished the Highland CPF and plans to resume operation of the Highland CPF dryer when favorable market conditions exist (Cameco, 2012a).

Ruth and North Butte

In 1981, the NRC staff issued license SUA-1401 authorizing R&D operations at the Ruth facility (NRC, 1981b). The NRC staff's review of this action was documented in an SER (NRC, 1981c) and an Environmental Impact Appraisal (EIA) (NRC, 1981d). The NRC staff authorized Uranerz, USA to expand Ruth to a commercial scale facility and to perform commercial scale operations at North Butte in 1990 (NRC, 1990a). The NRC staff's reviews of these actions were documented in an SER (NRC, 1990b) and an EA (NRC, 1990c). Pathfinder acquired Ruth and North Butte from Uranerz, USA in 1991 (Uranerz, 1991). After Pathfinder acquired both North Butte and Ruth, the NRC staff approved consolidation of these facilities into the North Butte license (NRC, 1991a). PRI acquired license SUA-1540 license for Ruth and North Butte in 2001 (Pathfinder, 2001). The NRC staff reviewed and approved this change of control on November 26, 2001 (NRC, 2001c). To date, no commercial scale production activities have occurred at Ruth. Current facilities in place at Ruth include: monitoring wells, storage ponds, and a building that contained processing equipment for the R&D operation. This infrastructure at the Ruth remote satellite is not currently in use. Previous NRC staff reviews for Ruth and North Butte evaluated the potential for operation of a yellowcake dryer at North Butte (NRC, 1990b), however, PRI no longer plans to have a dryer at North Butte (Cameco, 2012b). Cameco initiated operations at North Butte in 2013 and ships ion exchange resin from North Butte to the Smith Ranch CPP for the remaining steps of processing. Current facilities at North Butte include: monitoring wells; storage ponds; two mine units; a satellite processing building; and two deep disposal wells (DDW).

2003 License Amendment 5 to SUA-1548

By early 2003, PRI was the licensee for Smith Ranch (license SUA-1548), Highland (SUA-1511), Ruth, and North Butte (license SUA-1540). The Smith Ranch and Highland facilities shared a common boundary and the central processing facilities were located approximately 13 km (8 mi) apart. As part of its acquisition of these licenses, PRI consolidated the work forces and operations into one location at Smith Ranch (PRI, 2003b). In March 2003, PRI requested that the licenses for Smith Ranch, Highland, Ruth, and North Butte be combined into one license such that the operational and radiation safety commitments would be consistent for all

facilities (PRI, 2003b). The submittal also requested that the Smith Ranch license (license SUA-1548) be the surviving license (PRI, 2003b). The NRC staff approved this request on August 18, 2003 (NRC, 2003b) and amended license SUA-1548 to include conditions specific to Highland, Ruth, and North Butte.

Gas Hills

In June 1998, PRI submitted an amendment application for the Gas Hills remote satellite facility (PRI, 1998). Initially, this satellite facility was intended to be added to the Highland license (SUA-1511); however, the Highland and Smith Ranch licenses were consolidated into license SUA-1548 prior to the completion of the NRC staff's review of the Gas Hills amendment application. The NRC staff approved the request to amend license SUA-1548 to include ISR operations at Gas Hills on January 29, 2004; the NRC staff's review was documented in a SER and EA (NRC, 2004b and 2004a). To date, no commercial scale production activities have occurred at Gas Hills. The licensee has performed additional delineation drilling and installed monitoring wells at Gas Hills. The Carol Shop satellite building remains in place from previous activities at the site (PRI, 1998). When Gas Hills becomes operational, the licensee plans to ship yellowcake slurry to the Highland CPF for the final processing step (Cameco, 2012b).

Reynolds Ranch

In December 2004, PRI submitted an amendment application for the Reynolds Ranch satellite facility (PRI, 2004c). The NRC staff approved the request to amend license SUA-1548 to include ISR operations at Reynolds Ranch on January 31, 2007 (NRC, 2007a). Cameco has performed some development work and has installed a deep disposal well at Reynolds Ranch, but no commercial scale production activities have occurred to date at Reynolds Ranch. When Reynolds Ranch becomes operational, the licensee plans to ship ion exchange resins to Smith Ranch/Highland for further processing (PRI, 2004c).

Southwest Area, SR-2

Condition 10.5.1 of license SUA-1548 requires NRC review and approval of designs and specifications for new satellite facilities or waste water evaporation ponds. To comply with this condition, PRI submitted a request to construct and operate satellite facility SR-2 in October 2006 (PRI, 2006c). The proposed location of SR-2 was within the existing boundary of license SUA-1548, so there was no change to the facility boundary. The NRC staff approved the request to amend license SUA-1548 to include construction and operation of the SR-2 satellite facility on January 10, 2008 (NRC, 2008a). PRI completed construction of SR-2 in December 2008.

Table 2. Conditions Added or Modified in License SUA-1548
(new text marked with *underlined italics*; removed text marked with strikeout)

License Condition Number	SER Section	License Condition
9.3	Introduction	The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license renewal application and/or amendments, which are hereby incorporated by reference. These submittals include the following: Cameco Resources License Renewal Application dated February 1, 2012 (ML12234A537 and ML12234A539), as amended by submittals dated February 16, 2012 (ML121590502), November 18, 2014 (ML14353A323), December 9, 2014 (ML15040A602), April 10, 2015 (ML15133A397), April 21, 2015 (ML16063A418), March 7, 2018 (ML18130A032), July 30, 2018 (ML18239A084), and August 16, 2018 (ML18229A227 and ML18229A235).
9.5	6.3.4	The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR Part 40, Appendix A, Criterion 9, adequate to cover the estimated reclamation and closure costs, if accomplished by a third party, for all existing operations and any planned expansions or operational changes for the upcoming year. Reclamation includes all cited activities and groundwater restoration, as well as off-site disposal of all 11e.(2) byproduct material. Within three months of NRC approval of a ~~revised closure (~~decommissioning~~)~~ plan and its cost estimate, the licensee shall submit, for NRC review and approval, a proposed revision to the financial surety arrangement if estimated costs exceed the amount covered in the existing financial surety. The revised surety instrument shall then be in effect within 30 days of written NRC approval of the surety documents. Proposed annual updates to the surety amount, consistent with 10 CFR Part 40, Appendix A, Criterion 9, shall be provided to NRC 90 days prior to the anniversary date (e.g., renewal date of the surety instrument/vehicle) of September 30 of each year for Smith Ranch-Highland Uranium Project, March 26 for Ruth, April 30 for North Butte, November 7 for the Gas Hills Project. ~~The surety update renewal date for Reynolds Ranch will be determined following consultation with PRI and the State of Wyoming.~~ If NRC has not approved a proposed revision 30 days prior to the expiration date of the existing surety arrangement, the licensee shall extend the existing arrangement, prior to expiration, for one year. Along with each proposed revision or annual update of the surety, the licensee shall submit supporting documentation showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15 percent contingency, changes in engineering plans, activities performed, and any other conditions affecting estimated costs for site closure.

		At least 90 days prior to beginning construction associated with any planned expansion or operational change which was not included in the annual surety update, the licensee shall provide, for NRC approval, an updated surety to cover the expansion or change. The licensee shall also provide NRC with copies of surety-related correspondence submitted to the State of Wyoming, a copy of the State's surety review, and the final approved surety arrangement. The licensee also must ensure that the surety, where authorized to be held by the State, identifies the NRC-related portion of the surety and covers the above-ground decommissioning and decontamination, the cost of offsite disposal of 11e.(2) byproduct material, soil and water sample analyses, and groundwater restoration associated with the site. The basis for the cost estimate is the NRC-approved site closure plan or the NRC-approved revisions to the plan. Reclamation or decommissioning plan cost estimates, and annual updates, should follow the outline in Appendix E to NUREG-1569 (~~NRC, 2003~~*June 2003*), entitled "Recommended Outline for Site-Specific In Situ Leach Facility Reclamation and Stabilization Cost Estimates. ~~Power Resources, Inc. shall maintain approved surety instrument(s) in the total amount of no less than $243,612,543.00 for all facilities under this license. The minimum amount for each area of the license is identified in the following paragraphs.~~ ~~Power Resources, Inc., shall continuously maintain an approved surety instrument(s) for the Smith Ranch Highland Project, in favor of the State of Wyoming, in the amount of no less than $212,675,100.00 for the purpose of complying with 10 CFR Part 40, Appendix A, Criterion 9, until a replacement is authorized by both the State of Wyoming and the NRC.~~ ~~The licensee shall continuously maintain an NRC-approved surety instrument(s) for the current non-operational Ruth facility in the amount of no less than $364,900.00, in favor of the State of Wyoming, until a replacement is authorized by both the State of Wyoming and the NRC.~~ ~~The licensee shall continuously maintain an NRC-approved surety instrument(s) for the North Butte facility in the amount of no less than $27,738,300.00 in favor of the State of Wyoming, until a replacement is authorized by both the State of Wyoming and the NRC.~~ ~~The licensee shall continuously maintain an NRC-approved surety instrument(s) for the current non-operational Gas Hills Project facility in the amount of no less than $2,834,243.00 in favor of the State of Wyoming, until a replacement is authorized by both the State of Wyoming and the NRC.~~ *Power Resources, Inc. shall maintain approved surety instrument(s) for all facilities under this license, in favor of the State of Wyoming, in the total amount of no less than $245,095,600 for the purpose of complying with 10 CFR Part 40, Appendix A, Criterion 9, until a replacement is authorized by both the State of Wyoming and the NRC. The minimum amount for each area of the license is identified below.*

<table>
<tr><td></td><td></td><td>
<u>Minimum Surety Amounts</u>
<table>
<tr><th><u>Facility</u></th><th><u>Amount</u></th></tr>
<tr><td><u>Smith Ranch (including Highland and Reynolds)</u></td><td><u>$219,685,500</u></td></tr>
<tr><td><u>Ruth</u></td><td><u>$418,900</u></td></tr>
<tr><td><u>North Butte</u></td><td><u>$22,526,000</u></td></tr>
<tr><td><u>Gas Hills</u></td><td><u>$2,465,799</u></td></tr>
<tr><td><u>Total</u></td><td><u>$245,095,600</u></td></tr>
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At least six months prior to the expected commencement of construction of a commercial facility at the Ruth, and Gas Hills Project sites, the licensee shall submit for NRC and State approval, an itemized cost estimate for implementation of the NRC-approved decommissioning/restoration plan for the commercial facility. Site construction activities shall not commence until the NRC and State approve the surety amount and accept the surety arrangement. This surety shall be written in favor of the State of Wyoming or the NRC and shall be continuously maintained until a replacement is authorized by both the State of Wyoming and the NRC.
</td></tr>
<tr><td>9.13</td><td>6.2.3.2.1</td><td><u>Release of contaminated equipment, materials, or packages for unrestricted use shall be in accordance with the NRC guidance in “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Materials,” dated April 1993 (ML003745526). Radiation surveys for release of items for unrestricted use shall be performed by a qualified radiation safety officer or qualified health physics technician.</u></td></tr>
<tr><td>10.1.2</td><td>4.1.3</td><td>The licensee shall maintain effluent control systems as specified in Section 4.1.3 of the license application dated ~~September 27, 2000,~~ May 6, 200<u>3 (ML031390126).</u>~~, and July 9, 2003, as amended, with the following additions:~~

~~a. If during yellowcake drying operations any emission control equipment for the yellowcake drying or packaging areas is not performing within the operational specifications, the licensee shall not: (1) unload the dryer as part of the routine operations until the emission control equipment has been returned to service within operational specifications; or (2) reload the dryer with yellowcake until the emission control system has been returned to service within its operational specifications.~~

~~b. The licensee shall, during all periods of yellowcake drying operations, ensure that the specified operating pressure differential is maintained in the drying chamber. This shall be accomplished by either: (1) performing and documenting checks of air pressure differential approximately every 4 hours during~~</td></tr>
</table>

		~~operation; or (2) installing instrumentation that will signal an audible alarm if air pressure falls below the specified operating levels. If an audible alarm is used, its operation shall be checked and documented daily during dryer operations. Air pressure differential gauges for other emission control equipment shall be read and the readings documented at least once per shift during dryer operations.~~ ~~c.~~ The NRC shall be notified prior to restart of the Highland dryer.
10.1.6	4.2.3.4	~~Radium settling ponds for HUP shall have at least 3 feet of freeboard. The Satellite 1 and Satellite 2 purge storage reservoirs shall have at least 4 feet of freeboard. The licensee shall at all times maintain sufficient capacity in the Satellite 1 purge storage reservoirs to enable transferring the contents of any one radium settling pond to the reservoir. In the event of a radium settling pond leak and subsequent transfer of liquid, the freeboard requirements for the purge storage reservoir may be suspended during the repair period.~~
10.1.7	4.2.4	*At Smith Ranch Highland, a*~~A~~ll liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, discharged to the ~~solution evaporation~~ *storage* ponds, pumped to the purge storage reservoirs for disposal via land application or deep well injected.
10.1.8		Prior to uranium recovery operations, baseline groundwater quality data and restoration criteria shall be established for each uranium recovery unit as described in Chapter 5 in the approved license application. The number and location of Perimeter Monitor Wells, Production Zone Monitor Wells, and Upper and Lower Aquifer Monitor Wells shall be installed as described in section 3.5.1.2 (Monitor Well Spacing and Placement) of the License Application. Baseline water quality samples shall be obtained at these wells in accordance with Section 3.4.4.1 (Data Collection) of the License Application for each uranium recovery unit. a. Groundwater restoration goals shall be established on a parameter-by-parameter basis.~~, and the primary goal of restoration shall be to return the groundwater quality, on a uranium recovery unit average, to baseline conditions. Should baseline conditions not be achieved after application of the Best Practicable Technology (BPT) available, the licensee shall commit to a secondary goal of returning the groundwater to a quality consistent with pre-uranium recovery use, or uses, for which the water was suitable prior to ISL uranium recovery activities.~~ *Hazardous constituents in the groundwater shall be restored to the numerical groundwater protection standards required by 10 CFR Part 40, Appendix A, Criterion 5B(5). In submitting any license amendment application requesting review and approval of proposed alternate concentration limits (ACLs) pursuant to Criterion 5B(6), the licensee must show that it has first made practicable efforts to restore the specified groundwater constituents to the background or maximum contaminant levels (whichever is greater).* b. Prior to commencing ground-water restoration in each wellfield, the licensee shall, through the SERP process, add wellfields to the wellfield restoration plan in Chapter 6 of the application. The licensee shall

		be required to demonstrate baseline conditions are not achievable in order to apply any alternate standard of performance. Upon restoration completion of each wellfield, the licensee shall submit a wellfield completion report for NRC review and approval.
10.1.10	4.2.3.3.4	*The licensee shall monitor soil concentrations of natural uranium and radium-226 at the Satellite 1 and 2 land application facilities. In its semiannual effluent and environmental report due within 60 days after January 1 of each year, the licensee shall compare annual average soil concentrations of soil depths zero to 30.4 cm (zero to 12 in) to the concentration limits of 24 pCi/g natural uranium and 0.38 pCi/g radium-226. If these limits are exceeded, the licensee shall submit to NRC for approval, within 1 year of the last sample collected, a remediation plan that addresses the licensee's proposed plan to ensure the limits in 10 CFR 20.1301 and 10 CFR 40, Appendix A, Criterion 6(6) shall be met.*
10.1.11	5.7.3.3.1	*The licensee shall collect air samples in five occupied spaces inside the Selenium Treatment Plant during operation of the barium-radium sulfate sludge filter press, analyze the samples for natural U, Th-230, Ra-226, and Pb-210, and determine whether routine air sampling is warranted in accordance with Regulatory Guide 8.25. If routine air sampling is warranted, the licensee shall determine the appropriate derived air concentration (DAC) for the mixture in accordance with 10 CFR 20.1204. The minimum detectable concentration for air samples shall be less than 10% of the DAC for Th-230.*
10.1.12	7.3.1	*The licensee shall allow each drum filled with dried yellowcake to vent and cool at least 12 hours before the drum is sealed, and shall inspect each drum for pressurization prior to shipment.*
10.1.13	2.4.3.2.1	*The licensee shall properly plug and abandon any private well determined to be completed in the ore zone aquifer within 500 feet of the perimeter well ring of an existing or new mine unit.*
10.1.14	3.1.3.4.4	*The licensee shall use a bleed of at least 0.5-1.5% within all mine units to maintain an inward gradient at the monitoring well ring until the mine unit is restored and in restoration stability monitoring.*
10.1.15	2.4.3.2.1	*The licensee shall identify the location of any new private groundwater wells or new use of existing private wells, where the information is publicly available and/or known to the licensee, that are located within the Smith Ranch Highland, Ruth, North Butte, and Gas Hills license areas and within 2 km of any mine unit perimeter monitoring ring wells.*
10.1.16	6.1.3.3	*The licensee shall conduct four rounds of sampling of all WDEQ-LQD Guideline 8, Assay Suite A constituents during stabilization monitoring, with each well sample being at least three months apart. The licensee shall continue the stability monitoring until the data show the most recent four consecutive samples indicate no statistically significant increasing trend for individual constituents which would lead to an exceedance above the approved restoration target values.*

10.1.17	3.1.3.5.1	*The licensee shall continue to characterize and monitor the seepage from PSR 2 and any resulting contamination of sediments or aquifers. The licensee shall take corrective action as necessary to eliminate this seepage and remediate any resulting contamination. The licensee shall provide a written summary of its characterization of this seepage and its corrective actions in the semi-annual effluent monitoring reports to NRC.*
10.1.18	5.7.3.3.1	*Where air samples are taken to comply with 10 CFR 20.1204(a), the licensee shall perform isotopic analysis of air samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 at a frequency of once every 6 months for the first two years, and annually thereafter to ensure compliance with 10 CFR 20.1204(g).*
10.1.19	5.7.7.3.1	*At the end of the first full calendar quarter that occurs one year after issuance of the renewed license, and at the end of every calendar quarter thereafter, the licensee shall determine air effluent quantities of radon-222 and its short-lived progeny (i.e., curies per quarter) at facilities at which groundwater was processed during the previous quarter. Quarterly air effluent quantities shall be reported in semi-annual effluent monitoring reports. The licensee shall estimate air effluent quantities from sources for which monitoring is not practicable (i.e., unmonitored effluents). Unmonitored sources of air effluent quantities shall not exceed 30 percent of total air effluent quantities in any year. The licensee shall document its bases for which air effluent sources are monitored and unmonitored, and this document shall be available for inspection. In its semi-annual effluent reports, the licensee shall assume air effluent quantities of radon-222 short-lived progeny are equal to air effluent quantities of radon-222, unless the licensee has separately measured radon-222 short-lived progeny or documented an alternative approach acceptable to NRC for determining effluent quantities of radon-222 short-lived progeny. The licensee shall compare semiannual effluent quantities of radon-222 from each central processing plant and satellite building to an air effluent quantity limit of 100 curies per year (Ci/yr), and from each wellfield (including header houses) to an air effluent quantity limit of 1,000 Ci/yr. If any effluent quantity of radon-222 exceeds its applicable air effluent quantity limit, the licensee shall include that exceedance specifically in the semi-annual effluent report.*
10.2.3	4.2.4	*At the Ruth remote satellite, all liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, or discharged to the storage ponds.*
10.2.4	5.7.8.3.2	*The licensee shall quarterly sample all private wells within 2 km of an operating mine unit at the Ruth license area as described in Section 5.10.3.5 of the Technical Report.*
10.3.2	2.4.3.2.3	~~Prior to the onset of commercial *in situ* leach activities, the licensee shall prepare a new operations plan, in accordance with the guidance in NUREG-1569 (June 2003), for NRC review and approval.~~ *The licensee shall submit the hydrologic testing documents for mine units 1 through 5 to the NRC for review and verification.*
10.3.3	4.2.3.4	~~Prior to the onset of commercial *in situ* leach activities, the licensee shall propose plans for the conduct of daily visual inspections of the Gas Hills Project evaporation pond embankments, fences, and liners, including~~

		~~measurements of pond freeboard and checks of the leak detection system. The licensee shall also describe the actions it will take for fluid detected in the leak detection system standpipe, including the sampling and analysis of standpipe fluids and plans for the transfer of the evaporation pond contents to an alternate cell for the conduct of evaporation pond repairs.~~
10.3.3	3.1.3.6.3	*The average monthly flow rate at the Gas Hills Satellite shall not exceed 12,000 gallons per minute, exclusive of restoration flow. The average monthly flow rate at the Gas Hills Satellite can be increased to 13,500 gpm once the NRC staff has verified that the Class I DDW injection permits to operate have been obtained.*
10.3.4	4.2.3.4	*The licensee shall install four groundwater monitoring wells surrounding the evaporation ponds at the Gas Hills remote satellite. The monitoring wells shall be completed at a depth sufficient ability to monitor for potential seepage from the evaporation ponds. If no groundwater is detected after installation of the wells, they shall be checked for the presence of groundwater on a quarterly basis. If groundwater is found in a well, it shall be sampled and analyzed for the excursion indicator parameters of conductivity, chloride and alkalinity. If any of these indicators demonstrate levels which reflect similar water quality to the evaporation pond liquid waste, the licensee shall inform NRC in 30 days and conduct an investigation to determine if the source of elevated excursion indicator parameters is from the evaporation pond.*
10.3.5	4.2.4	*At the Gas Hills remote satellite, all liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, discharged to the evaporation ponds, or deep well injected.*
10.3.6	5.7.8.3.2	*The licensee shall quarterly sample all private wells within 2 km of an operating mine unit at the Gas Hills license area as described in Section 5.10.3.4 of the Technical Report.*
10.3.7	4.1.3.3	*Prior to operation of evaporation sprayers or forced evaporation and crystallization systems at the Gas Hills Satellite, the licensee shall assess whether additional air effluent monitoring and/or environmental monitoring is required in accordance with Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities." The licensee's documented assessment shall be available for inspection.*
10.4.1	3.1.3.6.2	*The average monthly flow rate at the North Butte Satellite shall not exceed 6,000 gallons per minute, exclusive of restoration flow.*
10.4.2	4.2.4	*At the North Butte remote satellite, all liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, discharged to the storage ponds, or deep well injected.*
10.4.3	5.7.8.3.2	*The licensee shall quarterly sample all private wells within 2 km of an operating mine unit at the North Butte license area as described in Section 5.10.3.3 of the Technical Report.*

1.0 PROPOSED ACTIVITIES

The NRC staff evaluated the licensee's summary of the proposed activities for which it requested a license renewal for the Smith Ranch Highland Uranium Project. The purpose of the NRC staff's evaluation was to gain an understanding of those proposed activities and the likely consequences of any safety or environmental impact. In accordance with SRP Section 1.3, "Acceptance Criteria," (NRC, 2003a), the NRC staff reviewed: (1) the corporate entities involved; (2) the location of the proposed activities; (3) land ownership; (4) ore-body locations and estimated uranium (U_3O_8) content; (5) proposed solution extraction method and recovery processes; (7) operating plans, design throughput and anticipated annual U_3O_8 production; (8) radiation safety protection; (9) estimated schedules for construction, startup, and duration of operations; (10) plans for project waste management and disposal; (11) source and byproduct material transportation plans; (11) plans for ground-water quality restoration, decommissioning, and land reclamation; and (12) surety arrangements covering eventual facility decommissioning, ground-water quality restoration, and site reclamation.

1.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its description of the proposed activities at the facility is in compliance with the applicable requirements in 10 CFR 40.31.

1.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR 40.31 using the acceptance criteria presented in Section 1.3 of NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications,"(NRC, 2003a) (SRP).

1.3 Staff Review and Analysis

Unless otherwise stated, information presented in this section was obtained from Smith Ranch Renewal Technical Report Section 1.0, "Introduction" (Cameco, 2012b). PRI is proposing to renew its source and byproduct materials license SUA-1548 for an additional 10-year period. The proposal is for the continued operations of the Smith Ranch Highland Uranium Project located in Wyoming. Activities authorized under license SUA-1548 include: a CPP at Smith Ranch, a central processing facility (CPF) at Highland, six satellite facilities, more than 15 installed mine units and associated infrastructure, two storage ponds, two purge storage reservoirs, evaporation ponds, two land application areas, and eight installed deep disposal wells. License SUA-1548 also authorizes PRI to recover uranium at the North Butte, Ruth, and Gas Hills remote satellite facilities. As remote satellite facilities, North Butte, Ruth, and Gas Hills are authorized to construct and operate mine units and related infrastructure, evaporation ponds for liquid byproduct material disposal, and shipment of ion exchange resins to Smith Ranch for final steps of processing into yellowcake. Cameco initiated operations at the North Butte remote satellite facility in 2013. While the remote satellite facilities at Ruth and Gas Hills have been licensed by the NRC, no commercial uranium recovery operations have occurred at these facilities to date.

Under license SUA-1548, the licensee is authorized to recovery uranium through the ISR process as source material (herein described as yellowcake) and dispose of byproduct material through a combination of deep disposal wells, land application, and evaporation ponds. Pursuant to current license, the annual yellowcake production limit is 2.5 million kilograms (kg) (5.5 million pounds [lbs]) as U_3O_8. The current license also limits the flow rate, measured on a

monthly average basis, to a total of 75,708 liters per minute (lpm) (20,000 gallons per minute [gpm]) and a specific 17,034 lpm (4,500 gpm) flow rate limit for Reynolds. The current license does not contain an explicit flow rate limit for North Butte, Ruth, or Gas Hills.

In addition to requesting a renewal of license SUA-1548, the licensee has proposed several changes to the current license. The proposed changes reflect items that are either: new, have changed since the last license renewal, or address a specific license condition. In summary, the licensee has proposed the following changes to the facility:

- Increase the licensed flow rate for the North Butte remote satellite to 22,680 lpm (6,000 gpm)
- Approval of an updated operations plan for the North Butte remote satellite to address condition 10.2.1 of license SUA-1548
- Approval of a new operations plan for the Gas Hills remote satellite to address existing condition 10.3.2 of license SUA-1548
- Increase the licensed flow rate for the Gas Hills remote satellite to 51,103 lpm (13,500 gpm)
- Approval of pond design for Gas Hills remote satellite
- Increase in licensed flow rate for the Reynolds satellite to 22,680 lpm (6,000 gpm)
- Increase in annual yellowcake production at the Highland CPF to 1.4 million kg (3 million lbs)
- Allow for processing of toll shipments of ion exchange (IX resin) and slurried yellowcake at the Highland CPF for drying and packaging

1.3.1 Corporate Entities Involved

In Section 5.1, “Corporate Organization and Administrative Procedures,” of the Smith Ranch Renewal Technical Report, the licensee stated that license SUA-1548 and related financial assurance mechanisms are issued in the name of Power Resources, Inc. (PRI). The licensee stated that PRI is a wholly owned subsidiary that does business as Cameco Resources (Cameco). The NRC staff confirmed the trade name of Cameco Resources through a search on the State of Wyoming website (Wyoming, 2018).

1.3.2 Location of Facilities

The Smith Ranch CPP is located Converse County, Wyoming, approximately 54.7 air kilometers [km] (34 air mi) northeast of Casper. The Highland CPF is located in Converse County, Wyoming, approximately 69.2 air km (43 air mi) northeast of Casper. The North Butte remote satellite is located in Campbell County, Wyoming and the Ruth remote satellite is located in Johnson County, Wyoming. Both the North Butte and Ruth remote satellites are located approximately 83.7 air km (52 air mi) north of Casper. The Gas Hills remote satellite is located in both Freemont and Natrona Counties, Wyoming, approximately 104.6 air km (65 air mi) west

of Casper. Figure 1~~Figure 1~~ shows the location of the facilities authorized under license SUA-1548.

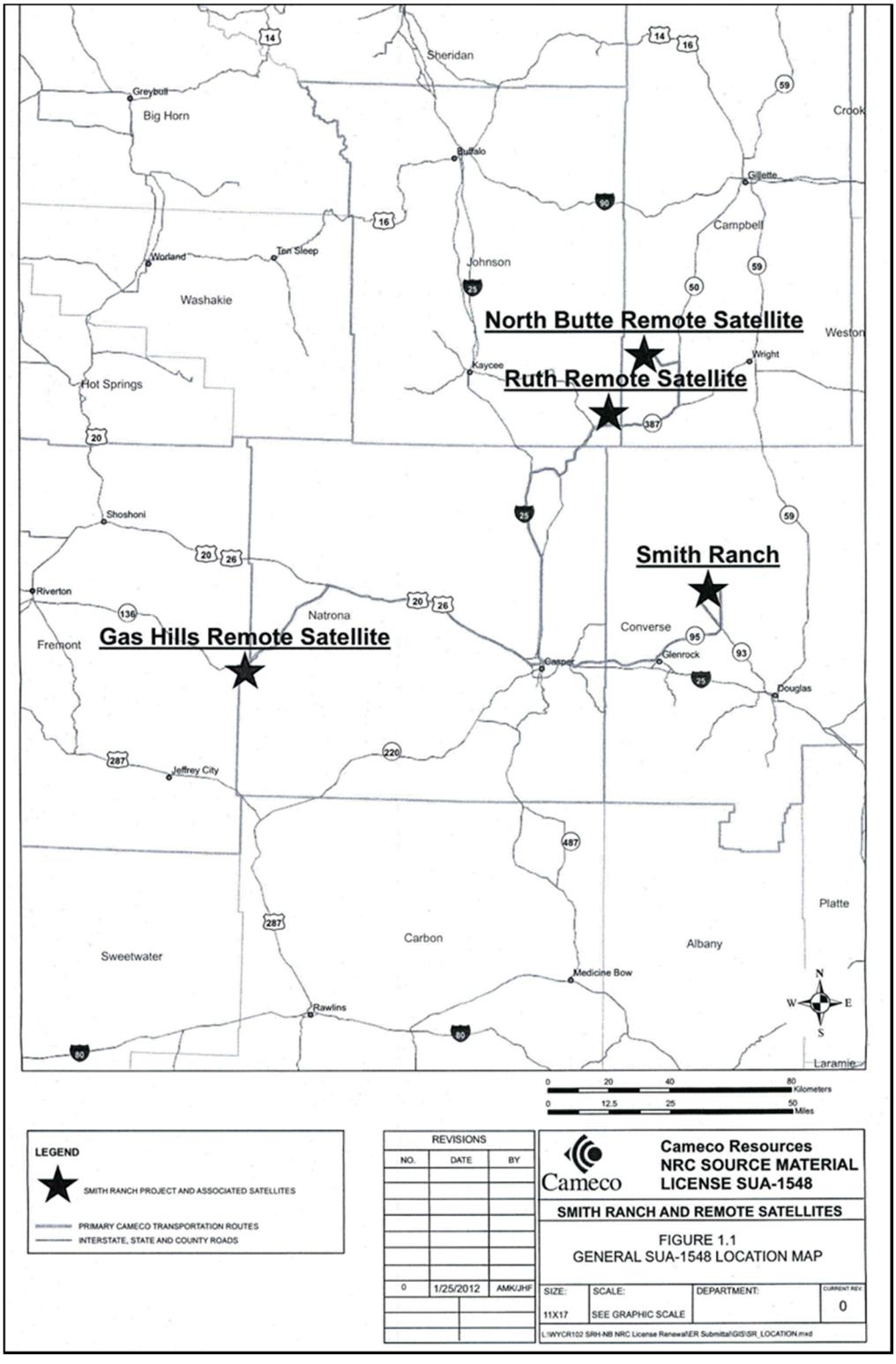

Figure 1. Location of Smith Ranch Highland Uranium Project Facilities

1.3.3 Land Ownership

The licensee has identified land ownership status for the approximately 20,400 hectares [ha] (50,000 acres [ac]) encompassed by License SUA-1548. Lands within the boundaries of license SUA-1548 are a mix of private, state, and federal ownership. Table 3~~Table 3~~ summarizes surface land ownership status for license SUA-1548. The licensee stated that Federal lands within the license area are administered by the Bureau of Land Management (BLM).

Table 3. Summary of surface ownership

Portion of facility	Private	State	Federal	Total	Reference
Smith Ranch Highland (including Reynolds)	31,760 ac 12,852.8 ha	3,940 ac 1,594.5 ha	3,795 ac 1,535.8 ha	39,495 ac 15,983.1 ha	PRI, 2003b; PRI, 2004c; Cameco, 2012b
North Butte	1,010 ac 408.7 ha	0	0	1,015 ac 408.7 ha	Cameco, 2012b
Ruth	1,289 ac 521.6 ha	0	125 ac 50.6 ha	1,414 ac 572.2 ha	Cameco, 2012b
Gas Hills	8,500 ac 3,439.8 ha	0	0	8,500 ac 3,439.8 ha	Cameco, 2012b
			Total	50,419 ac 20,403.8 ha	

1.3.4 Ore Body Locations and U_3O_8 content

The licensee has described the ore body locations and estimated U_3O_8 content for the Smith Ranch Highland Uranium Project and related remote satellite facilities. At the Smith Ranch Highland portion of the facility, the ore bodies are located between 61 to 366 m (200 and 1,200 ft) below the ground surface and the average ore grade is approximately 0.1 percent U_3O_8. At the North Butte remote satellite, the ore bodies are located between 152.4 to 182.9 meters (500 and 600 ft) below the ground surface. The average ore grade at the North Butte remote satellite is approximately 0.1 percent U_3O_8. At the Ruth remote satellite, the ore body is located between 152.4 to 182.9 m (500 and 600 ft) below the ground surface and has an average ore grade of approximately 0.1 percent U_3O_8. For the Gas Hills remote satellite, the ore body is located between 143 and 201 m (460 and 660 ft) below the ground surface. The average ore grade at the Gas Hills remote satellite is approximately 0.1 percent U_3O_8. The ore body locations and estimated U_3O_8 content were evaluated and approved during the previous license renewal (NRC, 2001a) or during other licensing actions (NRC, 2007a; NRC 2004b; NRC 1990b and 1990c).

1.3.5 Proposed Solution Extraction Method and Recovery Process

The licensee has described the solution extraction method and recovery process. The licensee plans to inject a lixiviant into the ore body through a series of injection wells, mobilize the uranium into solution, and extract the solution through a series of production wells. The licensee described the recovery process as consisting of ion exchange, precipitation, thickening, filtering, drying, and packaging, with the final product being yellowcake. The NRC staff evaluated and approved this extraction method and recovery process during the previous

license renewal (NRC, 2001a) or as part of other licensing actions (NRC, 2007a; NRC 2004b; NRC 1990b and 1990c).

1.3.6 Operating Plans, Design Throughput, and Annual U_3O_8 Production

The licensee has included new operations plans for the North Butte and Gas Hills remote satellite facilities. These operating plans were included to address conditions 10.2.1 and 10.3.2 of license SUA-1548. The NRC staff's review of these operating plans is documented in Section 3.1.4 of this SER. As previously discussed in this section, the licensee has requested increased design throughput for portions of the facility. Table 4~~Table 4~~ summarizes the licensed flow rates (in some cases the licensed flow rate was identified in the license application, but not specifically identified in license SUA-1548) and the request made by Cameco in this license renewal application.

Table 4. Summary of Current and Proposed Flow Rates

Portion of Facility	Current Flow Rate	Reference	Proposed Flow Rate	Reference
Smith Ranch Highland (Sat 2, Sat 3, SR-1, SR-2)	75,708 lpm 20,000 gpm	Amendment 17, condition 10.1.1	75,708 lpm 20,000 gpm	Cameco, 2012b
Reynolds	17,034 lpm 4,500 gpm	Amendment 17, condition 10.4.1 and NRC 2007 – Reynolds	22,680 lpm 6,000 gpm	Cameco, 2012b
North Butte	15,142 lpm 4,000 gpm	Amendment 6 to SUA-1540	22,680 lpm 6,000 gpm	Cameco, 2012b
Ruth	3,785 lpm 1,000 gpm	Amendment 6 to SUA-1540	TBD	Cameco, 2012b
Gas Hills	30,283 lpm 8,000 gpm (Carol Shop) 15,142 lpm 4,000 gpm (satellite)	PRI, 1998 – Gas Hills Application, section 3.2.3	13,500 gpm 51,103 lpm	Cameco, 2012b

Condition 10.1.1 of license SUA-1548 currently limits annual yellowcake production to 2.5 million kg 5.5 million (lbs) as U_3O_8. This annual production limit reflects the amounts identified in the separate licenses for Highland (SUA-1511) and Smith Ranch (SUA-1548), prior to the consolidation of the licenses in Amendment 5. The licensee is not requesting an increase to this annual production limit, but is requesting for the ability to produce more at the Highland CPF while remaining under the overall production limit.

1.3.7 Estimated Schedules for Duration of Operations

In the license renewal application, Cameco stated that current operations are expected to last for approximately 30 years (Cameco, 2012b). More recent projections that reflect current conditions in the uranium market and Cameco's future plans identify completion of decommissioning activities around 2045 (Cameco, 2017b). On April 2, 2018, Cameco informed the NRC of its decision to cease production at Smith Ranch Highland and the North Butte remote satellite (Cameco, 2018e). In its letter, Cameco states that it intends to maintain equipment to provide the option to resume full operations should market conditions warrant. Cameco did not request that the NRC staff cease its review of the license renewal request.

Therefore, the NRC staff proceeded with its review. The NRC staff recognizes that the duration of operations under license SUA-1548 is dependent on market conditions. Additionally, the NRC staff recognizes that market conditions will determine the amount of uranium recovered each year by the licensee.

Cameco uses a phased approach to recovering uranium by staggering mine unit operations. An area of potential uranium recovery will be chatacterized on a regional scale then much more intensly prior to operating a specific mine unit. The licensee stated it will conduct extensive hydrogeologic and baseline water quality testing of each mine unit before operation and provide this information to NRC in a mine unit hydrologic data testing document. The licensee described the information to be included in the mine unit hydrologic testing document in Section 3.4.3, "Hydrologic Testing Document," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). At a minimum the package will include: (1) description of mine units, (2) mine unit patterns and monitoring well location maps, (3) revised isopach maps, (4) revised geologic cross sections, (5) hydrologic test results including mine unit production zone aquifer pumping test results, (6) demonstration that the excursion monitoring wells are properly located, (7) baseline water quality data including proposed UCLs and restoration target values (RTVs), (9) discussion of the impact of faults and mining disturbances located in or near mine units and proposed mitigation methods, and (10) any other pertinent information. The licensee stated it will approve the information in the mine unit hydrologic testing document using its safety and environmental review panel (SERP) process, reviewed in SER Section 5.1.3, before it begins ISR operations in a mine unit. Wellfield packages detailing additional site characterization, water quality sampling, and installation of wells occur prior to operations in a specific mine unit.

1.3.8 Plans for Waste Management and Disposal

The licensee stated that currently approved disposal options for liquid byproduct material include deep well injection, land application, and storage or evaporation ponds. The licensee is not proposing any changes to disposal methods for liquid byproduct material at Smith Ranch Highland or at the North Butte remote satellite facility. In this license renewal application, Cameco has requested approval for the use of deep well injection at the Gas Hills remote satellite facility. Solid byproduct material is stored in labeled containers in secure areas around Smith Ranch Highland and at the North Butte remote satellite. The licensee maintains two disposal agreements with conventional mills for ultimate disposal of solid byproduct material. The NRC staff last reviewed these disposal agreements in 2017 (NRC, 2017f). The licensee collects solid waste on-site and disposes of this material at a municipal landfill. Domestic liquid wastes are disposed in septic/leach field systems permitted by WDEQ.

1.3.9 Plans for Groundwater Quality Restoration, Decommissioning, and Land Reclamation

The licensee described its approach for groundwater quality restoration, decommissioning, and surface reclamation. As described in Section 6.1 of this SER, the licensee's groundwater restoration efforts include groundwater sweep, treatment using reverse osmosis, and addition of a reductant. Decommissioning activities include decontamination of equipment and buildings and off-site disposal of solid byproduct material. Based on Cameco's April 2, 2018 (Cameco, 2018e) letter it is possible that restoration for some mine units could occur prematurely due to poor uranium market conditions.

1.3.10 Financial Assurance

In accordance with condition 9.5 of license SUA-1548, the licensee provides financial assurance covering the costs of groundwater restoration, decommissioning, and surface reclamation using a letter of credit. Cameco updates its financial assurance estimates on an annual basis. As a result of permitting history with WDEQ and licensing history with NRC, separate letters of credit are maintained for Smith Ranch, Highland, North Butte, Ruth, and Gas Hills. These letters of credit are typically held in favor of the State of Wyoming. Financial assurance amounts are calculated and submitted to NRC and Wyoming Department of Environmental Quality (WDEQ) on an annual basis for review and approval. Amendments 23 and 24 to license SUA-1548 (NRC, 2015d and NRC, 2016a, respectively) were the most recent NRC approvals of the financial assurance amounts for Smith Ranch, Highland, as well as the remote satellites at North Butte, Ruth, and Gas Hills. Further discussion of the financial assurance aspects of this review can be found in Section 6.3 of this SER. The current financial assurance amounts summarized in Table 5~~Table 5~~:

Table 5. Summary of Current Financial Assurance Amounts

Portion of facility	Amount	Notes
Smith Ranch Highland (including Reynolds)	$212,675,100	Amendment 24
North Butte	$27,738,300	Amendment 23
Ruth	$364,900	Amendment 24
Gas Hills	$2,834,243	Amendment 24
Total	$243,612,543	

1.3.11 Licensee Performance Review

The licensee has identified its proposed changes, provided a record of amendments since the previous renewal, and documentation of the inspection results in Section 1, “Introduction” of the Smith Ranch Renewal Technical Report (Cameco, 2012b).

The NRC staff has reviewed historical aspects of site operations. In conducting its evaluation of Cameco’s performance at Smith Ranch Highland Uranium Project, the NRC staff followed the guidance in Appendix A of NUREG-1569. Briefly, the NRC staff’s evaluation included a review of items such as: NRC inspection reports (including any violations), Cameco’s license amendment requests, changes to Cameco’s operating practices or procedures (documented in Safety and Environmental Review Panel [SERP] evaluations), semi-annual effluent and environmental monitoring reports, reports of spills or excursions, or any root cause analyses. The review documented the operational history of activities conducted under license SUA-1548 and to determine if any unreviewed safety-related concerns exist. The NRC staff’s review of Cameco’s performance under License SUA-1548 is documented in Appendix A of this SER.

1.4 Evaluation Findings

NRC staff reviewed the proposed activities at the Smith Ranch facility in accordance with review procedures in Section 1.2 and acceptance criteria outlined in Section 1.3 of the SRP, considering changes to the facility since the last license renewal, per Appendix A of the SRP. The NRC staff determined that the licensee acceptably described the proposed activities for: (1) the corporate entities involved; (2) the location of the facility; (3) land ownership; (4) ore-body locations; (5) the proposed recovery process; (6) operating plans and design throughput; (7)

schedules for construction, startup, and duration of operations; (8) waste management and disposal plans; (9) groundwater quality restoration, decommissioning, and land reclamation plans; and (10) financial assurance.

Based upon the NRC staff's review of the information presented above, the information provided in the application, as supplemented by information from NRC staff licensing actions, meets the applicable acceptance criteria of Section 1.3 of the SRP and the requirements of 10 CFR 40.31.

2.0 SITE CHARACTERIZATION

2.1 Site Location and Layout

2.1.1 Regulatory Requirements

The NRC staff determines if the licensee has adequately identified the site location in accordance with the requirements of 10 CFR 40.31(g)(2).

2.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR 40 using the acceptance criteria presented in SRP Section 2.1.3 (NRC 2003a).

2.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in their Smith Ranch Renewal Technical Report (Cameco 2012b). NRC staff visited the site on several occasions during the course of this review to confirm information presented in the application.

2.1.3.1 Smith Ranch and Highland

The licensee described the site location and layout of the Smith Ranch and Highland site including the Reynolds Ranch located in Converse County in Sections 2.2.1, “Site Location and Layout,” and 3.2.1, “Smith Ranch” of the Smith Ranch Renewal Technical Report (Cameco 2012b).

The licensee reported there have been many changes to the size and operation of the Smith Ranch Highland site since the last Smith Ranch license (SUA-1548) renewal on May 8, 2001 (NRC 2001a). The Smith Ranch site has been in commercial operation since 1992 (NRC 1992b). The Highland site operated as a commercially licensed uranium recovery facility (SUA-1511) from 1989 to 2003. The Highland site was combined with the existing Smith Ranch facility into a single NRC license (SUA-1548) on August 8, 2003 (NRC 2003b). The Reynolds Ranch satellite facility was added to the Smith Ranch Highland site in a license amendment issued in January 2007 (NRC 2007a).

The licensee provided a map of the location of the Smith Ranch Highland facility including Reynolds Ranch in Figure 1.1 of the Smith Ranch Renewal Technical Report (Cameco 2012b). The entire site is located in the southern Powder River Basin (PRB) in Converse County, Wyoming. The main Smith Ranch CPP facility is located 35 km (22 mi) northeast of Glenrock, WY and 40 km (25 mi) northwest of Douglas, WY. The site can be accessed from Ross Road, which is located at the intersection of State Highway 93 and State Highway 95.

The licensee provided a detailed map of the layout of the Smith Ranch, Highland and Reynolds Ranch site in Figure 1.3 of the Smith Ranch Renewal Technical Report (Cameco 2012b). Figures 1.4 through 1.9 provided additional details of each portion of the site. As shown in the figures, the Smith Ranch Highland site license area covers approximately 16,000 ha (40,000 ac). It currently consists of the Smith Ranch CPP, Highland CPF, five satellite facilities, as well

as existing and proposed mine units (MUs), two storage ponds, two Purge Storage Reservoirs (PSRs), two Irrigation Areas for land application and eight installed deep disposal wells (DDWs).

At the time of the last license renewal in 2001, the Smith Ranch site was composed of the Smith Ranch CPP and MUs 1, 3, 4 and K. It also included the east and west storage storage ponds near the CPP, and one DDW. The Highland Site was added to the license in August 2003 (NRC 2003b). In 2003, the major features at Highland site included the Highland CPF; Satellite 1, Satellite 2, Satellite 3; Highland MUs A, B, C, D, D ext, E , F, and H; PSRs 1 and 2; Irrigation Areas 1 and 2; and one DDW.

Since 2003, the Smith Ranch Highland facility has added two satellite facilities, SR-1 and SR-2, and begun uranium recovery operations in MUs 2, 4A, 7, 9, 10, 15, 15A and Highland MUs I, J, and K North. The licensee performed delineation of proposed MUs 8, 11, 16 and 17. It also installed six DDWs between 2005 and 2017. Finally, the licensee added a Selenium Treatment Plant in 2015. The licensee stated in Section 3.6.2.1, “General Facility Layout,” that Satellite 1 is no longer in operation as both MUs A and B have completed active groundwater restoration. PSR 1 and Irrigation Area 1 are also no longer in use for liquid byproduct material disposal.

The Reynolds Ranch Satellite was added to the Smith Ranch Highland License (SUA-1548) in January 2007 (NRC 2007a). To date, no satellite facility has been constructed at the site. The site has planned operations in eight MUs numbered 21-28. The monitoring well ring has been installed at MU 27, but no operations have occurred in any of the mine units. The site has one DDW that was installed in 2005 and has been used for liquid byproduct material disposal from the Smith Ranch Highland site operations.

The licensee reported there are two residences, Smith Ranch and Vollman Ranch, that are located within the boundary of the Smith Ranch Highland license area. The licensee reported that Vollman Ranch is occupied. Additionally, the licensee identified ten occupied residences within five miles of the license area in Section 3.1.6.1, “Local Land Use,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The location of these residences is shown in Figure 3.1.4, “Smith Ranch Ownership,” of the Environmental Report.

2.1.3.2 North Butte

The North Butte site was added to the Smith Ranch license in August 2003 (NRC 2003b). The licensee described the site location and layout of the North Butte site located in Campbell County in Section 2.3.1, “Location and Layout,” and 3.2.2, “North Butte Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco 2012b).

The licensee provided a map of the location of the North Butte in Figure 1.1 of the Smith Ranch Renewal Technical Report (Cameco 2012b). The entire site is located in the southern Powder River Basin (PRB) in southwest Campbell County, Wyoming. The main facility is located 80 km (50 mi) from the city of Gillette, WY and 64 km (40 mi) from the town of Wright, WY. The site can be accessed from State Highway 50, Van Buggenum Road, Christensen Road and an existing oil field road owned by T-Chair Ranch. The site covers approximately 410 ha (1015 ac).

The North Butte facility layout was provided by the licensee in Figure 1.10 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The North Butte Site was originally licensed as a stand alone ISR facility capable of producing dried yellowcake (NRC, 1990b and NRC, 1990c). The licensee has chosen to construct and operate North Butte as a satellite

facility with ion exchange and groundwater restoration operations, two evaporation ponds, two DDWs for waste water disposal and five mine units. The site was constructed in 2012. It began uranium recovery operations in MU1 in 2013 and added operations in MU 2 in 2014.

The licensee reported there are three occupied residences, Pfister Ranch, Christensen Ranch and Pumpkin Butte Ranch, are located within five miles of the North Butte license boundary in Section 3.1.7.1, "Local Land Use," of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The location of these residences is shown in Figure 3.1.6, "North Butte Remote Satellite Ownership," of the Environmental Report.

2.1.3.3 Gas Hills

The Gas Hills site was added to the Smith Ranch Highland license (SUA-1548) in January 2004 (NRC 2004b). The licensee described the site location and layout of the Gas Hills site located in Freemont County, WY in Section 2.4.1, "Site Location and Layout," and 3.2.3, "Gas Hills Remote Satellite," of the Smith Ranch Renewal Technical Report (Cameco 2012b).

The licensee provided a map of the location of the eastern portion of the Gas Hills site in Figure 1.11 and the western portion in Figure 1.12 of the Smith Ranch Renewal Technical Report (Cameco 2012b). The entire site is located in the Wind River Basin in Fremont and Natrona Counties, Wyoming. The main facility is located 104 km (65 mi) due west of the city of Casper, WY. The site can be accessed from State Highway 50, Van Buggenum Road, Christensen Road and an existing oil field road owned by T-Chair Ranch. The site covers approximately 3,400 ha (8,500 ac).

The Gas Hills site layout was provided by the licensee in Figures 1.11 and 1.12 of the Smith Ranch Renewal Technical Report (Cameco 2012b). The Gas Hills site was approved in 2004 as a satellite facility with five mine units and one satellite facility with ion exchange, groundwater restoration operations and two evaporation ponds. The Gas Hills remote satellite is in development status, the licensee has not commenced operations as of June 2018. The location of the approved main satellite facility is shown in Figure 1.11. However, in the license renewal, the licensee is requesting the addition of an alternate satellite facility with two possible locations as a shown in Technical Report Figure 1.12. The licensee is also requesting to include up to a total of six evaporation ponds and three DDWs for liquid byproduct material disposal as shown in Figures 1.11 and 1.12.

The Gas Hills site has a long history of uranium extraction by open pit and underground mining. The licensee reported that 14 historical open pits or underground mining operations were located within and adjacent to the Gas Hills remote satellite in Section 2.4.2, "Uses of Adjacent Lands and Waters," of the Smith Ranch Renewal Technical Report (Cameco 2012b). The abandoned open pit mines, underground mine workings and reclamation area features which have been remediated or remain at the site are shown in detail in Figures 1.11 and 1.12 of the Smith Ranch Renewal Technical Report and Plate D6-1 of Appendix D-6 of the WDEQ Smith Ranch Permit (Cameco 2012d). The Pathfinder Lucky Mc mine and open pit is located just north of the northern edge of MU-3 in the license area. The former UMETCO Minerals Corporation Gas Hills Project Facility is located on the border between Fremont and Natrona Counties, near proposed Mine 5. The UMETCO site includes the tailings disposal and heap leach areas of the old mine and mill. It covers approximately 777 ha (1920 ac). The site operated from 1960 to 1984 and was permanently shut down in 1987. The licensee reported that reclamation of the UMETCO site was completed in 2006.

The licensee reported there is one occupied residence, JE Ranch, within five miles of the Gas Hills license boundary in Section 3.1.8.1, “Local Land Use,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The location of these residence is shown in Figure 3.1.8, “Gas Hills Remote Satellite Ownership,” of the Environmental Report.

2.1.3.4 Ruth

The Ruth site was added to the Smith Ranch Highland license in August 2003 (NRC 2003b). The licensee described the site location and layout of the Ruth site located in John County, WY in Section 2.5.1, “Site Location and Layout,” and 3.2.4, “Ruth Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b).

The Ruth facility location was described by the licensee in Section 2.5.1, “Site Location and Layout,” of the Smith Ranch Renewal Technical Report (Cameco 2012b). The licensee provided a map of the location of the Ruth site in Figure 1.13, “Ruth Site Map.” The Ruth Site is located in the Powder River Basin in far southeast Johnson County, Wyoming. The site is approximately 83 km (52 mi) north of Casper and 21 km (13 mi) southwest of the North Butte facility. The site can be accessed from State Highway 387 down 6 km (4 mi) of gravel road at a turnoff located 27 km (17 mi) east of Edgerton at mile post 117. The site covers approximately 572 ha (1,414 ac).

The Ruth Site was originally licensed and operated as an ISR R&D facility (NRC 1981d). The Ruth R&D ISR facility had an ion exchange facility which was also used for groundwater restoration, two evaporation ponds for liquid byproduct material disposal and one mine unit. The Ruth R&D ISR began extraction in October 1981 and terminated operations in 1984. The groundwater was restored and the licensee reported that the wells in the R&D mine unit were plugged and abandoned (NRC 1990c).

The licensee later requested a license for commercial operation of the Ruth Site. The planned layout of the commercial Ruth Site was shown in Figure 3.2.2 of the 1990 Ruth and North Butte EA (NRC 1990c). It included a satellite facility with three mine units and two evaporation ponds. The licensee also stated it would seek an NPDES permit for surface water discharge of liquid waste in the 1990 EA (NRC 1990c). The site, however, was never developed. The licensee reported that the Ruth Site currently has a process building, generator building, and warehouse, two evaporation ponds, and three monitoring wells.

The licensee did not report the presence of any occupied residences within five miles of the Ruth Satellite license boundary in Section 3.1.8.1, “Local Land Use,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). However, Figure 3.4.8, “Ruth Surface Water & Groundwater Rights Location Map,” of the report did indicate a residence, noted as UT Ranch, 0.8 km (0.5 mi) to the southeast of the license boundary. The NRC staff examined an August 3, 2016, satellite photograph of this area using Google Earth and determined that no occupiable structure remains at this location (Google Earth 2018).

2.1.4 Evaluation Findings

The NRC staff has reviewed the site location and layout of the Smith Ranch, North Butte, Gas Hills and Ruth facilities in accordance with the review procedures in 2.1.2 and the acceptance criteria in SRP Section 2.1.3. The NRC staff finds that the licensee has described the site location and layout with appropriately scaled and labeled maps showing the site layout, principal facilities and structures, boundaries, and topography. Based upon the review conducted by

NRC staff as indicated above, the NRC staff concludes that the information provided in the application meets the applicable acceptance criteria of SRP Section 2.1.3 (NRC 2003a) and the requirements of 10 CFR 40.31(g)(2).

2.2 Meteorology

This section of the SER describes the NRC staff's evaluation of the licensee's meteorological monitoring program and specific meteorological data used to site environmental sampling stations and to estimate radiological public dose attributable to air effluents.

2.2.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the meteorological monitoring program, which is part of the site monitoring programs required by Criterion 7 of Appendix A to 10 CFR Part 40, is sufficient to site environmental sampling stations and to estimate radiological public dose attributable to air effluents.

2.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed to ensure that the facility will continue to operate so as to protect health and safety and the environment using the acceptance criteria presented in Section 2.5.3 of the SRP (NRC 2003a).

2.2.3 Staff Review and Analysis

The following sections present the NRC staff's review and analysis of various aspects of the meteorological monitoring at the Smith Ranch Highland Uranium Project. The NRC staff's evaluation included meteorological data acquisition, including data quality, and factors affecting atmospheric dispersion of radioactive material, including wind speed, wind direction, and stability class. Most of the regional and on-site meteorological data described in Section 3.6, "Meteorology, Climatology and Air Quality," of the Smith Ranch Renewal Environmental Report (Cameco 2012b), such as regional and on-site temperatures, relative humidity, and precipitation, are not used for safety-related facility design or operation. Therefore, the NRC staff did not evaluate this information. The information reviewed in this section is from information, data, and maps submitted by the licensee in its renewal application (Cameco 2012b).

Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities-Data Acquisition and Reporting," identifies the minimum amount of meteorological data needed for a siting evaluation (NRC 1988d). According to Regulatory Guide 3.63, applicants should collect data on a continuous basis for a consecutive 12-month period that is representative of long-term (e.g., 30 years) meteorological conditions in the site vicinity.

To verify if the period of record is representative of long-term meteorological conditions, the regulatory guide suggests comparing a concurrent period of meteorological data from a National Weather Service (NWS) station with the long-term meteorological data from that NWS station. The NWS station selected for this comparison should be in a similar geographical and topographical location and be within 80 km (50 mi) of the site.

2.2.3.1 Smith Ranch-Highland and Reynolds Ranch

In Section 3.6.2.1, “Site Specific Meteorological Information,” and Appendix B, “Smith Ranch Meteorological Analysis” of the Smith Ranch Renewal Environmental Report, the licensee provided a summary of onsite data collected at the Smith Ranch-Highland site from June 1, 2015 through May 31, 2017 (Cameco 2012b).

The licensee described the siting and instrumentation of its on-site meteorological tower in Appendix B, “Meteorological Siting Study,” to Appendix B, “Smith Ranch Meteorological Analysis,” of the Smith Ranch Renewal Environmental Report. The NRC staff evaluated this information to determine if the meteorological tower was sited in accordance with NRC staff regulatory positions in Regulatory Guide 3.63, “Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting” (NRC 1988d).

The licensee sited the meteorological tower at approximately the same elevation as the facility operation away from natural and man-made obstructions. Specifically, the tower was located approximately 400 m (0.25 mi) southeast of the CPP at an elevation of 1,711 m (5,614 ft). The data collected included, among other things, wind speed and wind direction at the 10 m (33 ft) elevation on the tower. The licensee determined atmospheric stability was determined using the variation in wind direction method. The NRC staff verified that the siting and instrument specifications, including instrument range, accuracy, and threshold, met the recommendations in Regulatory Positions C.2 and C.3 of Regulatory Guide 3.63. Though the licensee did not describe its actual data recovery rate for the two-year period of record, the licensee described its data acquisition, data quality assurance, and reporting requirements, which are consistent with Regulatory Position C.4 of Regulatory Guide 3.63. The NRC staff evaluated indirect indicators of acceptable data recovery rates. The NRC staff examined data presented by the licensee from its two-year period of record in multiple figures throughout Appendix B, “Smith Ranch Meteorological Analysis,” of the Smith Ranch Renewal Environmental Report (i.e., Figures 1 through 13). The NRC staff examined these figures and determined that there are no visible interruptions in meteorological data presented as trends over time. Any lengthy interruptions would have resulted in discontinuities or abrupt changes in data trends. The NRC staff therefore determined that Figures 1 through 13 indicate an acceptable data recovery rate for the two-year period of record.

In Section 4.0, “Long-term Representativeness of Baseline Monitoring Year,” of Appendix B, “Smith Ranch Meteorological Analysis,” of the Smith Ranch Renewal Environmental Report, the licensee provided the results of several statistical analyses that show the onsite meteorological station 2-year period of record for wind speed, wind direction, and atmospheric stability class was representative of long-term conditions (Cameco 2012b). The NRC staff examined these analyses of the 2-year and 14-year period of record from the Douglas airport, which included graphical comparisons of the two periods, and descriptions of the applicability and inapplicability of various statistical tests, including the chi-square test, the Student’s t-test, the Kolmogorov-Smirnov test, and linear correlation/regression analysis. The NRC staff determined that, taken together, these analyses support the licensee’s conclusion that the combination of visual evidence, summary statistics, linear correlation, and hypothesis testing provides a comprehensive demonstration that its June 1, 2015 through May 31, 2017 meteorological period of record is representative of long-term conditions.

2.2.3.2 North Butte

In Section 3.6.3.1, "Site Specific Meteorological Information," and Appendix C, "North Butte Remote Satellite Meteorological Analysis," of the Smith Ranch Renewal Environmental Report, the licensee provided a summary of onsite data collected at the North Butte site from December 21, 2010 through January 5, 2012 (i.e., about 380 days) (Cameco 2012b). The licensee collected wind direction, wind speed, and atmospheric stability data in accordance with the NRC staff's regulatory positions on data quality as described in Regulatory Guide 3.63, with a data recovery of 98 percent. Therefore, the NRC staff finds the length of the period of record (i.e., over 12 months) and types of data collected acceptable because they meet the recommendations in Regulatory Guide 3.63 (NRC 1988d).

The licensee determined the baseline period of data is representative by comparing a single calendar year 2011 (i.e., baseline) period of record with long-term data collected at the Antelope Coal Mine over a 25-year period of record from 1986 to 2012. The Antelope Coal Mine is located 58 km (36 mi) from the North Butte meteorological tower. The licensee provided wind roses for each period in Figure 2.5-27, "Antelope Mine 25-Year vs. Baseline Year Wind Roses" of the Smith Ranch Renewal Environmental Report. The licensee provided additional comparisons of the baseline calendar year 2011 data to the long-term period of record in Figures 2.5-28, "Antelope Mine 25-Year vs. Baseline Year Wind Speeds," and 2.5-29, "Antelope Mine 25-Year vs. Baseline Year Wind Directions." The licensee also provided regression analyses which indicate high correlation between the frequency distributions for short-term and long-term periods of record at the Antelope Mine: coefficient of determination (R^2) = 0.9766 for wind speed; and R^2 = 0.9533 for wind direction (Cameco 2012b).

The NRC staff evaluated the information provided by the licensee. Both wind roses in Environmental Report Figure 2.5-27 and the paired bars (i.e., short-term and long-term) in Environmental Report Figure 2.5-29 show a dominant wind direction from the west and west-southwest. The NRC staff observed other prevalent wind directions (e.g., with wind direction frequencies above the average value of about 6%) are indicated from the west-northwest to north directions and east-southeast. The NRC staff also examined the licensee's regression analysis of the frequency distributions for short-term and long-term wind directions at the Antelope Mine in Environmental Report Figure 2.5-31, "Antelope Mine 25-Year vs. Baseline Yr Wind Direction Distributions." In its wind direction regression analysis, the licensee calculated a slope of 0.7863, rather than a value closer to 1, that would be expected in a regression analysis of two similar frequency distributions. To study this further, the NRC staff independently performed regression analysis on the frequency data depicted in Environmental Report Figure 2.5-29 using Microsoft Excel (NRC 2018c). In its independent analysis, the NRC staff removed the two data pairs with the highest frequencies that appear to have affected the licensee's slope calculation—for the west and west-southwest wind direction frequencies. A regression of the remaining data (i.e., 14 of 16 compass sectors) indicates a slope of 1 and an R^2 = 0.9357. Based on this slope and high degree of correlation, the NRC staff determined only the west and west-southwest wind direction frequencies are anomalously higher in the baseline period as compared to the long-term period (e.g., a 13.3 percent frequency of winds blowing from the west-southwest in the 25-year period of period, as compared to 17.4 percent in the 2011 data). However, the short-term and marginally higher wind frequency from these directions in 2011, if it actually occurred at the North Butte facility, is not large enough to affect the placement of air samplers because these directions remain the dominant wind direction even if the frequencies of wind from these directions are actually lower over longer periods of time. Similarly, a small difference in wind direction frequency could have a small impact on the calculated dose of less than 0.01 mSv (1 mrem) to the individual likely to receive the highest dose, who is located about

1 km (0.6 mi) southeast of the facility at the Pfister Ranch. However, the NRC staff determined any difference would not be sufficient to raise the calculated dose above the limit in 10 CFR 20.1301. For this reason, the NRC staff determined that acceptance criterion 2.5.3(3) is met regarding meteorological data being representative of long-term conditions at and near the site.

2.2.3.3 Gas Hills

In Section 3.6.4, "Gas Hills Meteorology and Climatology," of the Smith Ranch Renewal Environmental Report, the licensee provided a summary of onsite data collected at the Gas Hills site from December 8, 2010 through January 27, 2012 (Cameco 2012b). The licensee collected wind direction, wind speed, and atmospheric stability data in accordance with the NRC staff's regulatory positions on data quality as described in Regulatory Guide 3.63, with a data recovery of greater than 99 percent. Therefore, the NRC staff finds the length of the period of record (i.e., over 12 months) and types of data collected acceptable because they meet the recommendations in Regulatory Guide 3.63 (NRC 1988d).

The licensee determined the baseline period of data is representative by comparing short-term and long-term data collected at the Riverton airport, located 80 kilometers (50 miles) from the Gas Hills meteorological tower. The licensee provided wind roses for each period in Figure 2.5-29, "Riverton 15-year vs Baseline Year Wind Roses" of Appendix D, "Gas Hills Remove Satellite Meteorological Analysis," of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The licensee provided additional comparisons of the baseline calendar year 2011 data to the long-term period of record in Environmental Report Figures 2.5-30, "Riverton 15-Year vs Baseline Year Wind Speeds," and 2.5-31, "Riverton 15-Year vs Baseline Year Wind Directions." The licensee also provided regression analyses which indicate high correlation between the frequency distributions for short-term and long-term periods of record at the Antelope Mine: coefficient of determination (R^2) = 0.9465 for wind speed; and R^2 = 0.9394 for wind direction. The licensee provided the same analyses using data from 2004 to 2011 collected at the Casper airport, which is located 93 km (58 mi) east of the site.

The NRC staff examined these analyses of the 1-year and 15-year period of record from the Riverton airport, which included graphical comparisons of the two periods, and descriptions of the applicability and inapplicability of various statistical tests, including the chi-square test, the Student's t-test, the Kolmogorov-Smirnov test, and linear correlation/regression analysis. The NRC staff determined that, taken together, these analyses support the licensee's conclusion the combination of visual evidence, summary statistics, linear correlation, and hypothesis testing provides a comprehensive demonstration that its December 8, 2010 through January 27, 2012 meteorological period of record is representative of long-term conditions.

2.2.3.4 Ruth

In Section 3.6.5.1, "Site Specific Meteorological Information" of the Smith Ranch Renewal Environmental Report, the licensee explained that there is no meteorological station in operation at the Ruth Remote Satellite (Cameco 2012b). The licensee committed to installing an on-site meteorological station when development at the site commences, and collecting and assessing at least 12 months of climatological data. The NRC staff finds this commitment acceptable because the licensee has demonstrated an acceptable method of collecting meteorological data at its other licensed areas.

2.2.4 Evaluation Findings

The NRC staff reviewed the monitoring of meteorological conditions at the Smith Ranch Highland Uranium Project in accordance with the SRP. The licensee either provided wind direction, wind speed, and atmospheric stability class consistent with Regulatory Guide 3.63 for each site, including remote satellites or provided appropriate commitments to collect this data prior to operations (i.e., Ruth Remote Satellite).

Based upon the review conducted by the NRC staff as indicated above, the information provided in the application meets the applicable acceptance criteria of Section 2.5.3 of the SRP and the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.3 Geology and Seismology

2.3.1 Regulatory Requirements

The purpose of this section is for the NRC staff to determine if the licensee provided sufficient characterization of geology and seismology at the Smith Ranch Highland Uranium Project for NRC staff to be able to analyze the licensee's ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the licensee's characterization of geology and seismology at the Smith Ranch Highland Uranium Project was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 2.6.3 of the SRP (NRC 2003a).

2.3.3 Staff Review and Analysis

The following sections present the NRC staff's review and analysis of various aspects of the geology and seismology at the Smith Ranch Highland Uranium Project. The aspects reviewed in the following sections include: regional geology, site geology, seismology and soils. Unless otherwise stated, the information reviewed in the following sections include regional geology, site geology, stratigraphy, lithology, exploration boreholes, seismology and soils. The information reviewed in this section is from information, data, and maps submitted by the licensee in their Smith Ranch Renewal Technical Report (Cameco 2012b). NRC staff also visited the site on several occasions during the course of this review.

2.3.3.1 Regional and Site Geology

2.3.3.1.1 Smith Ranch Highland

The licensee provided the characterization of the regional and Smith Ranch Highland site geology in Section 2.2.6, "Geology and Seismology," of the Smith Ranch Renewal Technical Report (Cameco 2012b). A full description with updates was presented in Appendix D-5 of the WDEQ Smith Ranch Permit (Cameco Resources, 2012d) and in Section 3.3.2.1, "Smith Ranch Geology," of the Smith Ranch Renewal Environmental Report (Cameco 2012b).

The licensee reported the Smith Ranch-Highland facility and adjoining Reynolds Ranch satellite are located in the Powder River Basin of Wyoming. The facility lies to the west of the Powder River Basin axis, which trends to the northwest-southeast along the western margin of the basin. No major faults or folds have been found within the bedrock. No new interpretation of the regional geology was presented by the licensee since the last license renewal (NRC, 2001a). The NRC staff review has found there is no new information to invalidate the previous characterization of the Smith Ranch Highland site regional geology since the last safety evaluation (NRC, 2001a and NRC, 2007a); therefore, the original findings stand and previous NRC staff conclusions that the licensee acceptably described the regional geology near the Smith Ranch Highland license area remain valid.

The licensee stated that the uranium deposits of interest at the Smith Ranch Highland site are located within the upper Fort Union and lower Wasatch formation. At the Smith Ranch and Reynolds Ranch, the individual sandstones in these formations have been and continue to be labeled from depth to the surface as the K, M, O, S, Q and W sands which are separated by shale layers of variable thickness. At Highland, the sandstones have been and continue to be labeled as the 0, 10, 20, 30, 40, 50, 60, 70, 80 up to 120 sands. The sandstones at the Smith Ranch site were correlated to those at the Highland Site as shown in Figure 3.3.1 of the Smith Ranch Renewal Environmental Report (Cameco 2012b).

The licensee provided an updated site geology section in Appendix D-5 of the WDEQ Smith Ranch Permit (Cameco Resources 2012d) and Section 3.3.2.1.2, “Smith Ranch Ore Zone Geology,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The licensee included updates to the abandoned borehole tables and cross sections for the Smith Ranch, Highland and Reynolds Ranch sites. The licensee also provided a cross section across all three sites in Environmental Report Addendums D-5 A2 and D-5 B2 and in Environmental Report Figure D5-3.4 of Appendix D-5. Figure D5-3.4 of the Environmental Report shows the correlation between the sand names and indicated which sands have or will be mined at each location.

The licensee also updated the site conceptual geological model for the Smith Ranch Highland site in Section 3.3.2.1.3, “Smith Ranch Update to the Site Conceptual Geologic Model,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). This update was based on the drill logs and geologic data obtained from the mine unit hydrologic data packages developed at the Smith Ranch Highland site since the last license renewal (NRC 2001a). The updated stratigraphy presented by the licensee for the site conceptual geological model is shown in SER Table 6~~Table 6~~ using the Smith Ranch site sand/shale nomenclature.

At Smith Ranch, the O, Q, M, and K sands are targeted for uranium recovery. At Highland, the 20-60 sands contain the mineralization which has been or will be targeted. At the Reynolds Ranch Satellite, the U/S and O sands are targeted. The licensee did not identify any new formations to be targeted for uranium extraction in the license renewal.

NRC staff, however, identified that the licensee had proposed new MUs 8, 12 13, 16, 17 at Smith Ranch and MUs H ext, I ext and M at Highland, in Figure 4-1 of Appendix E in the Cumulative Hydrologic Impact Analysis Report in the Smith Ranch Renewal Environmental Report (Cameco 2012b). These mine units were not previously reviewed or approved by NRC. The licensee gave a description of each of these mine units in Table 3-1.1 in the Smith Ranch Renewal Technical Report (Cameco 2012b). Specifically, Technical Report Table 3-1.1 provided the location of each of these proposed mine units and the targeted ores sands which are expected to be developed over the license renewal ten year period for the Smith Ranch

Highland site. SER Table 6~~Table 6~~ displays the sands to be targeted in these proposed mine units as reported in Technical Report Table 3-1.1.

Table 6. Smith Ranch Highland Site Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description	Proposed MU*
G sand		Wasatch sandstone (not targeted)	NA
F shale		Confining layer	NA
E sand		Wasatch sandstone (not targeted)	NA
School Coal Seam	0-6.1 (0-20)	Marker bed between Wasatch and Fort Union Formations	NA
W sand	0-25.9 (0-85)	Fort Union sandstone (not targeted)	NA
V shale	6.1-21.3 (20-70)	Confining layer	NA
U sand	0-21.3 (0-70)	Fort Union ore zone sandstone (discontinuous)	NA
T shale	0-45.7 (0-150)	Confining layer	NA
S sand	0-21.3 (0-70)	Fort Union ore zone sandstone (discontinuous)	NA
R shale	0-30.5 (0-100)	Confining layer	NA
Q sand	0-24.4 (0-80)	Fort Union ore zone sandstone (discontinuous)	NA
P shale	3-30.5 (10-100)	Confining layer	NA
O sand (20-80 sands)	12.2-91.4 (40 -300)	Fort Union ore zone sandstone (four distinct members separated by interbedded discontinuous shales)	Smith Ranch MUs 8, 12 13, 16 Highland MU- H ext (60 sand), MU- I ext (30/40 sand) and MU- M (50 sand)
N shale	1.5-33.5 (5-110)	Confining layer	NA
M sand	0-30.5 (0-100)	Fort Union ore zone sandstone (discontinuous)	Smith Ranch MU-17
L shale	3-27.4 (10-90)	Confining layer	NA
K sand	22.9-41.4 (75-135)	Fort Union ore zone sandstone (upper and lower units)	NA
J shale	2.4-45.7 (8-150)	Confining layer	NA
*Not previously evaluated mine units described in Table 3-1.1 of Smith Ranch Renewal Technical Report (Cameco 2012b)			

The NRC staff's review of the Smith Ranch Highland site geology included examination of updates to the isopachs, cross sections and structural contours in the vicinity of the license area

since the last license renewal. NRC staff also reviewed the stratigraphy of the proposed mine units. The NRC staff did not detect any significant changes with respect to the characterization of the site geology. Staff review has found nothing to invalidate previous characterization of the Smith Ranch Highland site geology since the last safety evaluation; therefore, the original findings stand and previous NRC staff conclusions that the licensee acceptably described the regional geology near the Smith Ranch Highland license area remain valid.

2.3.3.1.2 North Butte Satellite

The licensee provided the characterization of the site geology for the North Butte Satellite in Section 2.3.6, "Geology and Seismology," of the Smith Ranch Highland Renewal Technical Report (Cameco Resources 2012b) and in Section 3.3.2.2, "North Butte Geology," of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The site geology was updated in 2011 as presented in Appendix D-5 of the WDEQ North Butte Permit (Cameco Resources, 2012e). The isopach maps for the license area were updated in 2011 and provided in Plates D5-1.2 through D5-1.10 in Appendix D-5 of the North Butte WDEQ Permit (Cameco Resources, 2012e).

The North Butte remote satellite is also located in the Powder River Basin of Wyoming about 80 km (50 mi) north of the Smith Ranch facility. The facility lies to the east of the Powder River Basin axis, which trends to the northwest-southeast along the western margin of the basin. The facility is underlain by the Wasatch and Fort Union formations. No new interpretation of the regional geology was identified by the licensee since the last license renewal. The NRC staff's review has found there is no new information to invalidate the previous characterization of the North Butte site regional geology since the last safety evaluation; therefore, the original findings stand and previous NRC staff conclusions remain valid.

The licensee provided the updated stratigraphy in a site conceptual geological model based on the drill logs and geologic data obtained since the last safety evaluation (NRC 1990a and NRC 1990b). The updated stratigraphy is shown in SER Table 7~~Table 7~~ using the North Butte site sand/shale nomenclature. As shown in the table, the uranium deposits of interest lie within the Wasatch formation in the C, B, and A sands. These sands are separated by discontinuous confining layers and are often combined as one unit. The F-C shale acts as the overlying continuous confining layer. The A-1 shale acts as the underlying continuous confining layer. The licensee did not identify any new formations to be targeted for uranium extraction since the last safety evaluation (NRC 1990a and NRC 1990b).

The licensee reported that the F sand, which is the overlying aquifer to the A, B, and C ore sands, thins out and disappears in the north central portion of the permit area as shown on Environmental Report Plate D5-1.2 and cross section F-F. The licensee reported that the confining layer below the F sand, identified as the F-C shale, is continuous across the license area. It is shown as not less than 15 m (50 ft) in thickness on the isopach. The first ore sands, C and B, below this aquitard are continuous and often coalesce into one unit. The B-A shale, between these ore sands and the C ore sand, has been reinterpreted as continuous across the site and does not thin to less than 3 m (10 ft) on isopach. Therefore, based on updated drilling, the licensee determined that no direct contact exists between the A and B sands as previously reported. The licensee observed that the A sand is continuous across the site and may split into two members.

Table 7. North Butte Site Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description
F sand	0-30.5 (0-100)	Wasatch sandstone
F-C shale	15.2-54.9 (50-180)	Confining layer
C sand	0-39.6 (0-130)	Wasatch ore zone sandstone
C-B shale	0-18.3 (0-60)	Confining layer
B sand	15.2-48.8 (50-160)	Wasatch ore zone sandstone
B-A shale	3-30.5 (10-100)	Confining layer
A sand	6.1-45.7 (20-150)	Wasatch ore zone sandstone
A-1 Shale	21.3-42.7 (70-140)	Confining layer
1 sand	0-12.2 (0-40)	Wasatch sandstone

The licensee reported that the underlying confining layer to the A sand is known as the A-1 shale. The thickness of the A-1 shale had previously been reported as 30 to 84 m (99 to 275 ft) thick, however, the new interpretation describes the shale as continuous with a thickness as 21.3 to 42.7 m (70 to 140 ft). The underlying 1 sand is now reported to be 0 to 12.2 m (0 to 40 ft) thick instead of 0 to 21 m (0 to 68 ft). It is suspected to pinch out on the southeast side of the license area. The licensee stated that during development of the North Butte license area, more borings will penetrate the A-1 aquitard and 1 sand to allow a better interpretation of their thickness.

The NRC Staff review has found there is no new information to invalidate the previous characterization of the North Butte site geology since the last safety evaluation (NRC 1990a and NRC 1990b); therefore, the original findings stand and previous NRC staff conclusions that the licensee had adequately described the regional geology near North Butte remain valid.

2.3.3.1.3 Gas Hills Satellite

The licensee provided the characterization of the site geology for the Gas Hills Satellite in Section 2.4.6, “Geology and Seismology,” of the Smith Ranch Renewal Technical Report (Cameco 2012b) and in Section 3.3.2.3, “Gas Hills Geology,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The site geology was updated in 2011 and was presented in Cross sections A-A’ through O-O’ in Appendix D5 of the WDEQ Gas Hills Permit (Cameco Resources, 2012f). The isopach maps for the license area were updated in 2011 and provided in Plates D5-1.2 through D5-1.10 in Appendix D5 of the Gas Hills WDEQ Permit (Cameco Resources, 2012f).

The licensee reported that the Gas Hills satellite is also located along the south-central flank of the Wind River Basin of Wyoming about 151 km (94 mi) west of the Smith Ranch facility. It is

bounded to the south by the Beaver Divide. The site is underlain by the Quatenary Alluvium, Micoene Split Rock, Oligocene White River, Eocene Wagon Bed and Eocene Wind River formations. No new interpretation of the regional geology was provided by the licensee since the last license renewal. The NRC staff's review has found there is no new information to invalidate the previous characterization of the Gas Hills site regional geology since the last safety evaluation (NRC, 2004b); therefore, the original findings stand and previous NRC staff conclusions remain valid.

The licensee provided a detailed plan view and cross section of the site geology of the Gas Hills Satellite in Plate D5-1 of Appendix D5 of the WDEQ Gas Hills Permit (Cameco Resources, 2012f). The licensee reported uranium deposits of interest at the Gas Hills site lie within the Wind River formation in the 30 through 80 sands. The licensee indicated, however, that stratigraphic interpretation at the Gas Hills satellite is complicated by extensive intermingling of the strata and post–depositional faulting. Given the complexity of the site, the licensee provided a site geologic characterization that focused on the individual delineation and description of the five currently licensed mine units.

The licensee provided the stratigraphy for mine unit 1 as shown in is shown in SER Table 8~~Table 8~~ using the Gas Hills site sand/shale nomenclature. The targeted ore zone in mine unit 1 is located in the 70 sand which is continuous across the mine unit. The overlying sand is the 80 sand and the underlying sand is the 50 sand as the 60 sand is missing. The overlying units are separated by confining layers of shales, claystones and siltstones at least 3 m (10 ft) thick. The license stated there are no known traceable faults within mine unit 1.

Table 8. Gas Hills Mine Unit 1 (Muskrat Deposit) Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description
Sand	NR	Discontinuous Wind River sandstones
Shale	16.8-45.7 (55-150)	Confining layer
70 sand	6.1-24.4 (20-80)	Wind River ore zone sandstone
Shale	6.1-15.2 (20-50)	Confining layer
50 sand	0-21.3 (0-70)	Wind River sandstone

The licensee provided the stratigraphy for mine unit 2 as shown in SER Table 9~~Table 9~~ using the Gas Hills site sand/shale nomenclature. The targeted ore zones in mine unit 2 are located in the 40 through 80 sand which are discontinuous across the mine unit. They are separated by shale layer at least 1.5 m (5 ft) thick. The overlying sands to the 80 sand are discontinuous and there is no underlying sand to the 40 sand. The overlying units are separated by confining layers of shales, claystones and siltstones at least 22.9 m (75 ft) thick. The licensee reported are two traceable faults within mine unit 2, the Bountiful Fault and UPZ fault. The Bountiful Fault has 12.2 to 15.2 m (40 to 50 ft) of displacement. The UPZ fault has 15.2 m (50 ft) of displacement and is known to be transmissive. The licensee plans further drilling to characterize the geologic structure in mine unit 5.

Table 9. Gas Hills Mine Unit 2 (Bountiful Deposit) Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description
90 sand	NR	Wind River sandstone
Shale	22.9-122 (75-400)	Confining layer
80 sand	0-30.5 (0-100)	Wind River ore zone sandstone
Shale	1.5-6.1 (5-20)	Confining
70 sand	0-30.5 (0-100)	Wind River ore zone sandstone
Shale	1.5-6.1 (5-20)	Confining layer
60 sand	0-30.5 (0-100)	Wind River ore zone sandstone
Shale	1.5-6.1 (5-20)	Confining layer
50 sand	0-30.5 (0-100)	Wind River ore zone sandstone
Shale	1.5-6.1 (5-20)	Confining layer
40 sand	0-24.4 (0-80)	Wind River ore zone sandstone
Shales	>91.4 (>300)	Confining layers of shales and siltstones of Triassic Chugwater formation

The licensee provided the stratigraphy for mine unit 3 as shown in SER Table 10~~Table 10~~ using the Gas Hills site sand/shale nomenclature. The targeted ore zones in mine unit 3 are located in the 30 through 50 sands which are discontinuous across the mine unit. They are separated by shale layers up to 9.1 m (30 ft) thick. The overlying sands is the 60 sand that is separated by at least 1.5 m (5 ft) of shale. There is no underlying sand to the 30 sand which is underlain by at least 91.4 m (300 ft) of shale. The licensee reported are three traceable faults within mine unit 3, the PCH Fault, Jasper Fault and Lucky Mc Fault. The displacement of these faults has not been determined by the licensee. The licensee plans further drilling to characterize the geologic structure in mine unit 3.

The licensee provided the stratigraphy for mine unit 4 as shown in SER Table 11~~Table 11~~ using the Gas Hills site sand/shale nomenclature. The targeted ore zones in mine unit 4 are located in the 30 through 50 sands which are discontinuous across the mine unit. They are separated by shale layers up to 9.1 m (30 ft) thick. The overlying sand is the 60 sand that is separated by at least 1.5 m (5 ft) of shale. There is no underlying sand to the 30 sand which is underlain by at least 91.4 m (300 ft) of shale. The licensee reported one traceable fault within mine unit 4, the Buss Fault with 15.2 m (50 ft) of displacement. The licensee plans further drilling to characterize the geologic structure in mine unit 4.

Table 10. Gas Hills Mine Unit-3 (Peach Deposit) Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description
60 sand	0-30.5 (0-100)	Wind River sandstone
Shale	1.5-12.2 (5-40)	Confining layer
50 sand	0-15.2 (0-50)	Wind River ore zone sandstone
Shale	0-9.1 (0-30)	Confining layer
40 sand	0-15.2 (0-50)	Wind River ore zone sandstone
Shale	0-9.1 (0-30)	Confining layer
30 sand	0-15.2 (0-50)	Wind River ore zone sandstone
Shales	>91.4 (>300)	Confining layers of shales ,claystones and mudstones of Wind River, Thermopolis, Morrison and Frontier formations

The licensee provided the stratigraphy for mine unit 5 as shown in SER Table 12~~Table 12~~ using the Gas Hills site sand/shale nomenclature. The targeted ore zones in mine unit 5 are located in the 50 sand. They are separated by shale layers up to 9.1 m (30 ft) thick. The overlying 60 sand may interfinger with the 50 sand and be treated as one unit. The underlying shale is at least 6.1 m (20 ft) thick. It separates the 50 sand from the underlying East Canyon Conglomerate sand. The licensee reported one set of traceable parallel faults within mine unit 5, known as the North and South Thunderbird Faults. These faults bound the Thunderbird Graben within mine unit 5. The graben is downthrown by 45.7 m (150 ft). The licensee plans further drilling to characterize the geologic structure in mine unit 5.

NRC staff previously concluded that the Gas Hills site geology was acceptably described (NRC, 2004b). NRC staff review has found nothing to invalidate the previous characterization of the mine unit 1 geology; therefore, the original findings stand and previous NRC staff conclusions remain valid. However, NRC staff review finds that the licensee has not characterized the geologic structure with respect to the faults in mine units 2, 3, 4 and 5. The licensee plans further drilling to characterize the geologic structure in these mine units, which will be provided in the mine unit data packages as described in SER Section 2.4.3.2.3. The NRC staff will therefore require a license condition, as described in SER Section 2.4.3.2.3, that the licensee submit all mine unit hydrologic testing documents for review and verification.

Table 11. Gas Hills Mine Unit 4 (Buss Deposit) Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description
Sands	NR	Discontinuous Wind River sandstones
Shale	3-30.5 (10-100)	Overlying confining layer south of Buss Fault
90 sand	9.1-30.5 (30-100)	Wind River ore zone sandstone -top sand south of Buss Fault
Shale	3-12.2 (10-40)	Overlying confining layer north of Buss Fault
80 sand	9.1-30.5 (30-100)	Wind River ore zone sandstone –top sand north of Buss Fault
Shale	0-4.6 (0-15)	Confining layer
70 sand	9.1-30.5 (30-100)	Wind River ore zone sandstone
Shale	3-6.1 (10-20)	Confining layer
60 sand	9.1-30.5 (30-100)	Wind River ore zone sandstone
Shale	0-4.6 (0-15)	Confining layer
50 sand	9.1-30.5 (30-100)	Wind River ore zone sandstone
Shale	1.5-9.1 (5-30)	Underlying confining layer
Unamed sand	NR	East Canyon Conglomerate sandstone

Table 12. Gas Hills Mine Unit 5 (Pix Deposit) Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description
Sand	NR	Discontinuous Wind River sandstones
Shale	16.8-45.7 (55-150)	Confining layer
60 sand	6.1-24.4 (20-80)	Wind River ore sandstone
Shale	4.6-12.2 (15-40)	Confining layer
50 sand	15.2-21.3 (50-70)	Wind River ore zone sandstone
Shale	6.1-12.2 (20-40)	Confining layer
Unamed Sand	NR	East Canyon Conglomerate sandstone

2.3.3.1.4 Ruth Satellite

The characterization of site geology for the Ruth Satellite was presented in the application in Section 2.5.6, “Geology and Seismology,” of the Smith Ranch Renewal Technical Report and in Section 3.3.2.4, “Ruth Geology,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b).

The Ruth Satellite is located in the Powder River Basin of Wyoming about 22.5 km (14 mi) NNW of the Smith Ranch facility. The facility lies to the east of the Powder River Basin axis, which trends to the northwest-southeast along the western margin of the basin. The facility is underlain by the Wasatch and Ft. Union formations. No new interpretation of the regional geology was identified by the licensee since the last safety evaluation report (NRC 1990b). The NRC staff review has found there is no new information to invalidate the previous characterization of the Ruth site regional geology since the last safety evaluation; therefore, the original findings stand and previous NRC staff conclusions remain valid.

The licensee described the Ruth Site stratigraphy as shown in SER Table 13~~Table 13~~ using the sand/shale nomenclature similar to the North Butte site. The licensee stated that the uranium deposits of interest lie within the Wasatch formation in the A sand. The A sand is continuous across the site and contains discontinuous sandy shale stringers. The B-A shale acts as the overlying continuous confining layer and the B sand is the overlying sandstone unit. The A-1 shale acts as the underlying continuous confining layer and the 1 sand is the underlying sandstone unit. The licensee stated that there is no evidence of faulting or folding at the Ruth remote satellite based on field observations or drill hole correlations. The licensee did not identify any new formations to be targeted for uranium extraction since the last safety evaluation report.

Table 13. Ruth Remote Satellite Site Stratigraphy

Layer (Shallow to Deep)	Approximate Thickness in m (ft)	Description
B sand	NR	Wasatch overlying sandstone
B-A shale	9.1 (30)	Confining layer
A sand	15.2 (50)	Wasatch ore zone sandstone
A-1 Shale	9.1 (30)	Confining layer
1 sand	NR	Wasatch underlying sandstone

The NRC staff review has found there is no new information to invalidate the previous characterization of the Ruth site geology since the last safety evaluation; therefore, the original findings stand and previous NRC staff conclusions that the licensee has acceptably described the regional geology near the Ruth remote satellite remain valid.

2.3.3.2 Seismology

2.3.3.2.1 Smith Ranch Highland

The licensee characterized the seismology within and around the Smith Ranch Highland, site in Section 2.2.6, “Geology and Seismology,” of the Smith Ranch Renewal Technical Report and Section 3.3.3.1, “Regional Geology,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The licensee updated the area seismology by reporting recent seismic events in relation to the historical seismicity for the Converse, Campbell, Natrona and Johnson Counties as documented by USGS.

The licensee reported that only one significant earthquake with of magnitude 3.7 was reported in 26 km (16 mi) north–northeast of Casper since the last Smith Ranch Renewal (NRC 2001a). This magnitude of earthquake did not present any deviation from the seismic history of the area. The licensee reported that no exposed active faults with a surficial expression are present or have been identified since the last safety review, near or within the license areas, so no fault specific analysis can be conducted.

The NRC staff review has found there is no new information to invalidate the previous characterization of the Smith Ranch Highland site seismology since the last safety evaluation. Therefore, the original findings stand and previous NRC staff conclusions that the licensee acceptably described seismology near Smith Ranch Highland remain valid.

2.3.3.2.2 North Butte

The licensee characterized the seismology within and around the North Butte remote satellite in Section 2.3.6, “Geology and Seismology,” of the Smith Ranch Renewal Technical Report and Section 3.3.3.1, “Regional Geology,” of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee updated the area seismology by reporting recent seismic events in relation to the historical seismicity for the Converse, Campbell, Natrona and Johnson Counties as documented by USGS.

The licensee reported that no new earthquakes greater that magnitude 2.5 were reported for Campbell County where the North Butte remote satelite is located since North Butte was added to license SUA-1548 (NRC 2003b). The license reported that no exposed active faults with a surficial expression are present or have been identified sine the last safety review, near or within the license areas, so no fault specific analysis can be conducted.

The NRC staff review has found there is no new information to invalidate the previous characterization of the North Butte remote satellite seismology since North Butte was added to license SUA-1548; therefore, the original findings stand and previous NRC staff conclusions (NRC, 1990b and NRC 1990c) that the licensee acceptably described seismology near the North Butte remote satellite remain valid.

2.3.3.2.3 Gas Hills

The licensee characterized the seismology within and around the Smith Ranch Highland, North Butte, Gas Hills and Ruth satellites in Section 2.4.6, “Geology and Seismology,” of the Smith Ranch Renewal Technical Report and Section 3.3.3.2, “Gas Hills,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The licensee updated the area seismology by reporting

recent seismic events in relation to the historical seismicity for the surrounding areas identified as Atlantic City, Lander and Sand Draw/Gas Hills as documented by USGS.

The licensee indicated that no new earthquakes greater that magnitude 2.5 were reported in Atlantic City, Lander and Sand Draw/Gas Hills areas or Natrona County where the Gas Hills remote satellite is located since the last license amendment (NRC 2004b).

The license reported there are three exposed active faults in the vicinity of the Wind River Basin and the Gas Hills Remote Satellite. Of these faults, the licensee evaluated the Green Mountain Segment of the South Granite Mountain Fault System. The licensee stated it analyzed this fault because it is the only one that could be expected to produce a maximum credible earthquake in the Gas Hills license area. The licensee reported that the expected horizontal acceleration at the Gas Hills site would be about 0.06g (where g is the acceleration due to gravity) for a magnitude 6.75 earthquake at the closet segment of this fault, located 45.1 km (28 mi) from the Gas Hills Satellite. For reference, if an earthquake of this magnitude were placed within 15 km (9.32 mi) of any structure, it would be estimated to create an acceleration of 15 percent of gravity (0.15 g), which is a Level VI earthquake on the Mercalli Scale, and would be expected to create light to moderate damage.

The NRC staff review has found there is no new information to invalidate the previous characterization of the Gas Hills site seismology since the last safety evaluation; therefore, the original findings stand and previous NRC staff conclusions (NRC, 2004b) that the licensee acceptably described seismology near the Gas Hills remote satellite remain valid.

2.3.3.2.4 Ruth

The licensee characterized the seismology within and around the Smith Ranch Highland, North Butte, Gas Hills and Ruth satellites in Section 2.5.6, “Geology and Seismology,” of the Smith Ranch Renewal Technical Report and Section 3.3.3.1, “Smith Ranch, North Butte Remote Satellite, Ruth Remote Satellite,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b). The licensee characterized the area seismology using an analysis of the available literature and record of historical seismicity for the Converse, Campbell, Natrona and Johnson Counties as documented by USGS.

The licensee indicated that no new earthquakes greater that magnitude 2.5 were reported in Johnson County where the Ruth remote satellite is located since the Ruth remote satellite was added to license SUA-1548 (NRC 2003b). The license reported that no exposed active faults with a surficial expression have been identified, near or within the Ruth license area, so no fault specific analysis can be conducted.

The NRC staff review has found there is no new information to invalidate the previous characterization of the Ruth remote satellite seismology since it was added to license SUA-1548; therefore, the original findings stand and previous NRC staff conclusions (NRC, 1990b, and NRC, 1990c) that the licensee acceptably described seismology near the Ruth remote satellite remain valid.

2.3.3.3 Soils

The licensee provided a description of the soils for the Smith Ranch Highland, North Butte, Gas Hills and Ruth remote satellites in Section 3.3.4, “Soils,” of the Smith Ranch Renewal Environmental Report (Cameco 2012b).

The NRC staff previously concluded that the licensee adequately described major soil types in the license area and showed their areal extent on a soil maps in the last renewal for Smith Ranch Highland (NRC 2001a), and in the the initial licensing decisions for North Butte (NRC 1990b), Gas Hills (NRC 2004b) and Ruth (NRC 1990b) remote satellite license areas. The licensee provided no updates on the characterization of soils for any of the license areas in the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b).

The licensee, however, did state the total existing soil disturbance for the Smith Ranch Highland license area was approximately 591 ha (1460 ac) in the 2017-2018 financial assurance estimate update (Cameco Resources 2017b). The licensee also stated that 10.5 ha (26 ac) of soil at the Smith Ranch Highland license area had been impacted by spills from pipeline and header house leaks. The licensee also reported the total existing soil disturbance for the North Butte, remote satellite is approximately 56.7 ha (140 ac) in the 2018 financial assurance update for North Butte (Cameco Resources, 2018a).

The NRC staff review has found there is no new information to invalidate the previous characterization of the soils in the prior safety evaluations; therefore, the original findings stand and previous NRC staff conclusions that soils have been acceptably described remain valid. The NRC staff also finds the level of soil disturbance is in agreement with that originally expected for the sites. In addition, the licensee is recording the area of spills for later soil reclamation as required in the licensee commitments at the time of decommissioning.

2.3.4 Evaluation Findings

The NRC staff evaluated the licensee's site characterization information addressing geology, seismology, and soils at the Smith Ranch Highland, North Butte, Gas Hills and Ruth remote satellites in accordance in accordance with the review procedures in SRP Section 2.6.2 and the acceptance criteria in SRP Section 2.6.3.

NRC staff finds the licensee has acceptably characterized the geology seismology and soils at the Smith Ranch Highland, as well as the North Butte, Gas Hills and Ruth remote satellites in accordance with Section 2.6.3 of the SRP with one exception, by providing, as needed: (1) an updated description of the local and regional geologic structure; (2) an updated description of the local and regional stratigraphy; (3) updated geologic cross sections and isopach maps at acceptable scales showing surface and subsurface features and locations of all wells and logs used in defining site stratigraphy; (4) an updated discussion of the seismic history and hazard of the region; and (5) an updated description of the soil disturbance.

The NRC staff review, however, finds that the licensee has not characterized the geologic structure at the Gas Hills site with respect to the faults in mine units 2, 3, 4 and 5. The licensee plans further drilling to characterize the geologic structure in these mine units, which will be provided in the mine unit hydrologic testing documents as described in SER Section 2.4.3.2.3. The NRC staff will therefore require a license condition, as described in SER Section 2.4.3.2.3, that the licensee submitall of all of the mine unit hydrologic testing documents for Gas Hills for review and verification.

Based on the information provided in the license renewal application and the detailed review of updated characterization of the geology, seismology, and soils at the Smith Ranch Highland ISR facility and satellites, NRC staff concludes that the licensee's characterization of geology,

seismology, and soils is in compliance with 10 CFR 40.31b, which requires sufficient data to aid the NRC staff in its conduct of an independent analysis for license renewal.

2.4 Hydrology

2.4.1 Regulatory Requirements

The purpose of this section is to determine if the licensee has adequately demonstrated that the characterization of surface and groundwater hydrology at the Smith Ranch Highland Uranium Project is sufficient to support an analysis of the licensee's ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 2.7.3 of the SRP (NRC 2003a).

2.4.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the surface water and groundwater hydrology at the Smith Ranch Highland Uranium Project. The aspects reviewed in the following sections include surface water and surface water rights; and groundwater and groundwater rights. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in their Smith Ranch Renewal Technical Report (Cameco Resources 2012b). NRC staff also visited the site on several occasions during the course of this review.

2.4.3.1 Surface Water Hydrology

2.4.3.1.1 Smith Ranch Highland

The licensee provided a description of the surface water hydrology in Section 2.2.7, "Hydrology," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.2.1, "Surface Water," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided additional description of the surface water hydrology in Appendix D-6 of the WDEQ Smith Ranch mine permit which was revised in April 2011 (Cameco Resources, 2012d).

In the Smith Ranch Highland license area, the licensee did not have any updates to the description of the watersheds or drainages which were shown in Figure D6-1 and Plate D6-4 of Appendix D-6 of the WDEQ Smith Ranch mine permit application (Cameco Resources, 2012d). The licensee stated that all streams and drainages were described as ephemeral and flow only in response to snowmelt and heavy rainfall events. The licensee also stated that the stock ponds constructed in ephemeral streams are used for livestock but are dry most of the time.

The licensee updated the surface water rights for the Smith Ranch Highland permit through February 2012 in Table 3.4-3 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The location of the surface water rights are shown in Figure 3.4.1 of the Environmental Report. The licensee stated the majority of surface water rights are limited to small stock ponds and associated ditches. Five new surface water rights had been granted in

2005, but only one, P17548.OS, for stock water, was located within 2 km (1.2 mi) of a proposed or existing mine units (mine units 9 and 10). The licensee stated that surface water at the Smith Ranch Highland site is not used for any project related production or non-production purpose.

The licensee did not indicate any change to the description of the drainages within or near mine units in the Reynolds Ranch license area. NRC staff found no new surface water rights were added in the Reynolds Ranch license area in Table 3.4-3 and Figure 3.4.1 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b) since it was licensed (NRC 2007a).

The NRC Staff review has found there is no new information which significantly changes the characterization of the Smith Ranch Highland surface water hydrology since the last safety evaluation; therefore, the staff finds the characterization of the surface water hydrology including surface water features and surface water rights has not raised any new concerns that would change previous staff conclusions with respect to safety.

2.4.3.1.2 North Butte

The licensee provided a description of the surface water hydrology in Section 2.3.7, "Hydrology," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.3.1, "Surface Water," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided additional description of the surface water hydrology in Appendix D-6 of the WDEQ North Butte mine permit which was revised in April 2011 (Cameco Resources, 2012e).

The North Butte Satellite is located in the Willow Creek drainage. In the update to the surface water hydrology, the licensee completed a detailed analysis of the ephemeral tributaries to Willow Creek drainage which pass through the license area. The licensee provided a map of the tributaries in Figure D6-1.5. Thirteen channel cross sections were surveyed on the ephemeral tributaries and Willow Creek. The survey results were presented in Attachment D6-1.3 of Appendix D6 of the WDEQ North Butte mine permit (Cameco Resources, 2012e).

NRC staff reviewed the cross section surveys provided by the license in Attachment D6.1-3 of Appendix D-6 of the WDEQ North Butte mine permit (Cameco Resources, 2012e). The NRC staff found that drainages that were located in or near the North Butte mine units showed the majority are incised with significant bed slopes. Therefore, the peak flow rates in these drainages may incur high velocities in the channels. The licensee used the Hydro CAD model to estimate the peak flow rates in the channels for 50-yr and 100 yr 6 hr. storms. These peak flow rates were reported in Table 3.4-5 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee stated the peak flow rate values were used to design the culverts at the North Butte site to prevent failures which could impact infrastructure.

The licensee provided a table of surface water rights within 4.8 km (3 mi) of the license area in Table 3.4-10.1 of the Smith Ranch Highland Renewal Environmental Report (Cameco Resources 2012b). The approximate location of these rights was provided in Figure 3.4.5 of the Smith Ranch Highland Renewal Environmental Report (Cameco Resources 2012b). The licensee reported that all sixteen adjudicated (permanently granted) surface water rights are for either reservoirs or stock reservoirs. NRC staff found there were no surface water rights granted for Willow Creek or its tributaries within three miles of the license area. The NRC staff review found that ten of these sixteen surface water rights were granted in 2004 or later.

The licensee reported that at the end of 2004, Coal Bed Methane (CBM) wells were present immediately south and northwest of the North Butte Remote Satellite in Section 2.3.2, "Uses of Adjacent Lands and Waters," of Smith Ranch Renewal Technical Report (Cameco Resources 2012b). CBM is produced using wells to dewater the coal bed methane formations. The licensee stated that Anadarko's CBM wells began dewatering processes in the fall of 2010 in Section 2.3.2, "Uses of Adjacent Lands and Waters," of Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The completed wells in the Big George Coal seam are at a depth of approximately 472 meters (1,550 feet). The licensee reported the active life of the CBM wells will be 7 to 15 years from the initiation of dewatering.

Because the water quality of CBM produced water from dewatering is similar to water quality in leaks and spills for ISR operations, NRC staff finds it may be mistaken or confused with contamination from the ISR operation. The licensee reported that currently no CBM produced water is disposed or stored within the North Butte license area in Section 2.3.2, "Uses of Adjacent Lands and Waters," of Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated all CBM water is currently piped from CBM wells to an off-site discharge point near Salt Creek, Wyoming. In addition, the licensee reported that CBM industry does not discharge nor impound water to surface drainages that pass through the North Butte license area in the Smith Ranch Highland License Renewal Environmental Report (Cameco Resources 2012b). To verify this claim, NRC staff evaluated if any of the current surface water rights were associated with CBM produced water discharge. The NRC staff confirmed that all of them were associated with stock reservoirs and were not permitted to receive CBM produced water.

In addition, in Section 2.3.2, "Uses of Adjacent Lands and Waters," of Smith Ranch Renewal Technical Report (Cameco Resources 2012b), the licensee stated that lands near the North Butte Remote Satellite have been developed by the Anadarko Petroleum Corporation (Anadarko) in conjunction with their (Coal Bed Methane) CBM Willow Creek Plan of Development. The licensee stated it has a Surface Use Agreement with Anadarko that establishes how CBM activities will be integrated with ISR activities, including joint surface use. Therefore, NRC staff finds the licensee will continue to ensure CBM produced water is being generated and handled appropriately within the North Butte license area.

The NRC staff reviewed the surface water rights for reservoirs within 2 km (1.2 mi) of the North Butte license using the Wyoming State Engineers Office (WSEO) database. NRC staff verified that all of the surface water rights were for stock reservoirs and none were permitted to receive CBM produced water. The staff therefore concludes that surface water rights have been characterized and management of produced water from CBM operations in and near the North Butte license area has been adequately described.

The NRC Staff review of the characterization of the North Butte license area surface water hydrology, including surface water fearures and surface water rights, has not raised any new concern that would change previous staff conclusions with respect to safety.

2.4.3.1.3 Gas Hills

The licensee provided a description of the surface water hydrology in Section 2.4.7, "Hydrology," of the Smith Ranch Highland Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.4.1, "Surface Water," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided additional description of the

surface water hydrology in Appendix D-6 of the WDEQ Gas Hills mine permit which was revised in October 2010 (Cameco Resources, 2012f).

In the Gas Hills license area, the licensee did not have any updates to the description of the watersheds or drainages which were shown in Plate D6-2 of Appendix D-6 of the WDEQ Gas Hills mine permit application (Cameco Resources, 2012f). All streams and drainages not fed by springs were described as ephemeral and flow only in response to snowmelt and heavy rainfall events. Stock ponds constructed in many of the ephemeral streams are used for livestock but are dry most of the time.

The licensee updated the surface water rights for the Gas Hills license area through November 2011 in Table 3.4-13 of the Smith Ranch Highland Renewal Environmental Report (Cameco Resources 2012b). The location of the surface water rights are shown in Figure 3.4.6 of the Environmental Report. The licensee stated there are 8 surface water rights within 2 km (1.2 km) of the license area. All but one of the surface water rights are limited to stock water or wildlife purposes. This one new surface water right, known as the B-Spoils reservoir, was granted in 2007 and is for industrial purposes. NRC review of the WSEO permit found this reservoir is used for runoff and sediment control from the UMETCO mill tailings site north of Gas Hills MU5.

The NRC staff has found there is no new information which significantly changes the characterization of the Gas Hills license area surface water hydrology since the last safety evaluation; therefore, the NRC staff finds the characterization of the surface water hydrology including surface water features and surface water rights has not raised any new concern that would change previous NRC staff conclusions with respect to safety.

2.4.3.1.4 Ruth

The licensee provided a description of the surface water hydrology in Section 2.5.7, “Hydrology,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.5.1, “Surface Water,” of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b).

In the Ruth license area, the licensee did not have any updates to the description of the watersheds or drainages since Ruth was added to license SUA-1548 (NRC 2003b). The licensee, however, did update the surface water rights for the Ruth license area in permit through November 2011 in Table 3.4-16 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee reported a total of thirty-two surface water rights within 2 km (1.2 mi) of the license area. The location of the surface water rights are shown in Figure 3.4.8 of the Environmental Report. The NRC staff determined that thirty of the surface water rights were permitted since 2004. Three of these surface water rights were within the license area. The licensee stated the all but one of the surface water rights are for stock water reservoirs. The one industrial surface water impoundment is associated with the solar evaporation pond that was used for the prior R&D ISR operations at the Ruth Satellite.

NRC staff reviewed the surface water rights for reservoirs within 2 km (1.2 mi) of the Ruth license boundary using the Wyoming State Engineers Office (WSEO) database. NRC staff verified that all of the surface water rights were for stock reservoirs; however, the NRC determined that the source of water for all of them was from the disposal of CBM produced water to the reservoir. The licensee did not disclose this fact. The licensee also did not provide the WYPDES permits which describe the CBM produced water discharge locations (e.g. CBM

wells) to the permitted reservoirs, the allowable discharge flow rate and allowable limits on chemical constituents in the CBM discharge.

NRC staff has a concern with CBM produced water discharge in and around the Ruth license area as injected and recovered fluids and waste water from ISR operations and CBM produced water have very similar water quality (e.g. high TDS). Because of this similarity, the licensee must provide a plan to address how it would distinguish between surface water contamination from spills or leaks from ISR operations or from CBM produced water. NRC staff finds this is necessary to ensure the source of contamination is correctly determined and corrected.

The NRC staff therefore concludes the management of produced water from CBM operations in and near the Ruth license area has not been adequately described to ensure that a source of contamination will be identified and corrected. Therefore, the NRC staff will retain condition 10.2.1 in license SUA-1548, which requires that the licensee submit an operations plan for NRC review and approval prior to initiating operations at the Ruth remote satellite. The NRC staff recognizes that the locations of CBM development in the vicinity of the Rute remote satellite may change before the licensee decides to proceed with the Ruth remote satellite. As the licensee does not intend to operate the Ruth remote satellite during the renewal period, the license condition will provide an opportunity for the licensee and the NRC staff to fully evaluate the presence of CBM operations at an appropriate time. The NRC staff expects that the operations plan will: describe: (1) how CBM water will be managed at Ruth; (2) the sources of any CBM discharges; (3) information on any WYPDES permits at Ruth (location, discharge flow rate, and discharge water quality); (4) information on surface water rights for any impoundments; and (5) how the licensee plans to distinguish between contamination resulting from CBM produced water and contamination from ISR related activities.

In conclusion, NRC staff reviewed the surface water hydrology and surface water rights at the Ruth license area. Staff has identified one new safety issue as described above which will be addressed by the license condition.

2.4.3.2 Groundwater Hydrology

2.4.3.2.1 Smith Ranch Highland

The licensee provided a description of the Smith Ranch Highland groundwater hydrology in Section 2.2.7, “Hydrology,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.2.2, “Groundwater,” of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b).

The licensee stated that the regional aquifers of interest in the PRB where the Smith Ranch Highland site is located are from top to bottom, the Wasatch, the Fort Union and the Fox Hills-Lance. All of these aquifers are located above the Pierre Shale which acts as continuous confining layer (aquitard). The licensee reported that the nearby town of Glen Rock has two municipal wells completed in the Fox-Hills Lance aquifer which were reported to yield 1,306 lpm (345 gpm). The licensee stated no wells were completed in the Fox-Hills aquifer near the license area.

The licensee provided the updated description of hydrostratigraphy in Table D-6.1 of Appendix D6 in the Smith Ranch Highland WDEQ permit (Cameco Resources 2012d). The aquifers of interest within the Smith Ranch Highland license area are located from surface to depth in the alluvium, the Wasatch Formation, the Fort Union Formation and in the Lance and Fox Hills

Formation. The licensee reported alluvium is present on the surface and is one to thirty feet thick. The alluvium is typically not saturated and is not considered to be a significant source of groundwater. The licensee stated the Wasatch Formation is a significant aquifer at the site. It ranges from zero to 152 m (500 ft) thick across the license area. The Wasatch Formation well yields are typically in the range of 18.9 to 56.8 lpm (5 to 15 gpm). The licensee reported that the Fort Union Formation is also a significant aquifer at the license area. The formation is up to 914.4 m (3,000 ft) thick beneath the site. The wells in the Fort Union aquifer typically yield 18.9 to 113.6 lpm (5 to 30 gpm). The Lance Formation was noted to be 914.4 m (3,000 ft) thick and the Fox Hills was 152 to 304.8 m (500 to 1,000 ft) thick under the site. The licensee reported that little is known about the aquifers within the Lance and Fox Hills formations as no wells are completed in either aquifer within or near the license area.

The licensee provided the updated hydrostratigraphy for the proposed mine units in the Smith Ranch Highland license area in Table 3-1.1 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The mine units in the Smith Ranch area were identified as MU8, MU12, MU13, and MU16 with the ore zone in the O sand aquifer and MU17 with the ore zone in the M sand aquifer. NRC staff verified that all of the proposed Smith Ranch mine units are overlain and underlain by continuous aquitards of acceptable thickness (> 3 m [10 ft]) in a review of the relevant geologic cross sections for each mine unit reported in Table 3-1.1. The mine units in the Highland area were identified as MU H extension and MU M both in the 60 sand ore zone aquifer and the MU I extension in the 50 sand ore zone aquifer. NRC staff verified that the proposed Highland mine units are also underlain and overlain by continuous aquitards of acceptable thickness (> 3 m [10 ft]) in a review of the relevant geologic cross sections identified for each mine unit in Table 3-1.1. No new mine units were proposed for the Reynolds Ranch License area since the last safety evaluation (NRC 2007a).

The licensee updated the potentiometric surfaces near and within the existing mine units in the M (10), O (30/40/50), Q (90), R/S (100) sand ore zone aquifers in Figures D6-1A, D6-1B, D6-1C and D6-1D in the Smith Ranch Highland WDEQ permit including the Reynolds Ranch area (Cameco, 2012d). The updated maps indicate the potentiometric surface in these ore zone aquifers has not been significantly impacted by drawdown from the mine units in production or restoration. The licensee described the potentiometric surface changes in Section 3.4.2.2.5, “Aquifer Potentiometric Surfaces,” of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee stated there were minor variations in the groundwater potentiometric head and groundwater flow direction. NRC staff review concludes that the reported minor changes to groundwater flow and direction shown in the updated potentiometric surfaces are expected near mine units in operation and restoration and do not represent a safety issue. The licensee also reported that all of the ore zone aquifers remain confined (fully saturated) during ISR operations, with the water level elevations above the top of the respective formations. Because the aquifers have and continue remain confined (fully saturated), NRC staff finds the reported drawdown in any potentiometric surface in the ore zone aquifers from ISR operations does not present any new safety issue.

The licensee reported that several aquifer pumping tests were conducted as part of mine unit data packages since the last license renewal (NRC 2001a). The licensee presented some of the results of these aquifer tests in Section 3.4.2.2.4, “Aquifer Pump Test and Analysis,” of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). All of the aquifer test results demonstrated that the ore zone aquifers have acceptable transmissivity for ISR operation. In addition all of the aquifer test results demonstrated the integrity of overlying and underlying aquitards above and below the targeted ore zone aquifers. Based on these results, NRC staff finds that the aquifer tests demonstrate that hydraulic control of ISR fluids has and

will continue to be maintained in the existing and proposed mine units at the Smith Ranch Highland facility.

The licensee provided an updated listing of all of the groundwater rights within 5 km (3.1 mi) of the license area in Table 3.4-4 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided an updated map which displays all stock/domestic permits and groundwater rights in Figure 3.4.1 of the Environmental Report. The licensee did not identify private industrial, irrigation or miscellaneous wells on this map which may impact the operations: however, they were identified in Table 3.4-4.

The licensee stated there are over 1,400 groundwater rights within 5 km (3.1 mi) of the Smith Ranch Highland license area as listed in Table 3.4-4. Most of these water rights are associated with well installed for the ISR activities at Smith Ranch Highland (e.g. injection, extraction, monitoring). Of the remainder, 162 rights are associated with stock wells, 3 are associated with irrigation wells, 32 are dual stock domestic use and 16 are strictly domestic use. Five of the domestic wells are within the Smith Ranch Highland license boundary, all of which were present and reviewed in the last safety evaluation. NRC staff review found there has been no change to the location, well completion or water use of these existing domestic wells since the last safety evaluation (NRC 2001); therefore, NRC staff finds there is no new safety issue related to them.

NRC Staff review of the groundwater rights listed in Technical Report Table 3.4-4 found there were 13 new groundwater rights permitted within 2 km (1.2 mi) of an existing or proposed mine unit in the Smith Ranch Highland and Reynolds Ranch Permit areas since the last safety evaluation (NRC, 2001a and NRC, 2007a). All of the wells were permitted for stock use and none were for domestic or dual stock/domestic use. The permit number, well location, completion information and permitted use for each of these water rights are shown in SER Table 14~~Table 14~~.

NRC staff review found a few of these wells, such as Potts #1 and #2, are located within an existing mine unit. The licensee did not provide an evaluation to inform NRC staff review of whether any of these wells are completed within the ore zone aquifer of the mine units. NRC staff has therefore determined that there is a new safety issue with respect to protecting users of these wells. NRC staff will therefore impose a new license condition which requires that the licensee plug and abandon any wells which are found to be completed in the ore zone aquifer within 152 m (500 ft) of the perimeter well ring of an existing or new mine unit:

10.1.13 *The licensee shall properly plug and abandon any private well determined to be completed in the ore zone aquifer within 500 feet of the perimeter well ring of an existing or new mine unit.*

In Technical Report Table 3.4-4 the licensee reported there are two private irrigation wells, P2414.0W and P32561.0W in the license area. In its review, the NRC staff could not determine if the wells have been installed or if the permitted irrigation flow rates could affect hydraulic control of the ISR operations in nearby mine units. Therefore, NRC staff requested the licensee provide the current status of these wells and to identify the aquifers in which these wells are completed (NRC 2013b). NRC staff also requested the licensee evaluate if the use of these wells could affect the hydraulic control of nearby mine units in the Smith Ranch license area.

Table 14. Groundwater rights, well completions, and well use within 2 km of a Smith Ranch Highland mine unit

Water Right Permit Number	Priority Date	Well Name	Permit Use	Township	Range	Section	Permit Yield lpm (gpm)	Total Depth m (ft)
P151581.0W	06/03/2003	Taylor# 3	STK	035N	073W	03	26.5 (7)	85.3 (280)
P164093.0W	12/01/2004	Hay Meadow #1	STK	035N	074W	01	22.7 (6)	25.9 (85)
P154804.0W	11/04/2003	Hay Meadow #1	STK	035N	074W	02	30.3 (8)	25.9 (85)
P165194.0W	01/12/2005	Potts #1	STK	035N	074W	10	15.1 (4)	54.9 (180)
P165195.0W	01/12/2005	Potts #2	STK	035N	074W	10	11.4 (3)	74.7 (245)
P129283.0W	09/25/2000	Solar Panel 2	STK	035N	074W	11	37.9 (10)	24.4 (80)
P184775.0W	01/16/2008	East Lola	STK	035N	074W	16	26.5 (7)	(NR)
P163067.0W	10/04/2004	West Downs #1	STK	035N	074W	28	30.3 (8)	79.2 (260)
P163616.0W	11/04/2004	Mangy Coyote 55-1	STK	036N	073W	05	3.8 (1)	1.8 (6)
P144333.0W	05/06/2002	Terrell No. 1	STK	036N	073W	15	26.5 (7)	44.5 (146)
P153488.0W	08/13/2003	Duck Creek #17-2	STK	036N	073W	17	22 (5.8)	55.8 (183)
P163615.0W	11/04/2004	Duck Creek #17-1	STK	036N	073W	17	7.6 (2)	2.1 (7)
P160753.0W	07/12/2004	Reynolds #21-3	STK	036N	073W	21	18.9 (5)	96.6 (317)

The licensee addressed the potential for the irrigation wells to affect hydraulic control of nearby mine units in Attachment E of Appendix E of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). In this section, the licensee stated that only one of these permitted irrigation wells, P2414.0W (Smith #1), in Section 12 of T35N R74W could impact hydraulic control of ISR operations in a nearby mine unit. Specifically, the licensee stated that WSEO records indicate that the P2414.0W irrigation well has a total depth of 183 m (600 ft) and a permitted maximum flow rate of 378.5 lpm (100 gpm). The well is perforated from 66.4 to 70.1 m (218 to 230 ft), 106.7 to 122 m (350 to 400 ft), 122.5 to 128 m (402 to 420 ft), and 137.1 to 169.2 m (450 to 555 ft) below ground surface (bgs). The lower perforated zones are located in the O Sand within the Fort Union formation which is the ore zone aquifer for the adjacent Mine Unit 15A. The licensee calculated that the well is located approximately 975 m (3,200 ft) east of the closest injection and production wells (P196924W) in Mine Unit 15A (T35N R74W, Section 11). The injection and production wells are also perforated in the O Sand.

The licensee performed a groundwater flow simulation to address the influence of irrigation well Smith #1 on operations in the nearest mine unit completed within the 0-Sand (MU-15A). The licensee described the simulation and results in Attachment E of Appendix E of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee presented the resulting maximum drawdown and radius of influence produced by irrigation well Smith #1 after 5 months of irrigation on Figure 1 of Attachment E. The licensee stated the results in Figure 1 demonstrate irrigation pumping from Smith #1 should not adversely

affect hydraulic control of ISR solutions in neighboring mine units, as the drawdown and resulting radius of influence produced by irrigation pumping is insufficient to overcome the inward hydraulic gradient produced by the production bleed in MU-15A. The licensee also stated that it had made an agreement to buy hay for the rancher until Mine Units 15 and 15A are restored. Based on the information provided by the licensee and the analysis of the impact of the operation of the irrigation well, the NRC staff concludes that the licensee has successfully demonstrated there is no safety issue with respect to hydraulic control of the mine units near irrigation well P2414.0W, Smith #1.

The licensee reported the three industrial water rights permits, P193308.0W, P189481.0W, and P193341.0W, near Smith Ranch Highland license area. NRC staff review of these WSEO permits indicated that these wells were associated with oil and gas drilling operations and have permitted water use rates of 567.8, 94.6, and 567.8 lpm (150, 25, and 150 gpm), respectively. In its review, NRC staff could not determine if the wells have been installed or if the larger flow rates could affect hydraulic control of the ISR operations in nearby mine units. Therefore, in RAI 9 (NRC 2013b), NRC staff requested the licensee to provide the current status of these wells and to identify the aquifers in which these wells are completed. NRC staff also requested the licensee evaluate if the use of these wells could affect the hydraulic control of nearby mine units in the Smith Ranch license area.

In its response, the licensee provided an analysis of these wells in Attachment F of Appendix E of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). In Attachment F, the licensee reported that according to the WSEO records, Wells P193308.0W (Spillman Draw Unit 35-73 15-IH water well) and P189481.0W (Spillman Draw Unit 16-1 water well) were completed in 2011 and 2009, respectively. A third well permit (Well P193341.0W) was cancelled and is not addressed in the groundwater simulation. The licensee determined the wells were permitted to supply water for oil and gas fracking operation.

The licensee used the current completion information to perform an additional groundwater flow simulation to address the influence of fracking water supply wells P193308.0W and P189481.0W on operations in the nearest mine units located more than 6.4 km (4 mi) north of the fracking water supply wells. The licensee reported the resulting maximum drawdown produced by fracking water supply wells, P193308.0W and P189481.0W, in Figure 1 of Attachment F of Appendix E of the Smith Ranch Environmental Report (Cameco Resources, 2012b). These results show the effective drawdown from these wells was is essentially zero (0.03 m [0.1 ft] or less) at a distance of 2,438 m (8,000 ft) or less from the pumping source. The licensee reported that these results demonstrate that these two fracking supply wells should not affect hydraulic control of ISR solutions in the nearest mine units, as the resulting drawdown is much too limited to influence operations at Smith Ranch.

Based on the information provided by the licensee and the analysis of the impact of the operation of the fracking wells, the NRC staff concludes that the licensee has successfully demonstrated there is no new safety issue with respect to hydraulic control of the mine units from the fracking water supply wells.

The licensee described the oil and gas production existing in and near the Smith Ranch Highland license area in Section 2.2.2.2, “Oil and Gas Production,” of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). Figure 3.8 of Appendix E of the Environmental Report showed the location of Niobrara oil and gas wells and water supply wells,

the majority of which were located outside the Smith Ranch Highland license area. The licensee stated all of the oil and gas targeted in the license area would be from the Niobrara shale which is significantly deeper than the ore zones targeted for extraction. The ore zones are also separated from the Niobrara shale by the very thick Pierre shale in the license area. The licensee stated it therefore finds it unlikely that oil and gas operations in these zones will impact ISR operations. NRC staff therefore concludes the licensee has demonstrated there is no new safety issue associated with oil and gas operations within and near Smith Ranch Highland license area.

The NRC finds there is a safety concern related to the installation of new private wells or with the revised use of an existing well within 2 km (1.2 mi) of an operating mine unit which could impact hydraulic control of production fluids. Therefore, the NRC staff will issue the following new license condition to apply to Smith Ranch Highland and the associated remote satellite facilities at Ruth, North Butte, and Gas Hills.

10.1.15 *The licensee shall identify the location of any new private groundwater wells or new use of existing private wells, where the information is publicly available and/or known to the licensee, that are located within the Smith Ranch Highland, Ruth, North Butte, and Gas Hills license areas and within 2 km of any mine unit perimeter monitoring ring wells.*

2.4.3.2.2 North Butte

The licensee provided a description of the North Butte groundwater hydrology in Section 2.3.7, "Hydrology," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.3.2, "Groundwater," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided additional description of the groundwater hydrology in Appendix D-6 of the WDEQ North Butte mine permit which was last revised in February 2011 (Cameco Resources, 2012e).

The licensee stated North Butte site is located in the southern portion of the PRB. The regional hydrostratigraphy consists of aquifer in the alluvium, the Wasatch formation, Fort Union formation and the Lance – Fox Hills formations. The licensee reported that little is known about the aquifers within the Lance and Fox Hills formations as no wells are completed in either aquifer within or near the North Butte license area.

The licensee provided the description of site hydrostratigraphy in Section 3.4.3.2.1, "Hydrogeologic Stratigraphy," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The aquifers of interest within the North Butte license area are located the Wasatch Formation. Specifically, the ore zone aquifers are located from shallow to deep in the A, B, and C sands of the Wasatch formation. The overlying aquifer is located in the F sand and the underlying aquifer is located in the 1 sand. NRC staff verified that the proposed North Butte mine units are underlain and overlain by continuous aquitards of acceptable thickness (> 3 m [10 ft]) in the prior safety evaluation. No new mine units were proposed for the North Butte site since it was added it license SUA-1548 (NRC 2003b).

The licensee reported that portions of the North Butte license area are overlain by alluvium that consists of clays, silts, sands and gravels along Willow Creek. The thickness of the alluvium was estimated to be 0.3 to 9.1 m (1 to 30 ft) thick. The licensee conducted a field investigation in 2011 in the alluvium in Willow Creek in the southern portion of the license area to assess if there was a surficial aquifer present in the alluvium above the F sand overlying aquifer. The

licensee stated that one boring, WC#1, was drilled to a depth of 32 m (105 ft) and no water was detected in the alluvium. Another boring, WC#2, was drilled to 24.4 m (80 ft) and no saturation was detected in the alluvium. The licensee drilled and completed an offset well, WCA1, which will be evaluated for water saturation in the alluvium. The well logs for WC#1 and #2 and well completion details for WCA #1 were presented in Figures 3.4.2, 3.4.3 and 3.4.4, respectively of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee reported that WCA#1 has remained dry since it was installed in November 2011. The licensee concluded based on this investigation that the alluvium under Willow Creek is not water bearing; therefore, NRC staff finds the F sand remains the overlying and surficial aquifer at the site.

The licensee stated that static water levels were measured in monitoring wells in the F, CB and A sands in the North Butte site in the fall of 2010 in Section 3.4.3.2.6, "Aquifer Potentiometric Surfaces," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee prepared potentiometric map of the F sand shown in Figure D6-1.1 of the North Butte WDEQ permit application (Cameco Resources, 2012e). The license stated that the F sand was a confined aquifer (saturated) with flow to the south –south west at the site. The gradient was 0.02 in 2010 vs 0.008 in 1988. The average decline in water levels between 1988 and 2010 was 0.61 m (2 ft). The licensee also provide the potentiometric surface of the BC sand aquifer in Figure D6-1.2 developed from the 2010 water levels. The licensee stated the CB sand is also confined (saturated) with a groundwater flow toward the northwest and a gradient of 0.006 which is unchanged since 1998. The water level shows an average decline of 0.91 m (3 ft) in water level. The licensee reported that the A sand water levels measured in 2010 indicate the aquifer is confined (saturated) and groundwater flow is generally towards the northwest. The average gradient in the A sand in 2010 was 0.02 which is unchanged from 1988. The licensee noted the flow direction in the F sand was distinctly different than the A and CB ore zone aquifers.

The licensee did provide the results of any additional aquifer pumping tests since the last renewal (NRC 2001a). The licensee instead presented some of the results of the original aquifer tests in the A, B and C sands in Section 3.4.3.2.4, "A Sand Aquifer," and 3.2.3.2.5, "Summary of Aquitard Properties," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). All of the original aquifer test results demonstrated that the ore zone aquifers have acceptable transmissivity for ISR operation. In addition all of the original aquifer test results demonstrated the integrity of overlying and underlying aquitards above and below the targeted ore zone aquifers. NRC staff finds that the original aquifer tests demonstrate that hydraulic control of ISR fluids have been and will continue to be maintained in the existing and proposed mine units at the North Butte site.

The licensee provided the groundwater rights for the 5 km (3.1 mi) of the North Butte permit area in Table 3.4-10 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provide the name and location of these water rights in ER Figure 3.4.5. The licensee reported that about half of the rights are associated with CBM production wells most which were installed since 2000. The licensee stated there are three non-industrial wells within the North Butte Satellite area. All three of these wells are utilized by T Chair Land Company for stock watering. The licensee reported there are five permitted domestic wells and 31 additional stock wells within 5 km (3.1 mi) of the North Butte Site.

The licensee presented the permit name, location, completion, permitted use and flow rate of all private wells within 2 km (1.2 mi) of the North Butte site boundary in Technical Report Table 3.4-8. The licensee noted that five of these wells are no longer in operation. The licensee stated the remaining wells are still in use and are sampled quarterly according to Reg. Guide 4.14

(NRC 1980a). The NRC staff determined that all of these wells were present at the time North Butte was added to license SUA-1548 (NRC 2003b), so no new safety issue was identified. However, the NRC staff recognizes that new private wells could be installed or an existing private well could be repurposed. Therefore, the NRC staff is including condition 10.1.15 in license SUA-1548 so that all new private wells or re-purposed existing wells within 2 km (1.2 mi) of a mine unit are identified.

The licensee described the presence of CBM gas production near the license area in Section 2.3.2, "Uses of Adjacent Lands and Waters," of Smith Ranch Renewal Technical Report (Cameco Resources 20112b). The licensee stated that lands near the North Butte Remote Satellite have been developed by the Anadarko Petroleum Corporation (Anadarko) in conjunction with their (Coal Bed Methane) CBM Willow Creek Plan of Development. The licensee stated that at the end of 2004, CBM wells were located immediately south and northwest of the license area. The licensee stated that Anadarko would start up CBM operations in the fall of 2010, and the active life of the CBM wells would be 7-15 years. The licensee reported that the CBM wells target the Big George Coal seam which is located at depths greater than 472 m (1,550 ft) bgs. NRC review of the CBM well permits in Technical Report Table 3.4-10 confirms that they are permitted for depths around 457 m (1,500 ft) bgs or greater. The licensee stated it has a surface use agreement with Anadarko which establishes how CBM activities will be integrated with ISR operations. The NRC staff finds that given the depth of the coal bed methane operations, and the presence of confining layers between the CBM zone and the targeted ore zone aquifers, it is unlikely that the operation of the CBM wells will impact hydraulic control of the groundwater in the overlying North Butte mine units. In addition, the licensee stated it has an established agreement with Anadarko which addresses its conduct of CBM operations, which should allow the licensee the opportunity to resolve any issues which may arise. Therefore, NRC staff finds there is no new safety issue associated with the presence of the CBM wells in and near the North Butte license area.

2.4.3.2.3 Gas Hills

The licensee provided a description of the Gas Hills groundwater hydrology in Section 2.4.7, "Hydrology," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.4.2, "Groundwater," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided additional description of the groundwater hydrology in Appendix D-6 of the WDEQ Gas Hills mine permit which was last revised in October 2010 (Cameco Resources, 201f).

The licensee reported that the Gas Hills satellite is located along the south-central flank of the Wind River Basin of Wyoming. The regional hydrostratigraphy of the Wind River Basin consists in descending order in the aquifers in the post-Wind River alluvium and Split Rock formation and aquitards in the White River and Wagon Bed formations. Underlying these formations is a sequence of aquifers and aquitards in the Wind River formation which are targeted for ISR in the satellite license area. The pre – Wind River aquifers are located below these Wind River formations in the Cloverly, Nugget, Phosphoria and Tensleep formations. The licensee stated that little is known about the aquifers or their use on the regional scale, as the number of wells is small. The licensee stated the Phosphoria formation is also targeted for oil and gas production and the Tensleep formation is a highly productive aquifer, and has sufficient heat to be used as a geothermal water source.

The licensee provided the description of Gas Hills site groundwater hydrostratigraphy in Section 3.4.4.2.2, "Producing Sands and Confining Unit Characteristics," of the Smith Ranch Renewal

Environmental Report (Cameco Resources 2012b). The licensee also provided an updated description of the site hydrostratigraphy in Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee stated that the aquifers of interest in mine units 1 through 5 at the Gas Hills site are located in the Wind River Formation. The stratigraphy of the sands and shales at the Gas Hills site were discussed in SER Section 2.3.3.1.3. This stratigraphy indicates a very heterogeneous geology with numerous traceable faults across the site. In addition, the licensee reported that the Gas Hills site has a long and complicated history of open pit and underground uranium mining. These prior mining disturbances were presented by the licensee in Table D6-1-1 of Appendix D6 of the Gas Hills WDEQ permit application (Cameco Resources, 2012f). The NRC staff review finds the site has a complex groundwater system which is unique for each mine unit at the Gas Hills site. Therefore, the NRC staff review of the hydrostratigraphy is presented separately for each mine unit.

Mine Unit 1

The stratigraphy of mine unit 1 is shown in SER Table 8~~Table 8~~. The licensee reported the targeted ore zone aquifer is located in the 70 sand. The licensee reported the 70 sand is continuous with no traceable faults. The 70 sand aquifer also has a water level of more than one hundred feet, rising above the top of the 70 sand. This water level is sufficient to demonstrate the 70 sand aquifer is a confined aquifer (saturated). In Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee also stated that the 80 sand is discontinuous and acts as the ore zone aquifer in adjacent mine unit 2. Therefore, the licensee stated the overlying aquifer is in the 90 sand. The licensee also stated that the 60 sand is absent from the mine unit 1 area, so the underlying aquifer is in the 50 sand. The licensee reported there was 6.1 to 15.2 m (20 to 50 ft) of competent shale which acts as an aquitard between the 70 sand ore zone aquifer and the 50 sand underlying aquifer. NRC staff verified that the 70 sand is underlain and overlain by continuous aquitards of acceptable thickness (> 3 m [10 ft]).

Mine Unit 2

The stratigraphy of mine unit 2 is shown in SER Table 9~~Table 9~~. The licensee reported the targeted ore zone aquifers are located in the 40, 50, 60, 70 and 80 sands. The licensee reported that the variability in the sand thickness and ore zone locations in these sands will lead to different sands being targeted in different locations. The selection of the ore zones with be made based on delineation drilling during mine unit development as described in SER Section 3.1.3.2.3.

The licensee stated that the Chugwater formation is located directly beneath the 40 sand in mine unit 2. The Chugwater formation is composed of shale and is over 305 m (1,000 ft) and acts as an aquitard. Therefore, the licensee stated there is no underlying aquifer to the 40 sand in mine unit 2. The licensee did not state which aquifer would act as the overlying aquifer in mine unit 2. The licensee did not describe the water levels in the aquifers, so NRC staff could not assess if they are confined (saturated) or unconfined (unsaturated). As discussed at the end of this section of the SER, the NRC staff is including a license condition for review and verification of the hydrologic testing documents for Mine Units 1 thorugh 5. Information on the ground water levels will be provided in these packages.

The licensee reported there are two traceable faults in mine unit 2, the Bountiful and UPZ faults, in Section 3.3.3.3, “Gas Hills Mine Unit Locations,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that the behavior of these faults and their impact on groundwater hydrology in mine unit 2 will be assessed during the mine unit development. The licensee also reported that previous underground mining occurred in mine unit 2 by Federal American Partners (FAP). The FAP UPZ shaft is located on the southern side of the mine unit. The shaft was flooded in 1983 when it was 268 m (880 ft) deep. The shaft was reclaimed in 1991, filled with material and capped with concrete. The licensee stated the impacts of the prior mining on mine unit 2 area will be evaluated during hydrologic testing as described in the Section 3.4 of the technical report.

Mine Unit 3

The stratigraphy of mine unit 3 is shown in SER Table 10~~Table 10~~. The licensee reported the targeted ore zone aquifers are located in the 30, 40, and 50 sands in Section 3.3.3.3, “Gas Hills Mine Unit Locations,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee reported that the variability in the sand thickness and ore zone locations in these sands will lead to different sands being targeted in different locations. The selection of the ore zones with be made based on delineation drilling during mine unit development as described in SER Section 3.1.3.2.3.

The licensee stated that the 30 through 70 sands coalesce along the northwest side of mine unit 3. The 70 sand is overlain by a continuous claystone aquitard that is 1.5 to 9.1 m (5 to 30 ft) thick. The licensee therefore selected the 80 sand as the overlying aquifer. The Morrison, Cloverly and Thermopolis formations underlie the 30 sand. The licensee reported that the Morrison is not considered to be an aquifer. The Cloverly, however, was identified as an aquifer, but the licensee stated it is separated from the 30 sand by a thick sequence of Wind River aquitards. Therefore, the licensee did not identify an underlying aquifer for mine unit 3.

The licensee did not describe the groundwater levels in the targeted ore zone aquifers, so NRC staff could not assess if they are confined (saturated) or unconfined (unsaturated). The licensee, however, did report that the orebody is a southern extension of same ore body targeted at the Pathfinder Lucky Mc Mine pit located just north of mine unit 3. The licensee reported that dewatering of the Lucky Mc pit has lowered the water levels in the aquifers in the northern portion mine unit 3. The licensee stated that this dewatering may lead to the exclusion of ISR operations in these aquifers, but did not state which targeted ore sands were affected. As discussed at the end of this section of the SER, the NRC staff is including a license condition for review and verification of the hydrologic testing documents for Mine Units 1 thorugh 5. Information on the ground water levels will be provided in these packages.

The licensee reported two traceable faults within mine unit 3, the PCH Fault and the Jasper Fault. The displacement of these faults has not been determined by the licensee. In Section 3.3.3.3, “Gas Hills Mine Unit Locations,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b), the licensee stated that the behavior of these faults and their impact on groundwater hydrology in mine unit 3 will be assessed during the mine unit development. The licensee also reported that previous underground mining occurred in mine unit 3 at the abandoned Atlas underground mine. The mine was reclaimed in the 1980s. The licensee stated the impacts of this prior mining on mine unit 3 area will be evaluated during hydrologic testing as described in the Section 3.4 of the technical report.

Mine Unit 4

The stratigraphy of mine unit 4 is shown in SER Table 11~~Table 11~~. The licensee reported the targeted ore zone aquifers are located in the 50, 60, 70, 80 and 90 sands in Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee also reported that some ore may be present in the 40 sand in the southern portion of the mine unit. The licensee stated that the variability in the sand thickness and ore zone locations in mine unit 4 will lead to different sands being targeted in different locations. The selection of the ore zones with be made based on delineation drilling during mine unit development as described in SER Section 3.1.3.2.3.

The licensee reported there were different overlying confining layers across mine unit 4. In the production areas south of Buss Fault, the upper confining unit above the 90 sand is a continuous aquitard that is 3 to 30.5 m (10 to 100 ft) thick. The overlying aquifer is the 100 sand in this location. The confining unit north of the Buss Fault is a shale on top of the 60 sand which is 3 to 6.1 m (10 to 20 ft) thick. The overlying aquifers are the 70 and 80 sands in this location. The licensee stated the confining unit below the 50 sand that is 1.5 to 9.1 m (5 to 30 ft) thick. Below this aquitard, the licensee stated there is over 91.4 m (300 ft) of East Canyon conglomerate which acts as the underlying aquifer.

The licensee reported one traceable fault, the Buss Fault, within mine unit 4. The licensee stated the displacement of this fault is about 15.2 m (50 ft). In Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b), the licensee stated that the behavior of this fault and its impact on groundwater hydrology in mine unit 4 will be assessed during the mine unit development. The licensee also reported the Buss open pit mine is located in the northeastern potion of mine unit 4. The Buss mine extracted ore from the 60, 70, 80 and 90 sands. It was reclaimed in 1995. In addition, the licensee reported the 80 and 90 sands were mined in the Two States and Blackstone pits. An underground mine drift was developed south of the Two States pit. Other open pit activity was also conducted in mine unit 4. The licensee stated the impacts of this prior mining on mine unit 4 area will be evaluated during hydrologic testing as described in the Section 3.4 of the Technical Report.

The licensee did not describe the groundwater levels in the targeted ore zone aquifers, so NRC staff could not assess if they are confined (saturated) or unconfined (unsaturated). The licensee, however, did report that dewatering of the Buss pit has lowered the water levels in some of the aquifers in mine unit 4. The licensee stated that this dewatering may lead to the exclusion of ISR operations in these aquifers, but did not state which targeted ore sands were affected. As discussed at the end of this section of the SER, the NRC staff is including a license condition for review and verification of the hydrologic testing documents for Mine Units 1 thorugh 5. Information on the ground water levels will be provided in these packages.

Mine Unit 5

The stratigraphy of mine unit 5 is shown in SER Table 12~~Table 12~~. The licensee reported the targeted ore zone aquifers are located in the 50 sand in Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee also reported that some ore may be present in the 60 sand in the mine unit. The licensee stated that the selection of the sands and targeted ore zones with be made based on delineation drilling during mine unit development and hydrologic testing as described in SER Section 3.1.3.2.3.

The licensee reported that the 50 sand is overlain by a confining layer that is 4.6 to 12.2 m (15 to 40 ft) thick. The 60 sand is missing in this location, so the overlying aquifer was identified to be the 70 sand. The licensee stated that the confining layer below 50 sand is 6.1 to 12.2 m (20 to 40 ft) thick. The licensee reported this aquitard separates the 50 sand from the East Canyon conglomerate which acts as the underlying aquifer.

The licensee reported that mine unit 5 has two parallel striking faults which mark the Thunderbird Graben within the mine unit. The licensee stated the Thunderbird Graben is downthrown by about 45.7 m (150 ft). In Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b), the licensee stated that the behavior of these fault and their impact on groundwater hydrology will be assessed during the development and hydrologic testing of mine unit 5.

The licensee also reported mine unit 5 is located near several open–pit mines. In addition, the ROX and Thunderbird underground mines were location in the Thunderbird Graben, in the northern part of mine unit 5. The licensee stated these mines were abandoned in the 1960s and reclaimed in the 1980s. However, the licensee reported these two mines were most likely to affect operations in mine unit 5. The licensee stated the impacts of this prior mining on mine unit 5 area will be evaluated during hydrologic testing as described in the Section 3.4.3 of the technical report.

In addition, the license stated that mine unit 5 is located near the previously mined UMETCO uranium mill tailing impoundment and heap leach site. The licensee reported the majority of the UMETCO site is under the jurisdiction of the BLM. Reclamation of the UMETCO site was completed in 2006. The licensee report that there are two groundwater plumes which emanate from the UMETCO mill tailings impoundment and A-9 repository. The plume from the A-9 repository is moving south toward mine unit 5. In 2002, before the NRC approved the PRI SRHUP Gas Hills license amendment, the NRC approved an ACL for the UMETCO mill tailings impoundment and A-9 repository (NRC 2002a). The licensee indicated that it is aware that of the ACL and existing plume from the A-9 repository is moving toward mine unit 5. Therefore, the licensee stated it plans to design the operation of mine unit 5 as described in the TR section 3.4.3, "Hydrologic Testing Document," to prevent incursions of this plume. The NRC staff review therefore addresses this issue in SER Section 3.1.3.4.5.

The licensee described the groundwater flow in the Wind River aquifer in the Gas Hills license area in Section 3.4.4.2.4, "Aquifer Potentiometric Surfaces," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee provided an updated potentiometric map of the 2010 water levels measured in the sands of the mine units of the Wind River Aquifer in Technical Report Figure 3.4.7. The licensee clarified that the potentiometric surface included only water levels from wells in the saturated sands and not the overlying perched or underlying sands in the mine units. The figure showed that the groundwater flow in the Wind River aquifer sands was generally to the west and southwest. There was a clear area of groundwater flow to the north in the area of mine unit 3. The licensee indicated this flow deviation was a consequence of historic dewatering of the Lucky Mc Pit located just north of mine unit 3.

The licensee did not conduct any additional aquifer pumping tests for the Gas Hills remote satellite since the last safety evaluation report (NRC 2004b). The licensee instead presented some of the results of the original aquifer tests for mine units 1,2,3,4, and 5 in Section 3.4.4.2.3, "Aquifer Pump Test and Analysis," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). All of the original aquifer test results demonstrated that the ore zone

aquifers have acceptable transmissivity for ISR operation. The licensee stated the additional aquifer pumping test will be conducted in all mine units during hydrologic testing as described in the Section 3.4.3 of the technical report.

The licensee provided the groundwater rights within 2 km (1.2 mi) of the Gas Hills permit area in Table 3.4-15 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provide the name and location of these water rights in Technical Report Figure 3.4.6. The licensee reported that about the majority of the rights are associated with monitoring or industrial wells. The licensee stated there are seven groundwater rights associated with livestock watering. None of the groundwater rights was associated with domestic use. NRC staff review of the WSEO database of the water rights granted since the last safety evaluations found three wells were installed. Two of them were for licensee industrial use and one was for private industrial use. Therefore, the NRC staff determined that there was no new safety issue with respect to domestic or livestock water private wells within 2 km (1.2 mi) of the license area. However, the NRC staff recognizes that new private wells could be installed or an existing private well could be repurposed. Therefore, the NRC staff is including condition 10.1.15 in license SUA-1548 so that all new private wells or re-purposed existing wells within 2 km (1.2 mi) of a mine unit at Gas Hills are identified.

NRC staff review finds that all of the Gas Hills mine units were approved for operation in the last safety evaluation (NRC, 2004b). This approval was granted by NRC staff with the awareness that the licensee, given the complexity of the site, would conduct characterization and hydrologic testing to verify the groundwater hydrology of mine units 1, 2, 3, 4, and 5. This characterization would enable the licensee to select the mine unit ore zone aquifers to be targeted, address the behavior of the faults on these aquifers, verify the confined or unconfined behavior of the targeted aquifers (saturation), and assess the affect the legacy underground mining and mining pits would have on the unique groundwater system in each of these mine units. NRC staff therefore concludes based on the prior safety evaluation and NRC staff's current evaluation of the updated information, that the comprehensive characterization of the groundwater hydrology at the Gas Hills site must necessarily be conducted during mine unit development as it will require intensive drilling, well installation and hydrologic testing that can only occur after the mine unit is in place. The licensee has committed to conduct these evaluations during the development and hydrologic testing document of each mine unit as described in Section 3.4.3, "Hydrologic Testing Document," of the technical report, which was reviewed in SER Section 5.7.8.3.2. NRC staff finds this commitment is acceptable; however, NRC staff will require the following license condition that the final hydrologic testing document for Gas Hills mine units 1-5 be provided to NRC staff for review and verification, to ensure each mine unit is adequately characterized with respect to groundwater hydrology.

10.3.2 ~~Prior to the onset of commercial *in situ* leach activities, the licensee shall prepare a new operations plan, in accordance with the guidance in NUREG-1569 (June 2003), for NRC review and approval~~. *The licensee shall submit the hydrologic testing documents for mine units 1 through 5 to the NRC for review and verification.*

2.4.3.2.4 Ruth

The licensee provided a description of the Ruth groundwater hydrology in Section 2.5.7, "Hydrology," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) and in Section 3.4.3.2, "Groundwater," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided additional description of the groundwater

hydrology in Appendix D-6 of the WDEQ North Butte mine permit which was last revised in February 2011 (Cameco Resources, 2012g).

The licensee stated Ruth site is located in the southern portion of the PRB. The regional hydrostratigraphy consists of aquifer in the alluvium, the Wasatch formation, Fort Union formation and the Lance–Fox Hills formations. The licensee reported that little is known about the aquifers within the Lance and Fox Hills formations as no wells are completed in either aquifer within or near the Ruth license area.

The licensee provided the description of site hydrostratigraphy in Section 3.4.3.2.1, "Hydrogeologic Stratigraphy," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee reported that the ore zone aquifer is located in the A sand of the Wasatch formation. The overlying aquifer is located in the B sand above the B-A aquitard which is approximately 12.2 m (40 ft) thick and continuous. The underlying aquifer is located in the 1 sand which is separated from the A sand by the A-1 aquitard which is composed of two shale layers with an interbedded coal layer. The NRC staff verified that the proposed Ruth mine units are underlain and overlain by continuous aquitards of acceptable thickness (> 3 m [10 ft]). The licensee proposed no additional new mine units were for the Ruth site since it was added to license SUA-1548 (NRC 2003b).

The licensee stated that the groundwater potentiometric surface in the A sand indicates that groundwater flow is to the northwest. The licensee did not provide an update to the potentiometric surface of the A sand or the groundwater flow field. The licensee did not conduct any additional aquifer pumping tests since the Ruth remote satellite was added to license SUA-1548 (NRC 2003b). The licensee instead presented some of the results of the original aquifer tests in the B sand in Section 3.4.5.2.3, "Aquifer Pump Test and Analysis," of the Smith Ranch Renewal Environmental Report (Cameco Resources 20112b). All of the original aquifer test results demonstrated that the ore zone aquifers have acceptable transmissivity for ISR operation. In addition all of the original aquifer test results demonstrated the integrity of overlying and underlying aquitards above and below the targeted ore zone aquifers. NRC staff finds there has been no activity at the site since the last safety evaluation, therefore the prior safety evaluation of this information remains valid.

The licensee provided the groundwater rights for the 2 km (1.2 mi) of the Ruth license area in Table 3.4-17 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also provided the location of these groundwater rights in Environmental Report Figure 3.4.8. The licensee reported that the vast majority of these rights are associated with CBM production wells all of which were installed since 2002. The licensee stated there are 22 groundwater rights associated with livestock watering. The licensee reported there is one dual domestic/stock well permitted, P25860.0P, 0.8 km (0.5 mi) southeast of the license area. The NRC staff review of this well permit in the WSEO database indicated it was installed as a windmill in 1941. The depth of the well was unknown. The well was reported as not in use when the permit was reissued in 1974. The NRC staff determined that all of these groundwater rights, except those for CBM wells, were present at the time when the Ruth remote satellite wa added to license SUA-1548 (NRC 2003b), so no new safety issue for private domestic or stock wells was identified. However, the NRC staff recognizes that new private wells could be installed or an existing private well could be repurposed. Therefore, the NRC staff is including condition 10.1.15 in license SUA-1548 so that all new private wells or re-purposed existing wells within 2 km (1.2 mi) of a mine unit at Ruth are identified.

The NRC staff reviewed the possibility that the operation of CBM production wells could interfere with hydraulic control of fluid in the A sand ore zone aquifer during ISR operations. NRC staff review of the CBM well groundwater rights confirms that these wells are permitted for depths around 366 m (1,200 ft) bgs or greater as reported by the licensee in Table 3.4-17 of Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also reported the targeted A ore zone aquifer is around 163 m (535 ft) bgs at the Ruth site. The NRC staff finds that given the depth of the coal bed methane operations, and the presence of confining layers between the CBM zone and the targeted A sand ore zone aquifer, it is unlikely that the operation of the CBM wells will impact hydraulic control of the groundwater in the A sand aquifer targeted in the Ruth license area mine units. Therefore, NRC staff finds there is no new safety issue associated with the operation of the CBM wells in and near the Ruth license area.

The NRC staff, however, does have a concern with the discharge of produced water from these CBM wells within and near the Ruth license area. The licensee did not provide the WYPDES permits which describe the CBM produced water discharge locations (e.g., surface drainage or reservoirs), the allowable discharge flow rate and allowable limits on chemical constituents in the CBM discharge in and near the Ruth license area. NRC staff is aware that CBM produced water discharge from CBM wells has a very similar water quality (e.g. high TDS) to injected and recovered fluids and waste water from ISR operations a. Because of this similarity, the licensee must provide a plan to address how it would distinguish between groundwater contamination from spills or leaks from ISR operations or from CBM produced water. NRC staff finds this is necessary to ensure the source of contamination is correctly determined and corrected.

The NRC staff therefore concludes the management of produced water from CBM operations in and near the Ruth license area has not been adequately described. Therefore, the NRC staff will retain condition 10.2.1 in license SUA-1548. This condition requires that the licensee submit an operations plan for NRC review and approval prior to initiating operations at the Ruth remote satellite. The NRC staff recognizes that the locations of CBM development in the vicinity of the Rute remote satellite may change before the licensee decides to proceed with the Ruth remote satellite. As the licensee does not intend to operate the Ruth remote satellite during the renewal period, the license condition will provide an opportunity for the licensee and the NRC staff to fully evaluate the presence of CBM operations at an appropriate time. The NRC staff expects that the operations plan will: describe how CBM water will be managed at Ruth; identify the sources of any CBM discharges; contain information on any WYPDES permits at Ruth (location, discharge flow rate, and discharge water quality); information on surface water rights for any impoundments; and how the licensee plans to distinguish between contamination resulting from CBM produced water and contamination from ISR related activities.

2.4.4 Evaluation Findings

The staff review of the surface water and groundwater hydrology characterization for the Smith Ranch Renewal was conducted using the review procedures in Section 2.7.2 of the SRP and the acceptance criteria outlined in Section 2.7.3 of the SRP.

Surface Water Hydrology

The NRC staff found the licensee had acceptably characterized the surface water hydrology at the Smith Ranch Highland facility and North Butte, Gas Hills and Ruth satellites in prior safety evaluations by providing: a description and maps of all watersheds and drainages; a description and maps of all surface water features in and near the license area including type, size,

behavior ; an assessment of the potential for flooding; and maps and tables of surface water rights within and near the license boundaries.

In this license renewal, the licensee has provided the following updates to this information to characterize the surface water hydrology:

- peak flow rates in ephemeral drainages at North Butte
- updated surface water rights at the Smith Ranch Highland facility and North Butte, Gas Hills and Ruth satellites
- description of CBM produced water management at North Butte

Based on the information provided by the licensee, and the NRC staff's review conducted of the characterization of the surface water hydrology for the Smith Ranch Highland and satellite sites, the NRC staff concludes that the characterization information is sufficient as it meets the applicable acceptance criteria of SRP Section 2.7.3. Staff also finds the information is sufficient for staff to conclude, that in all but one case, the licensee can protect surface water and surface water users in the license area from production fluids containing source and byproduct materials, as required in 10 CFR 40.41(c). The NRC staff finds, however, that for the Ruth satellite site, the licensee has not described the management of CBM produced water in and near the Ruth license area. The NRC staff addresses the issues arising from CBM produced water management at the Ruth Satellite on surface water in SER Section 2.4.3.1.4. Because of the concerns with CBM operations at the Ruth remote satellite, the NRC staff will retain License Condition 10.2.1 in License SUA-1548 as described in SER Section 2.4.3.1.4 and shown in SER Table 2.

Groundwater Hydrology

The NRC staff found the licensee had acceptably characterized groundwater hydrology at the Smith Ranch Highland facility and North Butte, Gas Hills and Ruth satellites in prior safety evaluations by presenting a site wide evaluation of the hydrogeology using a monitoring well network installed by the licensee, and aquifer testing and an evaluation of hydrologic connectivity of aquifers. The characterization included: the hydrostratigraphy within each mine unit describing the targeted ore zone aquifers, aquitards, and overlying/underlying aquifers including depth, thickness, material type; aquifer water levels and ore zone production aquifer behavior (confined/unconfined) in each mine unit; maps of potentiometric contours of aquifers and estimates of groundwater flow direction and magnitude; review of historic aquifer tests and new aquifer tests to provide production zone aquifer hydrogeological parameters (transmissivity, conductivity) and to evaluate any hydrologic connection to overlying and underlying aquifers to the production ore zone aquifer(s) in the mine units; and maps and tables of groundwater rights within and near the license boundaries.

In this license renewal, the licensee has provided the following updates to characterize the groundwater hydrology:

- updated description of the hydrostratigraphy at the Smith Ranch Highland, and North Butte, and Gas Hills satellites
- updated potentiometric surfaces maps and description of groundwater flow at Smith Ranch Highland, and North Butte, and Gas Hills satellites
- updated aquifer pumping tests to evaluate the integrity of the confining layers and assess hydraulic parameters at the Smith Ranch Highland facility

- updated groundwater rights at the Smith Ranch Highland facility and North Butte, Gas Hills and Ruth satellites
- analysis of impact of irrigation wells and water supply wells for oil and gas fracking operations on hydraulic control in nearby mine units at Smith Ranch Highland facility

Based on the information provided by the licensee, and the NRC staff's review conducted of the characterization of the groundwater hydrology at the Smith Ranch Renewal, the NRC staff concludes that the characterization information is sufficient as it meets the applicable acceptance criteria of SRP Section 2.7.3 in all but three cases. Staff also finds the information is sufficient for staff to conclude that in all but these three cases, the licensee can protect groundwater and groundwater users in the license area from production fluids containing source and byproduct materials, as required in 10 CFR 40.41(c).

In the first case, as described in SER Section 2.4.3.2.1, the NRC staff finds the licensee did not evaluate the completion interval of private wells installed since the last safety evaluation within 2 km (1.2 mi) of the mine units at the Smith Ranch Highland license area. This evaluation is required to determine if any of these wells are completed within the ore zone aquifer of nearby mine units. NRC staff has therefore determined that there is a new safety issue with respect to protecting users of these wells. NRC staff will therefore impose a new license condition 10.1.13 to be added to the Smith Ranch Highland Source Materials License as described in SER Section 2.4.3.2.1 and shown in SER Table 2.

In the second case, the NRC staff finds that for the Ruth site, the licensee has not described the management of CBM produced water. The NRC staff addresses the safety issues arising from CBM produced water management on groundwater at the Ruth Satellite in SER Section 2.4.3.2.4. Because of the safety concerns with CBM operations at the Ruth Site, the NRC staff will retain Condition 10.2.1, requiring submittal of an operations plan for Ruth for NRC review and approval. This is further described in SER Section 2.4.3.2.4 and shown in SER Table 2.

In the third case, the NRC staff finds that for the Gas Hills site as described in SER Section 3.4.3.2.3, the licensee needs to conduct further characterization and hydrologic testing to verify the groundwater hydrology of mine units 1, 2, 3, 4, and 5. NRC staff concluded based on the prior safety evaluation and staff's current evaluation of the updated information, that the comprehensive characterization of the groundwater hydrology at the Gas Hills site must necessarily be conducted during mine unit development as it will require intensive drilling, well installation and hydrologic testing that can only occur after the mine unit is in place. The licensee has committed to conduct these evaluations during the development and hydrologic testing of each mine unit as described in Section 3.4.3, "Hydrologic Testing Document," of the Technical Report. NRC staff finds this commitment is acceptable; however, NRC staff will require by new license condition 10.3.2, as described in SER Section 2.4.3.2.3 and shown in SER Table 2, that the final hydrologic testing documents for Gas Hills mine units 1-5 be provided to NRC staff for review and verification, to ensure each mine unit is adequately characterized with respect to groundwater hydrology.

2.5 Background Surface Water and Groundwater Quality

2.5.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the characterization of surface and groundwater quality at the Smith Ranch Highland facility and satellites has been performed to meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 2.7.3 of the SRP (NRC, 2003a).

2.5.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the background surface water and groundwater quality at the Smith Ranch Highland Uranium Project. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in their Smith Ranch Renewal Technical Report (Cameco Resources 2012b). NRC staff also visited the site on several occasions during the course of this review.

2.5.3.1 Surface Water

Prior to operations, the licensee is required to sample and measure background surface water quality for one year in a sufficient number of surface water bodies within each licensed site in the Smith Ranch Highland Uranium Project. The surface water sampling program should include the analysis of physical indicator parameters, common cation and anion constituents, trace and minor metals and radionuclides including uranium and radium-226 as recommended in Table 2.7.3 of NUREG -1569 (NRC 2003a).

The licensee described the pre-operational background surface water quality of the Smith Ranch Highland, North Butte, Gas Hills and Ruth sites in Sections 3.4.2.1.2, "Water Use and Quality," 3.4.3.1.2, "Surface Water Use and Quality," 3.4.4.1.2, "Surface Water Use and Quality," and 3.4.5.1.2, "Surface Water Use and Quality," respectively, of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also described the location of surface water monitoring sites which were used for background monitoring in the Smith Ranch Highland, as well as the North Butte, Gas Hills and Ruth remote satellites in the operational surface water monitoring program description in Sections 5.10.2, "Surface Water Monitoring Programs," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The background surface water quality has been reviewed in the prior safety evaluations for Smith Ranch, Highland, Reynolds Ranch, North Butte, Gas Hills and Ruth. The licensee provided no updates on background surface water quality within the license area for the Smith Ranch Highland or Ruth remote satellite. The licensee provided the complete assessment of background surface water quality at the North Butte site before operations begin in 2012 and some updated surface water quality for the Reynolds Ranch and Gas Hills remote satellites as described below.

2.5.3.1.1 Reynolds Ranch

The licensee presented the Reynolds Ranch surface water quality sampling program and some updated measurements in Section 3.4.2.1.2, "Water Use and Quality," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The historical background surface water quality was presented in Attachment D6-2 of Appendix D-6 of the WDEQ permit for Smith Ranch Highland (Cameco Resources, 2012d). The historical background surface water monitoring locations for Reynolds Ranch were identified as Stock Pond Section 31, Silver Spoon Reservoir Section 12, Martin Springs Section 31, and Brown Springs Creek Section 31. NRC staff review of this data indicated no new sampling results since 1990, so there was no update since the last safety evaluation in 2007 (NRC 2007a).

The licensee also provided Reynolds Ranch surface water quality measurements for uranium and Ra-226 measured in August 2011 for new sites identified as Spring #1, Windmill Impoundment, White Rock Springs and Impoundment #6 in Table 3.4-1 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The sample locations were shown on Figure 5.7 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The results indicated that three of the four sites exceeded the EPA primary drinking water standards for uranium (0.03 mg/l). None of the sites exceeded the EPA primary drinking water standards for Ra 226 (5 pCi/l).

NRC staff's review found the licensee had established a sufficient number of surface water sites and measured the recommended constituents listed in Table 2.7.3 of NUREG -1569 (NRC 2003a). Prior to operations at the Reynolds Ranch site, the licensee will conduct one year of background surface water quality monitoring at these sites as required in Criterion 7 of 10 CFR Part 40.

2.5.3.1.2 North Butte

The licensee described the North Butte background surface water quality sampling program and results in Section 3.4.3.1.2, "Surface Water Use and Quality," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee established 27 new surface water quality sampling sites in addition to maintaining the three original points established by Uranerz (SWS1, SWS2, and SWS3). NRC staff review determined that 18 of these sites were located at an impoundment where a berm or dam structure was present to trap water. The remaining nine sites were located upstream or downstream of drainages sufficiently close to the operation. As reported by the licensee, all of the drainages are ephemeral; therefore, sampling is dependent on the presence of sufficient water. The background surface water monitoring locations for North Butte were shown in Figure D6-1.6 of Appendix D-6 of the WDEQ permit for North Butte (Cameco Resources, 2012e).

The licensee reported that all 30 sites were visited during field data collection in August 2010, June 2011, and September 2011 prior to startup of the North Butte operations in 2012. The licensee stated that sufficient water was available for sampling for three impoundment sites in August 2010; eleven impoundment sites and one drainage downstream site in June 2011 and two impoundment sites in September 2011.

The licensee presented this background surface water quality in Table 3.4-6 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). NRC staff review of the results indicated that one impoundment, NBI-15, exceeded EPA primary drinking water standards for natural uranium (0.03 mg/l). Two impoundments, NBI-5 and NBI-15, and the drainage, NBSD-

1, exceeded primary drinking water standards for Gross Alpha Activity (GAA) (15 pCi/l). No EPA primary drinking water standards were exceeded for metals or other constituents. EPA secondary standards were exceeded for Total Dissolved Solids (TDS) in four impoundments and in the downstream drainage.

NRC staff review found the licensee had established a sufficient number of surface water sites and measured the recommended constituents listed in Table 2.7.3 of the SRP (NRC 2003a) as required in Criterion 7 of 10 CFR Part 40. The NRC staff therefore found the licensee established the background surface water quality at the North Butte site.

2.5.3.1.3 Gas Hills

The licensee described the Gas Hills background surface water quality sampling program and updated results in Section 3.4.4.1.2, "Surface Water Use and Quality," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). Surface water quality was originally collected starting in 1996 and 1997 until 1999 from surface water monitoring locations shown in Plate D6-1 of Appendix D-6 of the Gas Hills WDEQ permit (Cameco Resources, 2012f). The sites included the mining pits known as Buss Pit, Veca Pit and the PC pit; sites WCC-1 and WCC-2 downstream of the spring on West Canyon Creek; sites SW 1-3; and sites SM- 5, 6, and 7. The licensee conducted additional sampling in 2006 and 2011 at the Buss Pit, Veca Pit, PC pit, Cameron Spring, WCC-1, WCC-2, and two new sites identified as the Cameron Pond and North Stock Pond.

The licensee presented the historical and recent background surface water quality sample results from the listed sites in Table 3.4-11 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). NRC staff review of the updated surface sampling results since the last safety evaluation from sites in 2006 and 2011 show that the surface water quality at Cameron Spring, Cameron Pond, WCC-1, and WCC-2 meets the EPA primary and secondary drinking water standards, except for GAA at the Cameron Spring. All of the mining pits, Buss, Veca, and PC, exceed EPA primary drinking water standards for natural uranium (0.03 mg/l) and GAA (15 pCi/l). The Buss Pit also exceeded EPA primary drinking water standards for beryllium (0.004 mg/l), selenium (0.01mg/l), and the secondary standards for pH, TDS, sulfate, fluoride, aluminum, iron, and manganese. The Veca pit also exceeded the secondary standards for TDS and sulfate. The PC pit also exceeded the secondary standards for TDS, sulfate, manganese. The North Stock Pond exceeded EPA primary drinking water standards for natural uranium (0.03 mg/l), GAA (15 pCi/l), arsenic (0.01mg/l), and the secondary standards for pH, TDS, aluminum, iron, and manganese.

The NRC staff found in the prior safety evaluation found that the licensee had established background surface water quality at the Gas Hills site as required in Criterion 7 of 10 CFR Part 40. NRC staff also finds the updated background surface water quality to be acceptable.

2.5.3.2 Groundwater

Prior to operations, the licensee is required to sample and measure background groundwater wells quality for one year in a sufficient number of wells in the aquifers of interest within each licensed site in the Smith Ranch Highland Uranium Project. The background groundwater sampling program should include the analysis of physical indicator parameters, common cation and anion constituents, trace and minor metals and radionuclides including uranium and radium-226 as recommended in Table 2.7.3 of the SRP (NRC 2003).

The licensee described the pre-operational background groundwater quality of the Smith Ranch Highland, as well as the North Butte, Gas Hills and Ruth remote satellites in Sections 3.4.2.2.6, "Groundwater Quality," 3.4.3.2.7, "Groundwater Quality," 3.4.4.2.5, "Groundwater Quality," and 3.4.5.2.5, "Groundwater Quality," respectively, of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). The licensee also described the location of groundwater monitoring sites which were used for background monitoring in the Smith Ranch Highland, North Butte, Gas Hills and Ruth sites in the operational groundwater monitoring program description in Section 5.10.3, "Environmental Groundwater Monitoring," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The background groundwater quality has been reviewed in the prior safety evaluations for the Smith Ranch Highland, Reynolds Ranch, North Butte, Gas Hills and Ruth sites. The licensee provided no updates on background groundwater quality within the license area for the Smith Ranch Highland or Ruth Sites. The licensee provided updated groundwater quality in 2010 for wells at the North Butte site and provided updated groundwater quality in 2006 and 2011 for wells at the Gas Hills site as described below.

2.5.3.2.1 North Butte

The licensee described the North Butte background groundwater quality sampling program in Section 3.4.3.2.7, "Groundwater Quality," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). Groundwater quality was originally measured starting in 1978 continuing until 1996 from monitoring well locations at the North Butte site. The licensee conducted additional sampling in 2010 at a subset of the wells in the ore zone aquifers (A, B, and C sands) and overlying aquifer (F sands) which were previously monitored.

The licensee presented the historical and updated background groundwater quality sample results from the A, B and C sand ore zone wells in Table D6-1.2 of Addendum D6-1 of the North Butte WDEQ Permit (Cameco Resources 2012e). The licensee compared the 2010 water quality data measured in the A, B, and C sand aquifers with the original background water quality to assess if there was a significant change since the North Butte license was granted. The licensee determined that of the 384 analyses made in the ore zone aquifers, only eight fell outside the previously established background range. The licensee reported one well, SS1-L, measured in June and August 2010, provided values of 183 and 184 PCi/l for Ra 226, which exceeded the baseline range of 0-82.4 PCi/l.

The licensee presented the historical and updated background groundwater quality sample results from the F sand overlying aquifer wells in Table D6-1.3 of Addendum D6-1 of the North Butte WDEQ Permit (Cameco Resources 2012e). The licensee reported that of the 264 constituents measured in the F sand overlying aquifer, 18 measurements fell outside the previously established background ranges. Of these measurements, only eight were exceedances. The constituents which exceeded their prior background ranges were fluoride, magnesium, sulfate, TDS, iron and manganese. These constituents are not hazardous.

NRC staff review of the updated groundwater sampling results since the last safety evaluation from wells in the A, B, and C sand ore zone aquifers in 2010 show the background groundwater quality has remained essentially the same as the original measurements. The NRC staff finds the F sand overlying aquifer displays more variability, but this variation did not indicate any anomalies of concern (e.g. contamination). The NRC staff found in the prior safety evaluation found that the licensee had established background groundwater quality at the North Butte site

as required in Criterion 7 of 10 CFR Part 40. NRC staff also finds the updated background groundwater quality to be acceptable.

2.5.3.2.2 Gas Hills

The licensee described the Gas Hills background groundwater quality sampling program in Section 3.4.4.2.5, "Groundwater Quality," of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). Groundwater quality was originally collected starting as early as 1981 and continuing through 1999 from groundwater monitoring locations shown in Plate D6-1 of Appendix D-6 of the Gas Hills WDEQ permit (Cameco Resources, 2012f). The licensee conducted additional sampling in 2006 and 2011 at the majority of the wells which were historically monitored.

The licensee presented the historical and recent background groundwater quality sample results from the Gas Hills monitoring wells in Table 3.4-14 of the Smith Ranch Renewal Environmental Report (Cameco Resources 2012b). NRC staff review of the updated groundwater sampling results since the last safety evaluation from approximately 36 wells in 2006 and 2011 show that the background groundwater quality has remained essentially the same as the original measurements for both radiological and non-radiological constituents.

The NRC staff found in the prior safety evaluation found that the licensee had established background groundwater quality at the Gas Hills site as required in Criterion 7 of 10 CFR Part 40. NRC staff also finds the updated background groundwater quality to be acceptable.

2.5.4 Evaluation Findings

The NRC staff finds that the licensee sufficiently described the preoperational background quality of surface and groundwater by providing appropriate chemical and radiochemical analyses of water samples from surface water drainages in and near the mineralized zones and appropriate subsurface aquifers in prior safety evaluations. The licensee presented updates to the pre-operational background for surface water at the Reynolds Ranch, North Butte and Gas Hills license areas. In addition, the licensee presented updates to the pre-operational background for groundwater quality at the North Butte and Gas Hills license areas. The NRC staff review finds the updated background surface and groundwater quality results do not demonstrate any new safety issues. Based upon this finding, the NRC staff concludes that the licensee has provided sufficient pre-operational background surface water and groundwater quality at the Smith Ranch Highland Uranium Project to satisfy the requirements of 10 CFR 40 Appendix A, Criterion 7 for pre-operational monitoring.

2.6 Background Radiological Characteristics

This SER section describes the NRC staff's evaluation of the licensee's description of background radiological characteristics at the Smith Ranch Highland Uranium Project. The licensee provided background radiological characteristics in the Smith Ranch Renewal Technical Report, Section 2.2.9, "Background Radiological Characteristics," (Cameco Resources 2012b) and the following sections of the Smith Ranch Project Environmental Report (ER) (Cameco 2012b):

- ER Section 3.11.5, "Smith Ranch Historical Baseline Radiological Survey Results"
- ER Section 3.11.6, "North Butte Historical Baseline Radiological Survey Results"

- ER Section 3.11.7, “Gas Hills Remote Satellite Historical Baseline Radiological Survey Results”
- ER Section 3.11.8, “Ruth Remote Satellite Historical Baseline Radiological Survey Results”

Background radiological characteristics are used to evaluate the potential radiological impact of operations on human health and the environment. Such impacts could result from spills, routine discharges from operations, and other potential releases to the environment. In addition, the data collected are used to identify a radiological baseline for decommissioning, restoration, and reclamation.

2.6.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the background radiological characteristics and the preoperational environmental monitoring program is in compliance with 10 CFR Part 40, Appendix A, Criterion 7.

License Condition 9.13 of Source Material License SUA-1548 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.”

2.6.2 Regulatory Acceptance Criteria

The NRC staff evaluated the Smith Ranch Renewal Technical Report and Smith Ranch Renewal Environmental Report for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria presented in SRP Section 2.9.3, “Acceptance Criteria” (NRC 2003a).

2.6.3 Staff Review and Analysis

In this SER, the temporal and spatial scope of the NRC staff’s evaluation of background radiological characteristics includes the period of time since Source Material License SUA-1548 was last renewed (i.e., since May 8, 2001), and the areal extent of new background radiological characterization of uranium recovery operations area that have not previously been reviewed by NRC staff. As explained further below, the NRC staff previously completed evaluations of background radiological characteristics of licensed areas that were added to Source Material License SUA-1548 by license amendment since May 8, 2001. The NRC staff has also previously evaluated, in accordance with License Condition 9.13, background radiological characteristics of individual licensed areas and mine units that the licensee planned to put into service.

With regard to the information provided by the licensee in Section 3.11, “Public and Occupational Health,” of the Smith Ranch Project Environmental Report (Cameco 2012b), the NRC staff determined that the data represented background radiological surveys performed in the 1980s and 1990s, which were the subject of individual licensing actions before the date of the last renewal of Source Material License SUA-1548. Therefore, as described below, the NRC staff focused its evaluation on background radiological survey information since May 8, 2001 that the NRC staff had not previously evaluated.

The NRC issued Amendment 5 of Source Material License SUA-1548 on August 18, 2003 (NRC 2003b). Amendment 5 was an administrative licensing action to consolidate previously-issued licenses for the Smith Ranch (Source Material License SUA-1548), Highland (SUA-

1511), and Ruth and North Butte (SUA-1401) areas. The NRC staff evaluated background radiological characteristics for those areas prior to issuance of the individual licenses described above. Likewise, on January 29, 2004, the NRC staff issued Amendment 6 to Source Material License SUA-1548, which included an NRC staff evaluation of background radiological characteristics for the Gas Hills remote satellite (NRC 2004b). In its January 31, 2007, safety evaluation in support of Amendment 11 to expand licensed operations to the Reynolds Ranch satellite area, the NRC staff did not explicitly evaluate background radiological characteristics, but added license condition 9.13 (See Section 2.6.1 of this SER) to require the licensee to survey background radiological characteristics, and submit this information for NRC staff review and approval, before engaging in uranium recovery operations in undeveloped areas (NRC 2007a). Since License Condition 9.13 was added to Source Material License SUA-1548 on January 31, 2007, the licensee has provided five submittals requesting NRC review and approval of background radiological characteristics, as follows.

- Mine Unit K, submitted April 26, 2007 (PRI 2007c); approved by NRC staff by letter dated July 5, 2008 (NRC 2008c).

- Southwest area, submitted April 20, 2007 (PRI 2007d); approved by NRC staff by letter dated July 5, 2008 (NRC 2008d).

- Reynolds Ranch satellite, submitted May 8, 2007 (PRI 2007e) approved by NRC staff by letter dated July 5, 2008, (NRC 2008e).

- Gas Hills satellite, submitted September 4, 2007 (PRI 2007g), approved by NRC staff by letter dated July 5, 2008, (NRC 2008f).

- Mine Units K-North, 7, 8, and 14, submitted September 7, 2011 (Cameco Resources 2011c).

The NRC staff has not previously reviewed and approved the licensee's September 7, 2011, submittal for mine units K-North, 7, 8, and 14. Therefore, the scope of the NRC staff's evaluation in this SER is this September 7, 2011, submittal. The NRC staff will continue to evaluate, in accordance with License Condition 9.13, the licensee's future submittals regarding background radiological characteristics as the licensee develops mine units it wishes to put into operation.

The NRC staff has reviewed and approved the background radiological surface water and groundwater monitoring data and programs for the Smith Ranch Highland, North Butte, Gas Hills and Ruth satellite license areas in this SER and prior safety evaluations. The licensee provided some updates to the background radiological monitoring results which are reviewed in SER Section 2.5.

2.6.3.1 Evaluation of Mine Units K-North, 7, 8, and 14

Mine unit K-North is located approximately 3.2 km (2 mi) north-northeast of the Central Processing Plant. In the licensee's analysis, Mine Unit K-North was called Study Area A. Mine Units 7, 8, and 14 are located approximately 2.4 km (1.5 mi) west of the Central Processing Plant. The licensee referred to minee units 7, 8, and 14 as Study Area B. Table 3-1, "Mine Unit Development Schedule," of the Smith Ranch Renewal Technical Report states that Mine Unit K

/ K-North is in operation, mine unit 7 is under development, mine unit 8 is proposed, and there is no longer a listing for mine unit 14 (Cameco Resources 2012b).

The licensee gathered direct gamma radiation measurements at 150 m (500 ft) intervals. Soil samples were collected at depths of 5 and 15 cm (2 and 6 in) every 300 m (1,000 ft) throughout the study areas. Consistent with the NRC staff's determination in its prior evaluation of Mine Unit K (NRC 2008c), the NRC determined that the licensee's soil sampling and direct radiation measurements are an acceptable survey methodology.

The NRC staff evaluated the licensee's analysis by examining the survey maps for each Study Area and reviewing the licensee's summary of sample results. The NRC staff's summary of the results is provided in Table 15~~Table 15~~ below.

Table 15. Background radiological characteristics in Mine Units K-North, 7, 8, and 14.

Study Area	Direct gamma µR/hr	Sample Depth cm (in)	Ra-226 pCi/g-dry	U(nat) mg/kg-dry	Th-230 pCi/g-dry	Pb-210 pCi/g-dry
Mine Unit K-North	14 - 26	5 (2)	0.8 – 5.0	1.13 – 2.11	0.6 – 1.5	0.7 – 1.2
		15 (6)	0.8 – 4.9	1.11 – 4.08	0.5 – 3.3	0.5 – 1.6
Mine Units 7, 8, and 14	12 - 36	5 (2)	0.1 – 11.7	0.91 – 2.45	0.2 – 1.8	0.2 – 1.6
		15 (6)	0.4 – 6.9	0.72 – 3.3	0.3 – 3.0	0.07 – 2.4

The NRC staff determined the licensee has adequately established the baseline radiological characteristics by providing (i) baseline radiological characteristics that include radionuclides monitored, sampling frequency, and methods, location, and density, and (ii) radiological analyses of soil samples taken at 5 cm (2 in) and 15 cm (6 in) depths. The licensee's report indicates that systematic soil sampling was performed at the density specified in Regulatory Guide 4.14, Revision 1 (NRC 1980a). The report also indicates that all soil samples were analyzed for radium-226 and 10 percent of the samples were analyzed for natural uranium, thorium-230, and lead-210, as specified in Regulatory Guide 4.14, Revision 1 (NRC 1980a).

2.6.4 Evaluation Findings

NRC has completed its review of the background radiological characterization information at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 2.9.2 and acceptance criteria outlined in SRP Section 2.9.3. The licensee has acceptably established background radiological characteristics by providing background radiological characteristics that include radionuclides monitored, sampling frequency, and methods, location, and density and radiological analyses of soil samples at 5 cm (2 in) and 15 cm (6 in) depths. Based on the information provided in the application, and the additional review conducted of the characterization of the background radiological characteristics at the Smith Ranch Highland Uranium Project, the NRC staff concludes that the information is acceptable to allow evaluation of the radiological background of the site and is in compliance with 10 CFR Part 40, Appendix A, Criterion 7 and License Condition 9.13 of Source Material License SUA-1548.

3.0 DESCRIPTION OF THE FACILITY

3.1 In Situ Recovery Process and Equipment

3.1.1 Regulatory Requirements

The staff determines if the licensee demonstrated that the equipment and processes used during ISR operations at the Smith Ranch Highland, North Butte, Gas Hills and Ruth facilities meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.1.2 Regulatory Acceptance Criteria

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

3.1.3 Staff Review and Analysis

The following sections present the NRC staff's review and analysis of various aspects of the ISR processes and equipment proposed for the Smith Ranch Highland Uranium Project. Review areas addressed in this section include: site description and facilities layout; mine unit and mineralized zone description; well completion and mechanical integrity testing; mine unit design and operation; mine unit operational monitoring; water balance and waste water management; consumptive use and drawdown; and proposed schedule. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in their Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The NRC staff also examined the inspection reports as described in SER Appendix A. The staff also visited the site on several occasions during the course of this review to confirm information presented by the licensee.

License Condition 10.3.2 of SUA-1548 requires that prior to the onset of commercial ISR activities at the Gas Hills Remote Satellite, the licensee must prepare a new operations plan in accordance with the guidance in NUREG-1569 for NRC review and approval. This requirement differs from the license condition 10.2.1 for North Butte and Ruth, in that it does not limit the submittal to "those activities not previously assessed by the NRC". The licensee stated that details on how the facility will be operated and the basis for the performance based license are contained in Sections 3 through 6 of NUREG -1569. These four sections require a description of the proposed facility, effluent control systems, operations, and restoration and decommissioning. The licensee therefore stated that it is providing Sections 3.0 through 6.0 of the Technical Report as its updated Operations Plan for the entire license, including the Gas Hills remote satellite. NRC staff therefore reviewed these sections as new information to be evaluated and approved.

3.1.3.1 Site Description and Facilities Layout

3.1.3.1.1 Smith Ranch Highland

The licensee provided the description of the Smith Ranch Highland CPP and CPF facilities layout in Sections 3.2.1, "Smith Ranch," and 3.6.1.1, "General Facility Layout," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that the Smith Ranch CPP facility is located in in the Section 36 of T36N R74W as shown in Figure 1.3

of the Technical Report. The CPP facility houses the IX columns, resin transfer, elution, yellow cake processing and drying and packaging circuits. The licensee reported that the CPP has a design production capacity of 17,034 lpm (4,500 gpm). The licensee stated that the main Smith Ranch IX facility serves MUs 1, 2, and 3. The facility has two Reverse Osmosis (RO) units with a capacity of 757 lpm (200 gpm) each for restoration.

The licensee stated that the former Highland CPF complex is located in Section 29, T36N R72W as shown in Figure 1.3 of the Technical Report. The CPF was refurbished in 2013 to resume IX processing and yellow cake drying. The facility will also be used for third party toll processing. The CPF is currently on standby status.

The licensee provided the description of the Smith Ranch Highland Satellite facilities layout in Section 3.6.2.1, "General Facility Layout," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that there are five satellite IX facilities at the Smith Ranch Highland Facility. The licensee reported that Satellites 1, 2, and 3 are located on the Highland portion of the license area. The licensee stated that satellites SR-1 and SR-2 are located on the Smith Ranch portion of the license area.

The licensee reported that Satellites 2, 3, SR-1 and SR-2 are all operational and being used for production and restoration of MUs. All of these building house IX columns, water treatment equipment, resin transfer facilities, RO units and bioremediation treatment materials for restoration circuits as well as labs and employee offices.

The location of Satellite 1 was provided by the licensee in Figure 3.22 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee reported that Satellite 1 is no longer in operation. When in operation, Satellite 1 had a design production capacity of 6,814 lpm (1,800 gpm) and served MUs A and B. MUA was approved for restoration by NRC and WDEQ (NRC 2004c). The licensee stated that MUB has been approved for restoration by WDEQ. The licensee has prepared and submitted an ACL application for NRC approval of the restoration of MUB.

The location of Satellite 2 was provided by the licensee in Figure 3.23 and the floor plan in Figure 3.24 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Satellite 2 has a design production capacity of 12,113 lpm (3,200 gpm). The licensee stated it currently serves MUs C, D, D-Extension, F, E, H, and I. The selenium treatment facility which is used to treat waste water before land application is located immediately adjacent to Satellite 2 as shown in Technical Report Figure 3.2.3.

The location of Satellite 3 was provided by the licensee in Figure 3.25 and the floor plan in Figure 3.26 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Satellite 3 has a design production capacity of 22,712 lpm (6,000 gpm). The licensee stated it currently serves MUs D-Extension, F, J and K.

The location of Satellite SR-1 was provided by the licensee in Figure 3.27 and the floor plan in Figure 3.28 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Satellite SR-1 has a design production capacity of 17,034 lpm (4,500 gpm). The licensee stated it currently serves MUs 3, 4, 15 and 15A. The RO capacity of Satellite SR-1 is 1,893 lpm (500 gpm).

The location of Satellite SR-2 was provided by the licensee in Figure 3.29 and the floor plan in Figure 3.30 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

Satellite SR-2 has a design production capacity of 18,927 lpm (5,000 gpm). The licensee stated it currently serves MUs 9 and will serve Mus 10, 11, and 12 after they are constructed. The RO capacity of Satellite SR-1 is 1,893 lpm (500 gpm).

The licensee reported that a sixth satellite facility is planned for Reynolds Ranch, but has not yet been constructed. The NRC staff approved the Reynolds Ranch satellite in 2007 (NRC, 2007a). The proposed location of Reynolds Ranch satellite facility was provided by the licensee in Figure 3.31 and the floor plan in Figure 3.32 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). This satellite will have a design production flow rate capacity of 22,712 lpm (6,000 gpm), therefore, the licensee has requested approval for this flow rate increase over the currently licensed flow rate of 17,034 lpm (4,500 gpm). The licensee stated it will serve all of the Reynolds Ranch satellite after they are constructed. The planned RO capacity of the Reynolds Ranch satellite is 3,785 lpm (1,000 gpm).

With the exception of the requested production flow rate increase at Reynolds Ranch which is reviewed in this SER Section 3.1.3.5.1, NRC staff have previously reviewed the description of the site and facilities layout at the Smith Ranch Highland license area. NRC staff has found no new safety issue related to updated description of the existing site description or facilities layout.

3.1.3.1.2 North Butte

The licensee provided the description of the North Butte Satellite facility in Sections 3.2.2, "North Butte Remote Satllite," and 3.6.3.1, "General Facility Layout," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that the North Butte Satellite facility is located in in the NE ¼ Section 24, T44N, R75W as shown in Figure 1.10 of the Technical Report. The North Butte main facility was constructed in 2013. The satellite facility houses IX columns, resin transfer facilities, water treatment equipment, RO units and bioremediation treatment materials for restoration circuits as well as labs and employee offices. The North Butte facility was originally licensed for a production flow rate of 15,142 lpm (4,000 gpm). However, the licensee has requested approval of a production flow rate of 22,712 lpm (6,000 gpm). The licensee stated that the main North Butte satellite facility will serve all five of the North Butte MUs.

With the exception of the requested production flow rate increase at North Butte which is reviewed in this SER Section 3.1.3.5.2, NRC staff have previously reviewed and approved the description of the site and facilities layout at the North Butte license area (NRC, 1990a). NRC staff has found no new safety issue related to updated description of the North Butte site or facilities layout.

3.1.3.1.3 Gas Hills

The licensee provided the description of the Gas Hills Satellite facility in Sections 3.2.3, "Gas Hills Remote Satellite," and 3.6.4.1, "General Facility Layout," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that the Gas Hills Satellite facility is located in in the SW ¼ Section 33 of T33N R89W. It will include the Carol Shop Satellite Building as shown in Figure 1.11 of the Technical Report. It will also include the Gas Hills Alternative Satellite Building in one of two possible locations as shown in Figure 1.11 and 1.12 of the Technical Report. The Carol Shop satellite facility will house IX columns, resin transfer facilities, water treatment equipment, RO units and bioremediation treatment materials for restoration circuits as well as labs and employee offices. The Carol Shop facility may also house a yellow cake slurry circuit. The Alternative Satellite will house IX columns, resin transfer

facilities and additional RO treatment for restoration. The Gas Hills facility was originally licensed for a production flow rate of 45,425 lpm (12,000 gpm). However, the licensee has requested approval for the design production flow rate of 51,103 lpm (13,500 gpm). This production will be split as 34,069 lpm (9,000 gpm) at the Carol Shop Satellite and 17,034 lpm (4,500 gpm) at the Alternative Satellite facility. The licensee stated that the two satellite facilities will serve all five of the Gas Hills MUs.

With the exception of the requested production flow rate increase at the Gas Hills site which is reviewed in this SER Section 3.1.3.5.3, NRC staff have previously reviewed and approved the description of the site and facilities layout at the Gas Hills license area (NRC, 2004b). NRC staff has found no new safety issue related to updated description of the existing site description or facilities layout.

3.1.3.1.4 Ruth

The licensee provided the description of the Ruth Satellite facility in Sections 3.2.4, “Ruth Remote Satellite,” and 3.6.5.1, “General Facility Layout,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The Ruth Satellite is located in T42N R77W Sections 1, 3, 14, 23, 24, and 26 as shown in Figure 1.13 of the Technical Report. The licensee reported that the facility currently has three buildings, two evaporation ponds and three monitoring wells. All existing facilities at the Ruth Satellite are non-operational. The current licensed flow rate is 3,785 lpm (1,000 gpm).

The licensee stated it does not plan to extract uranium at Ruth in the next 10 years. The licensee stated that an operations plan that details the mine units, IX circuit and other details has not been developed. The NRC staff therefore finds that the licensee has not provided sufficient information to operate the Ruth Satellite site. NRC staff will retain the current license condition 10.2.1 in License SUA-1548 that will require that the licensee provide an operations plan for the Ruth remote satellite for NRC review and approval before operations begin.

3.1.3.2 Mine Unit and Mineralized Zone Descriptions

3.1.3.2.1 Smith Ranch Highland

The licensee described the mine units and mineralized areas within the Smith Ranch Highland license area including the Reynolds Ranch Satellite in Section 3.3.1, “Smith Ranch,” of Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee provided a description of the current and proposed Smith Ranch Highland Mine units in Section 3.3.1.3, “Smith Ranch Mine Unit Locations,” and in Table 3-1. The table indicated that MU A and B had been approved for restoration by WDEQ. MU A has received NRC approval for restoration (NRC, 2004c). MUs F, H, I, J, K, K North, 2, 3, 9, 15 and 15 A have been constructed. MUs 7, 10, 11 and 21 through 28 were being delineated with some monitoring and production well drilling completed. MUs Hext, Iext, M, 8, 12, 13, 16 and 17 were proposed but not yet delineated. Technical Report Table 3-1 also showed that MUs C, D, D extension, E, 1, 4, 4A were not producing. The licensee reported that C and D extension are in restoration. NRC has received an ACL application for review and approval for restoration of MU1 (Cameco Resources, 2018b).

The licensee identified several proposed mine units including MUs 8, 12 13, 16, 17, H ext, I ext and M. The licensee provided a description of these mine units in Technical Report Table 3.1-1,

including total acreage, the sands which contain the ore zone(s), and overlying and underlying aquifers/aquitards. None of the proposed mine units target ore sands which were not previously characterized; therefore, Technical Report Table 3.1-1 also provided the hydraulic parameters of the production zone aquifers in adjacent mine units (e.g. hydraulic conductivity), as an estimate of values which are likely to be representative of the ore sands targetd in the proposed mine units. The licensee reported no change in the number or location of mine units at Reynolds Ranch. The licensee previously reported that the economic uranium deposits at the Smith Ranch Highland license area occur in roll front deposits of the Eocene Wasatch Formation and Paleocene Fort Union Formation. The licensee reported that the two common ore minerals are uraninite and coffinite. The ore is located at different depths in sands identified as the K, M, O, Q, S and U sands at the Smith Ranch and Reynolds Ranch sites and the 20 through 60 sands at the Highland site. The stratigraphy at the Smith Ranch, Highland and Reynolds Ranch site was provided in SER Table 6~~Table 6~~.

NRC staff have previously reviewed the description of the mine units and uranium mineralization at the Smith Ranch Highland license area. NRC staff has found no new safety issue related to updated description of the proposed mine units or uranium mineralization.

3.1.3.2.2 North Butte

The licensee described the mine units and mineralized areas within the North Butte Satellite license area in Section 3.3.2, “North Butte Remote Satellite,” of Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee provided a description of the current and proposed North Butte mine units in Section 3.3.2.3, “North Butte Mine Unit Locations,” of the Technical Report. The location of MU1 was shown in and in Figure 3.5 of the Technical Report. MU1 has been installed and operating since 2013. MU2 has been delineated and some wells have been installed. MUs 3-5 have not undergone further delineation. The NRC staff reviewed the geologic description of MUs 1-5 and the targeted ore zones in SER Section 2.3.3.1.2 and provided the stratigraphy in SER Table 7~~Table 7~~.

The licensee reported that the economic uranium deposits at the North Butte Satellite license area occur in roll front deposits of the Eocene Wasatch Formation. The licensee previously reported that the uranium mineralization was present as coffinite. The uranium was deposited on detrital sands and interstitial clays. The primary interstitial clay present was montmorillonite, with some kaolinite and smectite.

The licensee reported it conducted a new detailed mineralogical study of two cores from the North Butte ore zones in 2010. The licensee reported these cores confirmed the major uranium mineralization was coffinite associated with tyuyamunite, however, a minor amount of uraninite mineralization was also found. The uranium was also confirmed to be deposited on detrital sands between layers of montmorillonite or chlorite clays. The core study also showed that thorium was present and may have influenced some of the radiometric drill hole logging data.

NRC staff have previously reviewed the description of the mine units and uranium mineralization at the North Butte license area. NRC staff has found no new safety issue related to updated description of the proposed mine units or uranium mineralization.

3.1.3.2.3 Gas Hills

The licensee described the mine units and mineralized areas within the Gas Hills Satellite license area in Section 3.3.3 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee provided a description of the proposed Gas Hills mine units 1 through 5 in Technical Report Section 3.3.3.3, "Gas Hills Mine Unit Locations." The location of the mine units were also shown in Technical Report Figures 1.11 and 1.12. The NRC staff reviewed the geologic description of the location of the MUs 1 through 5 and the targeted ore zones in SER Section 2.3.3.1.3 and provided the stratigraphy in SER Table 8~~Table 8~~ through SER Table 12~~Table 12~~.

The licensee reported that the economic uranium deposits at the Gas Hills Satellite license area occur in roll front deposits of the Puddle Springs Arkose Member of the Wind River formation in the 30 through 80 sands. The licensee previously reported that the uranium mineralization at the Gas Hills Satellite was present as uraninite and coffinite. The roll fronts are as much as 47.5 m (156 ft) thick and vary in width from 0.3 to 30.5 m (1 to 100 ft).

The licensee indicated that stratigraphic interpretation of the ore zones at the Gas Hills satellite is complicated by extensive intermingling of the strata and post – depositional faulting. It presented its current evaluation of the complex setting of the proposed ore zones in each of the mine units in Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Technical Report. The licensee, given the complexity of the site, stated it would conduct additional characterization and hydrologic testing to verify the hydrostratigraphy and groundwater hydrology of MUs 1, 2, 3, 4, and 5. This characterization would enable the licensee to select the final ore zones to be targeted in each mine unit.

The NRC staff reviewed the proposed ore zone designations and associated complex hydrostratigraphy and groundwater hydrology of the Gas Hills MUs 1 through 5 in SER Section 2.4.3.2.3. NRC staff review finds that all of the Gas Hills mine units and proposed targeted ore zones were approved in the last safety evaluation (NRC 2004b). This approval was granted by NRC staff with the awareness that the licensee, given the complexity of the site, would conduct further ore zone characterization of MUs 1, 2, 3, 4, and 5 to enable the licensee to finalize the ore zones to be targeted. The licensee stated in Section 3.4.3, "Hydrologic Test Document," of the Technical Report that it would provide the updated mine unit information in a hydrologic testing document to the WYLQD. The content of the hydrologic testing document is provided in Section 3.4.3, "Hydrologic Test Document," of the Technical Report.

NRC staff concludes, based on the prior safety evaluation and staff's current evaluation of the updated information, that the comprehensive characterization of the ore zones at the Gas Hills site must be conducted during mine unit development as it will require intensive drilling and testing that can only occur after the mine unit infrastructure is in place. The licensee has committed to conduct these evaluations during the development and hydrologic testing of each mine unit as described in Sections 3.4.2, "Hydrologic Testing Proposal," and 3.4.3, "Hydrologic Testing Document," of the Technical Report. NRC staff finds this commitment is acceptable; however, NRC staff will require by license condition 10.3.2, that the final mine unit hydrologic testing document for Gas Hills MUs 1 through 5 be provided to NRC staff for review and verification, to ensure each mine unit ore zone is adequately characterized. This condition is further discussed in SER Section 2.4.3.2.3 and shown in SER Table 2~~Table 2~~.

3.1.3.2.4 Ruth

The licensee described the mine units and mineralized areas within the Ruth Satellite license area in Section 3.3.4, “Ruth Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The original license stated three MUs were to be installed. These mine units will target uranium ore in the A sand as shown in SER Table 13~~Table 13~~.

The licensee reported that the economic uranium deposits at the Ruth Satellite license area occur in roll front deposits of the Eocene Wasatch. The licensee previously reported that the uranium mineralization at the Ruth Satellite was present as amorphous uraninite, sooty pitchblende and some cartonite. The uranium is deposited on individual grains or upon interstitial clays. The clays present are mainly montmorillonite and some kaolinite. No updates to the uranium mineralization were presented.

The licensee stated that it does not plan to extract uranium at Ruth within the next license period. The licensee stated it has not yet completed an updated operation plan and the final Ruth satellite layout and mine units has yet to be developed. NRC staff will therefore continue to retain the current license condition 10.2.1 in License SUA-1548 that requires the licensee to provide a plan of operations for the Ruth Site for NRC review and approval before operations begin.

3.1.3.3 Well Completion, Mechanical Integrity Testing, and Abandonment

3.1.3.3.1 Well Completion

The licensee presented well construction and completion techniques to be used at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.2, “Well Construction and Completion Techniques,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that all wells will be constructed and completed in accordance with WSEO, WQD and LQD rules and regulations for the State of Wyoming. In Technical Report Section 3.5.2.1, “General,” the licensee stated that three types of wells will be installed including injection, extraction and monitoring wells. The licensee provided schematic drawings of the completion and construction for the injection, extraction and monitoring wells in Technical Report Figures 3.11, 3.12, and 3.13, respectively.

The licensee described the well construction materials in Section 3.5.2.2, “Well Construction Materials,” of the Technical Report. The licensee reported that the typical well casing to be used will be Standard Dimension Ratio 17 (SDR-17) polyvinyl chloride (PVC) casing with a nominal 12.7 cm (5 in) outside dimension. The casing will be in lengths of 6.1 m (20 ft) and will be joined mechanically using a water tight O-ring seal with a high strength nylon spline. The licensee stated that no glue or screws will be used to join casing. Alternative casing materials such as fiberglass or steel may be used along as they meet applicable ASTM standards for well casing and are suited to the intended use.

The licensee described the well completion method as a series of steps in Section 3.5.2.3, “Typical Well Construction Techniques,” of the Technical Report. After drilling and casing the well, the licensee stated the well annulus will be filled will be with cement or bentonite grout to the surface to prevent contamination form the annulus to overlying aquifers. The well screen will be inserted and secured within the target ore zone aquifer at the desired interval. A gravel pack may be installed depending on the condition of the ore zone formation and use of the well. The completed well will be developed by pumping or swabbing to ensure that the screens are

cleared of drilling fluids and other debris. Each production well will be protected by a flange installed over the well head. A fiberglass or plastic protective cover is placed over each well. Once the well is completed, a well completion report will be prepared and maintained on site.

NRC staff have reviewed these well completion methods which are currently in use at existing Smith Ranch Highland and North Butte mine units. NRC staff finds the licensee has corrected the issue of numerous MIT failures, described in SER Section 3.1.3.3.2, by eliminating screw and glue joints in wells and using only O-ring and nylon spline to join casing. Since correcting this issue, the NRC has identified no performance issue with these well completion methods (see SER Appendix A). In addition, NRC staff has found no new safety issue related to use of these methods as proposed by the licensee in the existing or proposed mine units at the Smith Ranch Highland Uranium Project.

3.1.3.3.2 Well Mechanical Integrity Testing

The licensee presented the well mechanical integrity testing (MIT) procedures which will be used at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.2.5, "Well Integrity Test Procedures," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that all cased wells will be undergo an MIT following well completion and prior to their initial use. All injection wells will be retested at least once every five years. In addition, the licensee also stated it will test any well which has undergone any underream or any work over operation involving the use of a cutting tool. The licensee stated it will also conduct an MIT on any well suspected to be damaged from an operational issues, such as overpressurization.

The licensee stated that only MIT procedures approved by EPA will be used on wells at the Smith Ranch Highland Uranium Project. The MIT procedure described by the licensee stated the casing will be isolated by packers and will be pressured to 125% of the expected maximum operation pressure. The well will be closed in and the interior casing pressure will be monitored for ten minutes. If the well loses more the 10% of the pressure during the time period, the well will be considered to have failed the MIT. The well will then be retested. If well fails the MIT a second time it can be repaired and retested in 120 days or it can be plugged and abandoned (P&A) within 120 days. The licensee also stated that if a well fails MIT after use as an injection well, the licensee will investigate if the well failure may have released fluids to a non-exempt aquifer. The licensee provided the procedure to investigate any release of fluids from the failed well in Section 3.5.2.5 of the Technical Report. The licensee stated that if a well fails an MIT, it will be reported to NRC and WY LQD. All MIT results will be documented and maintained on site.

During the prior operating period, the licensee experienced numerous MIT failures in MUs C, E, and F at the Smith Ranch Highland license area. These MIT failures are described in the NRC staff performance review of license SUA-1548 in SER Section A.4 of Appendix A. In its root cause analysis, the licensee determined that these MIT failures were caused by the use of screw and glue joints in the well casings, where the screws deteriorated and caused leaks in the casing joints. The licensee plugged and abandoned all of the wells which suffered these casing failures. All of the new and replacement wells were completed using the O-ring and spline method to join the casings as described in SER Section 3.1.3.3.1. The licensee has reported minimal MIT failures since adapting this well construction method.

After the numerous MIT failures in MUs C, E and F, the licensee also undertook a Casing Leak Investigation (CLI) to investigate if leaks from these failed wells reached non-exempt aquifers in the mine units affected. This CLI is described in SER Section 3.1.3.4.6.

NRC staff have reviewed these MIT methods which are currently in use at existing Smith Ranch Highland and North Butte mine units. NRC has found no performance issue with these techniques (see SER Appendix A). In addition, NRC staff has found no new safety issue related to use of thee MIT methods as proposed by the licensee in the existing or proposed mine units. NRC staff notes that License SUA-1548 has a License Condition 10.1.3 that addresses the MIT testing procedures used at the Smith Ranch Highland Uranium Project. NRC staff finds License Condition 10.1.3 reflects the licensee's current MIT commitment in the license renewal and requires no modification.

3.1.3.3.3 Well Plugging and Abandonment

The licensee described the methods that will be used for plugging and abandonment (P&A) of exploration holes and wells at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.2.7, "Abandoned Exploration Drill Holes," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that all exploratory drill holes and wells will be plugged and abandoned (P&A) in accordance with the State of Wyoming and WY LQD rules and regulations.

NRC staff have reviewed these well plugging and abandonment techniques which are currently in use at existing Smith Ranch Highland and North Butte mine units. NRC has found no performance issue with these techniques (see SER Appendix A). In addition, NRC staff has found no new safety issue related to use of these techniques as proposed by the licensee in the existing or proposed mine units.

The licensee stated that it maintains a database listing the coordinates, elevation, depth drilled and completion date of all known drill holes completed by previous land owners and Cameco Resources at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.2.8, "Historical Drill Hoel Abandonment," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee reported there are more than 50,000 drill holes located within the SUA-1548 license areas. The licensee stated the number of plugged and abandoned drill holes was 2,700 at the North Butte Satellite and 14,000 the Gas Hills Satellite. The license provided tables and maps of known abandoned drill hole location in Section 7.0 of Appendix D-5 of the WDEQ Smith Ranch Permit (Cameco Resources, 2012d), Section 4 of Appendix D-5 of the WDEQ North Butte Permit (Cameco Resources, 2012e) and Appendix D-5 of Appendix D5-3 of the WDEQ Gas Hills Permit (Cameco Resources, 2012f).

The licensee stated it continues to work to find improperly plugged and abandoned wells within all of the license areas of the Smith Ranch Highland Uranium Project using the methods described in Section 3.4.3, "Hydrologic Testing Document," of the Smith Ranch Renewal Technical Report (Cameco Resources, 2012b). The NRC staff reviewed these methods to find improperly plugged and abandoned wells at Smith Ranch Highland Uranium Project are acceptable and found no performance issue in their use (see SER Appendix A). In addition, NRC staff has found no new safety issue related to use of these methods in the existing or proposed mine units.

3.1.3.4 Mine Unit Design and Operation

3.1.3.4.1 ISR Process and Lixiviant Composition

The licensee stated the ISR process at the Smith Ranch Highland Uranium Project has been and will continue to be conducted by injecting lixiviant into the mine units and recovering uranium bearing solution to be processed by ion exchange. The licensee described the composition of the lixiviant and the geochemical reactions involved in the ISR process at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Sections 3.5.3.1, "Lixiviant Composition," and 3.5.3.2, "Anticipated Geochemical Reactions," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee stated that the lixiviant injected into the ore zone aquifers at the Smith Ranch Highland has and will continue to consist of native groundwater with the addition of sodium bicarbonate/carbonate, carbon dioxide, hydrogen peroxide or oxygen. The licensee stated the hydrogen peroxide or oxygen present in the lixiviant will oxidize the uranium off of the ore bodies and the carbonate will complex the uranium into solution as governed by geochemical reactions presented in Techical Report Section.

The licensee stated that the target dissolved oxygen concentration in the lixiviant would be maintained at approximately 400 mg/l using oxygen gas or hydrogen peroxide. The licensee presented an equation (3) in Section 3.5.3.2 which it will use to calculate the concentration of dissolved oxygen which can be maintained in solution for a given pressure. This pressure is dependent on the water level in the ore zone aquifer. The licensee stated that if the water level (known as head) in a target ore zone aquifer is insufficient to maintain the desired level of dissolved oxygen in solution, the oxygen concentration will be monitored and adjusted in each mine unit as necessary to maintain oxygen in solution and avoid off- gassing.

NRC staff agree that the licensee should actively monitor the oxygen concentration in ore zone aquifers with low water levels (head) to avoid off- gassing. This off-gassing can create an undesirable condition known as "gas lock," where the dissolved oxygen that comes out of solution in response to low head becomes a free gas phase in the aquifer (Uranium One, 2009). As a free gas phase, the oxygen can cause significant and unpredictable reductions in permeability in the ore zone which can cause significant loss of injectivity at injection wells and create preferential flow paths. These effects can lead to loss of hydraulic control of fluids. In addition, the presence of a free gas also creates two phase flow (water and gas) in well casing, pumps, pipes, and pressure/flow meters. This two phase flow can cause safety issues such as slug flow in piping, cavitation in pumps and failure in flow/pressure meter measurements as these systems were not designed for two phase flow. Active monitoring of oxygen levels by the licensee should detect any free oxygen and allow adjustment of the dissolved oxygen levels in the lixiviant to prevent "gas lock" conditions.

The licensee stated it has over 20 years of experience of successful uranium recovery with this ISR process and lixiviant composition at the Smith Ranch Highland facility. In addition, the licensee reported that standardized leach tests conducted on two cores from North Butte in 2009 confirmed the amenability of the ore zone providing an 85% recovery of uranium using a lixiviant composed of 1 g/l sodium bicarbonate. The licensee also stated that this ISR process and lixiviant composition is compatible with the type of clays found in the ore zones at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites.

NRC staff have reviewed the ISR process and composition of lixiviant which is currently in use at existing Smith Ranch Highland and North Butte mine units and planned for the Gas Hills and Ruth mine unit. The NRC staff finds this lixiviant composition is in agreement with the License Condition 10.1.4 of current license SUA-1548. NRC has found no performance issue with the ISR process or lixiviant composition (see SER Appendix A). In addition, NRC staff has found no new safety issue related to use of this ISR process or lixiviant composition as proposed by the licensee in the existing or proposed mine units.

3.1.3.4.2 Mine Unit Piping and Header House Design, Equipment and Instrumentation

The licensee described the general mine unit piping and header house design, equipment and instrumentation for mine units at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.3.3, "Mine Unit Piping, Instrumentation, and Operation," and 3.6.1.6, "Equipment, Instrumentation, and Control," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee reported that underground piping is used for the transfer barren and uranium rich lixiviant between the mine units and the CPP, CPF, and satellite processing facilities at the Smith Ranch Highland Uranium Project during production operations in Section 3.5.3.3, "Mine Unit Piping, Instrumentation, and Operation," of the Technical Report. The licensee stated that the pipeline systems have been designed to facilitate production and allow restoration activities to begin as soon as production has ceased in a mine unit or portion of a mine unit. Therefore, the licensee stated that production and restoration flow to and from the processing facilities and header houses of each mine unit run through separate but parallel pipelines. Additional pipelines may be installed to carry carbon dioxide or oxygen to the header houses, to act as cleanout lines for waste water from well cleaning operations, or to carry groundwater treatment RO reject brine to the purge storage reservoir or deep disposal wells.

The licensee stated that all pipelines are constructed of high density polyethylene piping (HDPE). The diameter of the piping varies from 5.1 cm (2 in) for injection and recovery lines running to and from mine unit injection and recovery wells to the header houses to as much as 45.7 cm (18 in) on the injection and recovery lines which run between the header houses and processing facilities. The HDPE piping is welded together using a manufacturer approved butt fusion technique.

The licensee stated that all pipelines are buried a minimum of 1.52 m (5 ft) bgs to protect from freezing. The licensee stated that the design objective for the layout of pipelines is to install all in a single trench at the same time where possible to minimize surface and ground disturbance. The licensee stated all pipelines that are field welded are pressure tested for leakage before they are put into use. Pipelines which are not field welded are examined for manufacturing defects and transportation damage before installation. The licensee also stated that during operation all continuous service pipe lines will be equipped with high and low pressure sensors and flow meters to warn operators of upset conditions such as breaks or blockages to enable appropriate corrective action to be taken.

The licensee described the mine unit header house design, equipment and instrumentation for mine units at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.6.1.6, "Equipment, Instrumentation, and Control," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee reported it maintains continuous, real-time monitoring and control of the total production and injection flow rates; and pressure on the injection trunk lines at the header houses. The trunk lines are connected to manifolds known as headers. There is an injection header to supply the individual injection wells, and a production header to recover fluids from the individual production wells. The licensee stated that all new header houses are equipped with a combination of pressure reducing valve and shutoff valve on the injection header. The new header houses are equipped with a process logic controller (PLC) that monitors the injection and production header pressure transducers. If the injection pressure is exceeded on the header, the valve will shut down the injection line. In addition, the PLC is programmed to detect high and low pressure set points and will shut down the valve and turn off the pumps in the header house. A beacon that is installed on the house illuminates to alert mine unit operators that a header house has shut down. In addition, The PLC also signals the control room computer at the satellite that a header house is shut down.

The licensee stated that each new header house is installed with a concrete basement that is equipped with a sump and sump pump capable of pumping leaked fluids back into the production pipeline. The licensee reported that a conductivity probe, a level transducer or float, is used to detect the presence of liquids in the mine unit basement in new header houses. There are two separate alarms. The first alarm is triggered when 7.6 cm (3 in) of water is detected and starts the sump pump. A second alarms is triggered when water has reached 0.61 to 0.91 m (2 to 3 ft) in depth, indicating that the sump pump is not sufficient to handle the leak. If the second alarm is triggered, the PLC shuts down the injection flow and production wells at the header house. A beacon is activated and the PLC signals the control room computer that the header house is shutdown.

The licensee reported that some older mine unit header houses do not have PLC connectivity or concrete basements. However, all header houses have the same valve configuration on the injection line which shuts down if the high pressure set point is exceeded. In addition, all header houses have leak detection with sump pumps. Beacon lights are also triggered to inform mine unit operators of header house shut down.

The licensee also stated that the oxygen injection system on each header house has a solenoid operated valve that closes in the event of power failure or header house shut down. If a carbon dioxide injection system is present, it is also instrumented in the same way. Instrumentation to monitor pH is also installed and monitored by the PLC in new header house.

The licensee states the flow rate and pressure on the individual injection and production wells are measured daily and adjusted in the mine unit header houses. Starting with the new header houses in MU 15A, the individual well flow meter instantaneous rate is monitored by the PLC. If the PLC detects an upset condition in the flow, it sends an alarm to the satellite control room. The licensee reported that starting with MU 15A, the licensee installs well head leak detection instrumentation on all production and injection wells. The well head instrumentation is linked to the header house PLC so if there is a leak detected on an individual well, it is shut down.

The licensee stated that the main trunklines running from the header houses to the satellites are also monitored by a PLC. If an upset condition in pressure is detected, an alarm is sent to the control room of the satellite. Each manhole valve which services these lines has a leak detection alarm that provides a visual alarm if the manhole is filled with water. The manholes are routinely inspected.

The licensee reported that each header house and mine unit is inspected daily. In addition, all leak detection equipment are tested monthly.

NRC staff have reviewed the existing and updated mine unit piping, header house design, equipment and instrumentation for the Smith Ranch Highland Uranium Project mine units. The NRC staff has identified performance issues with spills and leaks from mine units and header houses which are reviewed in SER Appendix A and SER Section 3.1.3.4.6. The NRC staff, however, finds that the licensee has addressed these performance issues with corrective actions including the improvements to mine unit piping, header house design, equipment, instrumentation and leak detection systems described in the Technical Report. With these improvements, NRC staff has found no new safety issue related to mine unit piping, header houses design, equipment and instrumentation to be employed in the existing or proposed mine units at the Smith Ranch Highland Uranium Project.

3.1.3.4.3 Mine Unit Injection and Recovery Well Patterns and Monitoring Wells

The licensee described the general mine unit well patterns and monitoring well placement to be used in mine units at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.1.1, “General Well Pattern Types and Spacing,” and 3.5.2.1, “General,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee stated that the mine unit boundaries and patterns will depend on the outline of the ore, the grade and thickness of the ore, and the permeability of the ore sand units. The licensee stated the primary pattern to be used will be the five-spot as shown in Figure 3.8 of the Technical Report, in which one recovery well is located in the center of square pattern with four injection wells at the corners. The licensee stated that if the permeability is low, a seven spot pattern, with six injection wells and one recovery well, as shown in Figure 3.9 of the Technical Report, may be used. The licensee also said that alternating and staggered line drive patterns may be used along narrow portions of ore bodies as shown in Figure 3.10 of the Technical Report. The licensee stated the distance between injection and recovery wells will be between 15.2 to 36.6 m (50 to 120 ft). NRC staff have reviewed these mine unit patterns for the Smith Ranch Highland and North Butte mine units where they have been used and no performance issue was identified (see SER Appendix A). NRC staff finds no new safety issue related to use of these well patterns in the existing or proposed mine units.

In Section 3.5.2.4, “Alternative Well Completion Techniques,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b), the licensee stated that some of the mine units, especially at the Gas Hills satellite, have multiple ore trends which overlap within one hydrologic unit, a condition known as stacked ore zones. The licensee stated it will produce stacked ore zones in the same mine unit using alternative well completion methods such recompletion (aka multiple completion) or well twinning. For recompletion, the licensee stated the injection or recovery well in the ore zone will be recompleted after the lower ore zone has been depleted. In this case, the lower depleted zone is sealed with cement, and a new screen is installed across the upper zone in the same well. For well twinning, the licensee stated it will inject or produce simultaneously from a pair of horizontally closely spaced wells, where one well each is completed into lower and upper ore zones. The licensee stated that these techniques will only be used within the same production sand unit, not in units separated by a confining layer. The licensee also said it will only use these techniques when ore intervals are vertically separated by more than 4.57 m (15 ft).

The licensee committed that whenever it has stack ore zones in a mine unit, it will include a description of the well completion techniques to be used in the mine unit hydrologic testing document. These hydrologic testing documents will be reviewed and approved by WYLQD. NRC staff have also included a license condition 10.3.2, which states that all of the Gas Hills mine unit hydrologic testing documents will be provided to NRC for review and verification. This condition is further discussed in SER Section 2.4.3.2.3 and shown in SER Table 2~~Table 2~~. NRC staff have reviewed the use of well recompletion and twinning in existing Smith Ranch Highland mine units where they have been used and no performance issue was identified (see SER Appendix A). NRC staff has found no new safety issue related to the use of recompletion or well twinning in existing or proposed mine units.

The licensee described the monitoring well placement and spacing to be used in mine units at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.1.2, "Monitor Well Spacing and Placement," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee stated that up to five types of monitoring wells may be used. The licensee reported that "M "wells will be installed in the ore zone, laterally from the production zone, to detect any lateral movement of fluids form the production zone. NRC staff review of mine units finds the "M" wells are located in ring around each mine unit where the lateral distance from the "M" well from the mine unit is typically 91.4 to 152.4 m (300 to 500 ft) and the spacing between the "M" wells on the ring is 91.4 to 152.4 m (300 to 500 ft). The licensee stated that "MO" wells are installed in the overlying aquifer at a density of one per 1.2 hectare (3 ac) to detect any vertical migration of fluids form the ore zone. "MU" wells are installed in the underlying aquifer a density of one per 1.2 hectare (3 ac). "MP" wells are installed in the production ore zone at a density of one for 1.2 hectare (3 ac), to establish baseline water quality in the mine unit. Finally, the licensee stated that "MT" wells may be installed between the well pattern edges and "M" wells. "MT" wells are installed as a preventive measure to allow greater operational hydraulic control of fluids when unique mine unit conditions are present. The licensee stated examples of unique conditions may include the presence of pre-existing conventional mine pits or underground mine workings near the proposed mine unit.

NRC staff have reviewed the type and placement of monitoring wells in existing Smith Ranch Highland and North Butte mine units and no performance issues were identified (see SER Appendix A). NRC staff has found no new safety issue related to type or placement of these monitoring wells as proposed by the licensee in the existing or proposed mine units.

3.1.3.4.4 Mine Unit Injection and Production Well Rates, Bleed Rate and Injection Pressures

The licensee described the flow rates, bleed rates and injection pressures to be used in mine units at the Smith Ranch Highland, North Butte, Gas Hills and Ruth Satellites in Section 3.5.3.4, Patern Balancing, Injection Pressures, and Flow Rates," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

The licensee stated that the injection and production flow rates will vary well to well in each pattern mine unit. The rate will depend on the screen thickness, the permeability of the ore zone, the available water level, the depth of the ore zone, and capacity of pumps. The licensee stated that the injection rates will vary from 7.6 to 113.6 lpm (2 to 30 gpm), while the production rates will typically vary from 18.9 to 151.4 lpm (5 to 40 gpm). The maximum injection flow rates are adjusted to achieve the maximum production rate. The licensee also stated this maximum rate is adjusted to maintain adequate groundwater head in the target aquifer to keep dissolved

oxygen and carbon dioxide in solution to prevent the “gas lock” condition which was described in SER Section 3.1.3.4.1.

The licensee stated the injection and production rates in the well patterns are adjusted to maintain an inward gradient by creating a cone of depression in the groundwater head in the individual mine unit. This cone of depression is necessary to maintain hydraulic control of the production fluids to prevent excursions from the mine unit. The licensee stated the inward gradient or cone of depression in the mine unit is created by having a production rate that is higher than the injection rate, to create a “bleed.” The licensee stated that the “bleed” rate to maintain the inward gradient or cone of depression is typically 0.5-1.5%. The licensee stated that the bleed is distributed across the mine unit based on an engineering design which considers both geologic and hydrologic factors. The licensee stated that the flow rates for the injection and production wells are measured and recorded each day. These measurements are compared to the targets for each well and adjusted to maintain the well pattern balance and desired bleed.

The licensee reported the injection pressure in the wellhead and casing above the ground will be maintained at least 10% below the pressure rating of the casing (e.g. 120 psi) to prevent casing failures. The licensee stated the pressure in the casing downhole can withstand greater pressures because it is cemented in place. The licensee stated that all downhole injection pressures, however, must be maintained below the formation fracture pressure as required by WY LQD rules and regulations. The licensee stated it uses a very conservative formation fracture pressure gradient of 0.7 psi/ft to calculate the maximum wellhead injection pressure in the following equation:

$$P_{surface} = \{[FG - 0.433\ psi/ft * SG] * (depth)]\}$$

where:

Psurface= maximum allowable wellhead injection pressure (psi)
FG= formation fracture gradient (psi/ft)
SG= specific gravity of well fluid (~1.0)
Depth = depth from surface to injection zone (feet)

The licensee stated the maximum injection pressure will be calculated for each header house in a mine unit. This maximum injection pressure will be posted near the injection trunk line pressure gauge in the header house. The pressure of the injection trunk line is monitored daily in each mine unit. The licensee stated that the injection pressure in the header house is not allowed to exceed the maximum wellhead injection pressure. In addition, the licensee has committed, as described in SER Section 3.1.3.3.2, to perform an MIT on any well which has been subjected to an overpressurization if this maximum wellhead pressure is exceeded in the header house.

NRC staff have reviewed the injection, production rates and bleed rates and wellhead injection pressures used in the existing Smith Ranch Highland and North Butte mine units and no performance issue was identified (see SER Appendix A). The licensee has committed to maintaining a bleed of 0.5 to 1.5 % so that an inward gradient exists. This is acceptable to the NRC staff. NRC staff has found no new safety issue related to the determination of these rates or the maximum wellhead injection pressures. The NRC staff, however, finds that the maintenance of bleed and the resulting inward gradient is a significant issuethat should be reflected in the license. Therefore, to ensure that the licensee maintains the inward hydraulic

gradient and associated bleed until the mine unit is restored, the NRC staff will impose the following license condition for all mine units:

10.1.14 *The licensee shall use a bleed of at least 0.5-1.5% within all mine units to maintain an inward gradient at the monitoring well ring until the mine unit is restored and in restoration stability monitoring.*

3.1.3.4.5 Gas Hills Mine Units Special Operation Considerations

The licensee stated that the ore zones of interest in MUs 1 through 5 at the Gas Hills site are located in the Wind River Formation. As described in SER Sections 2.3.3.1.3 and 3.1.3.2.3, the licensee reported that geologic and hydrogeologic interpretation of the ore zone and aquifers in the Wind River Formation at the Gas Hills satellite is complicated by extensive intermingling of the strata and post – depositional faulting. In addition, the licensee reported that the Gas Hills site has a long and complicated history of open pit and underground uranium mining. A description of the prior mining disturbances, including name, location and reclamation status was presented by the licensee in Table D6-1-1 of Appendix D6 of the Gas Hills WDEQ permit application (Cameco Resources 2012f). The locations of the disturbances were also shown in Plates D6-1 and D6-3 of the Gas Hills WDEQ permit application (Cameco Resources 2012f).

The licensee provided its current evaluation of the complex geologic and hydrogeologic setting of the proposed ore zones and the prior mining disturbances near and within the proposed Gas Hills MUs 1 through 5 in Section 3.3.3.3, "Gas Hills Mine Unit Locations," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). As described in SER Sections 2.4.3.2.3 and 3.1.3.2.3, the NRC staff evaluated the current description of the ores zones and associated hydrogeology in the mine units. The NRC staff review determined the licensee did not finalize the selection of the ore zones in MUs 1 through 5 for reasons presented in SER Section 2.4.3.2.3. However, the NRC staff will require, by license condition 10.3.2, that the final mine unit hydrologic testing documents for Gas Hills MUs 1 thorugh 5 be provided to NRC staff for review and verification, to ensure each mine unit ore zone is identified and the hydrogeology is adequately characterized before ISR operations commence. The license condition can be found in SER Section 2.4.3.2.3 and SER Table 2~~Table 2~~.

The licensee stated that the complex hydrogeologic setting and presence of prior mining disturbances near and within the Gas Hills mine units will create challenges with respect to the licensee's ability to maintain hydraulic control of fluids in many of the ore zone aquifers. The licensee therefore provided a description of the special considerations for the operation of mine units at the Gas Hills Satellite license area in Section 3.5.3.8, "Special Considerations for Gas Hills Remote Satellite Wellfield Operations," of Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Specifically, the licensee provided methods it would use for the Gas Hills mine units to: (1) address the impact of faulting and associated offset between ore zones and overlying and underlying aquifers on hydraulic control; (2) address the impact of nearby abandoned mining pits and underground workings on the hydraulic control; and (3) minimize the potential for incursions of poor water quality into ore zone aquifers from these mining disturbances. In addition, the licensee addressed how it would evaluate and potentially conduct operations in MU-5, which is located immediately south of the reclaimed UMETCO mill tailings impoundment, to minimize any impact on the two existing groundwater contaminant plumes which have previously been granted ACLs by NRC (NRC 2002a). License Condition 10.3.2, which requires NRC review and verification of mine unit hydrologic testing documents for mine units 1 through 5 at Gas Hills will provide the NRC staff the opportunity to evaluate the

hudrologic conditions that exist when the licensee is ready to proceed with recovery from mine unit 5.

The licensee described the faults that are located near and within the approved mine units at Gas Hills in Section 3.3.3.3, “Gas Hills Mine Unit Locations,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated that the delineation and hydrologic testing of these mine units, which will be provided in the hydrologic testing document, will enable better characterization of these faults, including an assessment of the conductivity along the faults (e.g. no flow or flow) and confining unit competency near the faults. Depending on the results of this characterization, the licensee presented a series of methods it will use to address the fault behavior in Section 3.5.3.8, “Special Considerations for Gas Hills Remote Satellite Wellfield Operations,” of the Technical Report. The licensee stated if a fault does not cross the mine unit, it will use primary engineering controls such as well pattern balancing, mine unit scheduling and groundwater monitoring to control and minimize interaction with the fault. If a fault crosses the mine unit, the licensee stated it would use minimum setbacks from the fault or secondary engineering controls. These secondary engineering controls may include a “water fence” in which clean water is injected to form a high pressure ridge to block groundwater flow from the mine unit toward the fault. Finally, the licensee recognized that engineering controls may not be sufficient, particularly in cases where the production ore zone is offset and in direct contact with overlying or underlying aquifers across the fault. In this case, the licensee stated it may extend the production zone to include the juxtaposed aquifers. The licensee also committed to identify a new overlying or underlying aquifer and to restore the combined production zone if this approach is taken.

The licensee also addressed how it will manage hydraulic control in mine units which have mine pits or underground mine workings located within or near them in Section 3.5.3.8, “Special Considerations for Gas Hills Remote Satellite Wellfield Operations,” of the Technical Report. The licensee stated it would use production pattern balancing on which it would adjust the production and injection rates in well patterns in mine units to minimize the movement toward or away from these disturbed areas. Although the pattern balancing would lead to variable bleed across the mine unit, the licensee committed that the total bleed would still be 0.5 to 1.5 % to ensure a cone of depression would be maintained. In addition to production pattern balancing, the licensee also stated that minimum setbacks of the boundary of the mine units could be used to maintain hydraulic control and prevent incursions of poor water quality from mine pits and mine workings in Section 3.5.3.8, “Special Considerations for Gas Hills Remote Satellite Wellfield Operations,” of the Technical Report.

The licensee stated that groundwater modeling would be used to design the well pattern balancing and minimum setbacks. The licensee provided examples of groundwater modeling of well pattern balancing at Gas Hills MU3 in Appendix C of the Technical Report to demonstrate its use for hydraulic control. The licensee stated the well pattern balancing could be optimized as operational data on the mine unit patterns are obtained. The licensee also provided examples of groundwater modeling at Gas Hills MU3 in Appendix C which demonstrated that minimum setbacks of the well patterns from disturbed areas could prevent incursions of poor water quality.

The licensee also addressed how it would evaluate and potentially conduct operations in MU-5 in Section 3.3.3, “Gas Hills Remote Satellite,” of the Technical Report. MU5 is located immediately south of the reclaimed UMETCO mill tailings impoundment. Two groundwater plumes, known as the western and south-western flow regimes, are emanating from the

UMETCO site in the Wind River aquifer. Both of the existing groundwater contaminant plumes were previously granted ACLs by NRC (NRC 2002a).

The licensee stated that the ore zone at MU5 may be in the same Wind River aquifers where the western and southwestern regime groundwater plumes are located. Therefore, the licensee recognized that the operation of MU5 may lead to incursions of poor water quality into MU5 from these plumes. As a result, the licensee stated that it will design the operation and use minimum setback of the boundaries of MU5 to minimize incursions. In addition, the licensee recognized that the operation of MU5 in these aquifers may also interfere with the approved UMETCO ACLs for the western and the southwestern flow regime plume. NRC staff is particularly concerned with the southwestern flow regime plume, as NRC staff have determined that the UMETCO plume leading edge is located immediately northwest of MU5. The NRC staff therefore concludes that the southwestern flow regime plume is more likely to be impacted by any change to the natural groundwater flow regime created by ISR operations in MU5.

The licensee stated it will conduct hydrologic testing including pumping tests in MU5 to identify the relationship between the sands affected by the approved UMETCO ACLs and the production, overlying and underlying aquifers at MU5. The licensee reported it will use the information from the pumping tests and groundwater modeling to design operations in MU5 to minimize incursions and interference with the approved UMETCO ACLs.

The NRC staff finds that the licensee has provided a satisfactory description of the methods it intends to use to address the special operating conditions at Gas Hills mine units. The licensee also committed in Technical Report Section 3.5.3.8, “Special Considerations for Gas Hills Remote Satellite Wellfield Operations,” to provide a hydrologic testing document for each Gas Hills Mine unit which includes a detailed fault assessment and evaluation of abandoned mines and underground mine workings. As described in SER Section 2.4.3.2.3, the NRC staff will require by license condition 10.3.2, that the final mine unit hydrologic testing documents for Gas Hills MUs 1 through 5 be provided to NRC staff for review and verification of the licensee’s assessment of each mine unit. In addition, the NRC staff will be able to review the MU5 hydrologic testing document to assess if the licensee has evaluated and addressed the hydrology of MU5 sufficiently to design its operation to prevent incursions of poor water quality and avoid interference with the approved ACLs at the UMETCO site.

3.1.3.4.6 Mine Unit Spill and Leak Incidents and Corrective Action

The licensee provided details of the mine unit spill and leak prevention and detection systems used at the Smith Ranch Highland Uranium Project in mine unit piping in Section 3.5.3.3, “Mine Unit Piping, Instrumentation, and Operation,” and mine unit header houses in Section 3.6.1.6, “Equipment, Instrumentation, and Control,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The systems were reviewed in SER Section 3.1.3.4.2. The licensee also conducts MIT testing to detect casing failures which can cause leaks as reviewed in SER Section 3.1.3.3.2.

The licensee described the incidents of spills and leaks which have occurred since the last safety evaluation at the Smith Ranch Highland Uranium Project in Section 3.10.1.1, “Summary of Spills and Releases,” of the Technical Report. The licensee provided a list of the spills and leaks which occurred since November 15, 1999 through July 22, 2011 at the Smith Ranch Highland and North Butte facilities which are in operation in Technical Report Table 3-15. The table includes the date, location, description, cause and resolution of each spill. Technical Report Table 3-15 reports a total of 94 releases, mostly in the mine units or header houses.

The NRC staff presented its performance review of spill and leak incidents in SER Section A.4 of Appendix A. The NRC staff found, that in this updated time period, there were a total of 89 unplanned releases from June 2001 to February 2016. The description of the date, volume, liquid type, and location of each spill in this time frame is presented in a table in SER Section A.4. The NRC staff review of the spills and leaks finds the licensee has never had a spill that exceeded the threshold criteria for a reportable spill under the regulations of 10 CFR Part 20.

The licensee has, however, had numerous leaks and spills that were required to be reported to the state regulators due to their volume and/or contaminant concentration. NRC staff review of these spills finds the licensee's in-house Spill Committee has investigated the impacts immediately following the release/spill and taken corrective actions to clean up spills as required. The licensee's Spill Committee has also done a root cause analysis of each spill. Based on the evaluation of the spills and root causes by the licensee's Spill Committee, the licensee presented a list of corrective actions that have and continue to be used to prevent future spill incidents in Section 3.10.1.1, "Summary of Spills and Releases," of the Technical Report. The licensee has also maintained a list of the spills/leaks on site and understands it will be required to demonstrate compliance with the soil and groundwater standards for unrestricted release during NRC review of decommissioning.

The licensee also reported it has experienced hundreds of MIT failures in some mine units. The licensee provided a list of some of these MIT failures for the time frame of 2001 to 2011 in Table 1-6 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The overwhelming majority of the MIT failures were located in MUs C, E and F. As described in SER Section 3.1.3.3.2, the licensee determined that the cause of the MIT failures was from the use of screw and glue joints in well casing, a practice which has been eliminated. The licensee plugged and abandoned wells which failed MITs in these units.

The State of Wyoming WDEQ-LQD issued an Administrative Order of Consent (AOC) in 2000 requiring the licensee to characterize the potential impacts from casing leaks and to develop a characterization and corrective action strategy for current and future impacts to aquifers. In response to this AOC, the licensee began a Casing Leak Investigation (CLI) in MUs C, E and F. Specifically, the licensee has been conducting an investigation of the shallow aquifers in these mine units to determine if any groundwater has been contaminated by casing leaks from these MIT failures. If the licensee finds that groundwater has been contaminated, the licensee will need to propose and undertake corrective actions to meet the groundwater quality standards.

The licensee provided a summary of the major actions related to its CLI in Technical Report Section 3.5.2.5.1, "Summary of Major Actions Related to Casing Leak Investigations." From 2001 to 2011, the licensee conducted mitigative and remedial actions in response to the casing leakage. It evaluated the location of the casing failures in each well which failed MIT. It installed numerous monitoring wells and conducted sampling in the shallow aquifers which could be affected based on the location of the well casing leaks. The licensee submitted a CLI Sampling and Analysis Plan to WDEQ and NRC in March 2012 to characterize potentially impacted areas and evaluate the past remedial and mitigative efforts. Based on these efforts, the WDEQ terminated the AOC in September 2015. The licensee stated it continues to work closely with WDEQ to establish a path forward on the CLI, including any remediation of contamination.

The NRC staff has been aware of the CLI and has reviewed the CLI quarterly monitoring reports (NRC, 2012e, NRC, 2013c, NRC, 2014e, and NRC, 2015c). NRC review has also reviewed the

status of the CLI during NRC inspections since 2011 (NRC, 2011g, NRC, 2012a, NRC, 2013d, NRC, 2013e, NRC, 2014g, NRC, 2015a, NRC, 2016e). The NRC staff understands that casing leaks and contamination of non-exempt aquifers are primarily regulated under the WDEQ Class III permit. (NRC 2015a). The NRC staff continues to work with the licensee and WDEQ to ensure that any aquifers affected by the CLI will be remediated.

The NRC staff concludes the licensee has plugged and abandoned the wells which leak and failed MITs in the affected mine units. The licensee has replaced many of these wells and installed all new wells using a well completion which joins the casing with an O-ring and spline to completely eliminate the use of a "screw and glue" casing joints as descirbed in SER Section 3.1.3.3.1. The NRC has found on inspection that the reported MIT failures at the Smith Ranch Highland Uranium Project have been greatly reduced since the licensee eliminated the use of "screw and glue" joints in well casings. This is discussed in more detail in Section A.4 of Appendix A of this SER. Therefore, NRC staff finds the licensee has identified the major cause of the casing leaks and MIT failures in injection wells and taken appropriate corrective action to prevent them.

NRC staff have reviewed the incidents of spills and leaks at existing Smith Ranch Highland and North Butte mine units. NRC has found that the licensee has correctly reported incidents of spills and leaks. The licensee has also investigated the root causes of leak and spill incidents and taken corrective action as needed. In addition, NRC staff has found no new safety issue related to spill and leak prevention, detection and corrective actions as conducted or proposed by the licensee in the existing or proposed mine units.

3.1.3.5 Waste Water Management

3.1.3.5.1 Smith Ranch Highland

The licensee described current and historical waste water management since the last license renewal of the Smith Ranch Highland facility in Sections 3.6.1.5, "Waste Water Management," and 3.6.2.3, "Waste Water Management," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated there are five primary waste water streams for the Smith Ranch CPP which include mine unit bleed, groundwater restoration waste water, excess water from elution process, well workover water and wash down water. All of these waste water streams are currently combined, treated at the CPP or Smith Ranch satellites by filtration, and disposed of in the East or West storage Ponds, in Class I deep disposal wells or with radium and selenium treatment and disposal at the Purge Storage Reservoir 2 (PSR2) with land application at the PSR 2 irrigation circle.

The licensee provided the description of all the current waste water management operations at the Smith Ranch Highland license area in Sections 3.6.1.5, "Waste Water Management," and 3.6.2.3, "Waste Water Management," of the Technical Report. The licensee described the use of the east and west storage ponds located immediately adjacent to the CPP. These ponds were constructed in 1981. The ponds are used for process effluent disposal and solids retention prior to transfer to the deep disposal injection wells. Each pond holds 962 m^3 (0.78 acre-ft) of waste water. The NRC staff also discussed the east and west storage ponds in SER Section 4.2.3.4.

The licensee provided the names, permit numbers and authorized injection rates of all the DDWs used for waste water disposal in Technical Report Table 3-6. The location of all the DDWs were provided in Technical Report Figures 1.4 through 1.8. The licensee installed six

additional DDWs between 2005 and 2017 for a total of nine wells at the Smith Ranch Highland and Reynolds Ranch facilities. The deep disposal wells handle all types of waste water at the facility. The NRC staff's evaluation of the DDWs can be found in SER Section 4.2.3.

The licensee described the Selenium Treatment Facility which was installed immediately southwest of Satellite 2 in Section 3.6.2.3, "Waste Water Management," of the Technical Report. The licensee reported this facility treats waste water from Satellites 2 and 3 to remove radium and selenium before it is disposed of in PSR 2 and sent for land application at the PSR irrigation circle. The floor plan of the Selenium Treatment Facility was provided in Technical Report Figure 3.23. The license stated the radium is first removed by addition of a barium chloride solution. The precipitate is allowed to gravity settle and concentrated by a filter press. Next the waste water is process through selenium removal columns. The columns are washed and the resulting precipitate is allowed to gravity settle. The precipitate is then concentrated by a filter press. Both the radium and selenium treatment filtered solids are disposed at an NRC licensed 11e. (2) byproduct disposal facility. The licensee stated the radium circuit replaced the old radium treatment and settling basins used for waste water at Satellites 2 and 3. The selenium treatment circuit was added to reduce the selenium concentration to a target concentration of 0.1 mg/l before it is land applied at the PSR 2 irrigation circle.

The licensee also described the operation of PSR 2 and land application at the PSR 2 irrigation circle in Section 3.6.2.3, "Waste Water Management," of the Technical Report. PSR 2 is a large impoundment with a capacity of 395,947 m^3 (321 acre-feet). PSR 2 was permitted in 1994 to receive waste water from the Highland ISR for storage before it was land applied (NRC, 1994). PSR 2 is underlain by low permeability clay units which act as a natural clay liner barrier. PSR 2 and the associated irrigation circle have been in continuous use since 1994. PSR 2 is currently used for the disposal of mine unit purge and groundwater restoration fluids from Satellites 2 and 3. When weather conditions are acceptable for optimal evaporation, typically from June through September, the fluids from PSR 2 are land applied on the adjacent irrigation circle which has an area of 32.4 ha (80 ac). The land application is also regulated under WY WDQ permit 93-410. The land applied fluids must meet water quality constituent concentrations and land application rates specified in the WDEQ permit.

The licensee also described the waste water management systems that were but are no longer in use in Section 3.6.2.3, "Waste Water Management," of the Technical Report. The license first described Satellite 1 radium settling basins were part of the original waste water radium treatment circuit. Specifically, two 1.2 ha (3 ac) ponds were constructed east of Satellite 1 in 1987 to settle residual barium sulfate after treatment and filtration of Satellite 1 waste water. The licensee reported the radium basins have since been decommissioned and partially reclaimed. The licensee reported the clay liners have been removed. The licensee is making final assessments to complete final reclamation and decommissioning.

The licensee also provided a description of the operation of Purge Storage Reservoir 1 (PSR1) and the associated land application area. PSR 1 was permitted by WY WQD under Permit No. 93-178 and later under permit 95-156R. PSR 1 was used to store purge and treated mine unit water from restoration of Mine Units A and B. The PSR 1 water was periodically land applied in an adjacent 23.5 ha (58 ac) irrigation circle. Seepage was detected from PSR 1 in 1994 and corrective action was taken. The licensee indicated that PSR 1 has not been in use since the last license renewal (Cameco, 2012b). The licensee stated it contains no water except precipitation or snow melt. The licensee stated there is an investigation at the PSR1 and the associated land application area to determine the best use of the area.

NRC review found two performance issues with the waste management at the Smith Ranch Highland license area since the last license renewal as noted in SER Appendix A Section A.4. These issues are leaks at the east and west storage ponds and seepage from PSR 2.

The licensee reported that leaks were detected in the east and west storage ponds in Section 3.10.3.1, “East and West Storage Ponds,” of the Technical Report. The licensee stated a total of 14 leaks were detected. The licensee took corrective action as soon as possible to stop and contains leaks, including lowering water levels, recovering pond leakage from the secondary containment, and isolation and repair of the liner. The licensee reported the leaks have been caused by minor breaches such as small holes in the primary liner. The licensee has made several design and operational changes which were listed, including installation of new liner in the west storage pond in 2004 and east storage pond in 2008. The licensee reported that since the liner installation the storage pond has experienced no leaks. The east storage pond has continued to experience leaks from holes or tears in the liner. After a series of repairs to the east storage pond, the licensee ultimately decided to add a new uppermost liner in both the east and west storage ponds. Since the repairs were completed in September 2014, the licensee has not reported any leaks in the east or west storage ponds. Additionally, as discussed in Appendix A of this SER, the NRC staff did not identify any operational issues related to the east and west storage ponds sice the liners were replaced in 2014. The licensee has not found any evidence of groundwater contamination in their investigation of the east and west storage pond leaks.

In 2011, the NRC staff issued Inspection Report 040-08964/11-002 (NRC 2011g) that concluded that fluids from PSR 2 were seeping into the surrounding sediments. As stated in the inspection report, this conclusion was reached based on the NRC staff assessment of PSR 2 shallow monitoring well data provided in semiannual effluent monitoring reports. At the time of the inspection, the licensee committed to assess if groundwater has been impacted by PSR 2 seepage by investigating the groundwater quality of the first underlying aquifer to PSR 2. The plan of this investigation is provided in the “PSR2 Shallow Groundwater Investigation Characterization Plan” in Appendix J of the Technical Report. In addition, the licensee was conducting a separate casing leak investigation as described in SER Section 3.1.3.4.6 to evaluate the water quality of the shallow aquifers impacted by MIT failures in the northern portion MUC just south of PSR 2. NRC staff review of the results of the PSR 2 groundwater investigation and the quarterly monitoring reports of the CLI water quality investigation also showed there was evidence of contamination from PSR 2 seepage to the shallow aquifers.

The licensee described the history of PSR 2 operations and its investigation of the impacts from PSR 2 seepage in Section 3.10.3.2, “Purge Storage Reservoir 2,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee reported it installed two monitoring wells, the East and South wells, immediately adjacent to PSR 2, in 1994. These two wells have been monitored quarterly. In addition, the licensee has installed 16 additional monitoring wells between 2009 and 2014. These wells are monitored quarterly for water level, radium, uranium and selenium and other constituents. The licensee provided the sampling results for the East and South wells from 2009 to 2011 in Table 3-17 of the Technical Report. The licensee stated these results and others from the monitoring wells show there is a large groundwater mound under PSR 2 and the uranium, selenium, and chloride concentrations are elevated in the sediments surrounding the reservoir, except just north of PSR 2.

By letter dated August 24, 2015 (NRC 2015c), NRC staff requested the licensee provide a corrective action plan to addressed to address and alleviate impacts from PSR 2 seepage as required by 10 CFR Part 40 Appendix A Criterion 5D. The licensee provided the corrective

action report on November 9, 2015 (Cameco Resources, 2015e). The corrective action plan characterized the extent of the groundwater mound under PSR 2 and the areal extent of the contamination plume. The corrective action plan also provided a description of the plans for future monitoring of the plume and a system of three recovery wells to capture and remediate the seepage from PSR 2.

The NRC staff is currently reviewing the corrective action plan. The NRC staff understands that licensee is implementing the corrective action plan at this time and has no objection. In addition, the licensee has added a selenium treatment facility which has reduced the selenium concentration in the waste water discharged to PSR 2 to less than 0.1 mg/l. NRC staff has reviewed the implementation of the corrective action plan in recent inspections. NRC staff has and will continue to review the monitoring well data from PSR 2 provided in the semi-annual monitoring reports to evaluate if the corrective action plan is reducing the impacts from the seepage. However, to ensure that the licensee continues to address the seepage from PSR 2 the NRC staff will impose the following new license condition:

10.1.17 *The licensee will continue to characterize and monitor the seepage from PSR 2 and any resulting contamination of sediments or aquifers. The licensee will take corrective action as necessary to eliminate this seepage and remediate any resulting contamination. The licensee will provide a written summary of its characterization of this seepage and its corrective actions in the semi-annual effluent monitoring reports to NRC.*

NRC staff review has found the licensee has adequately described the waste water management at the Smith Ranch Highland facility. Two performance issues were identified and have been or are being addressed to NRC staff satisfaction; however, the performance issue of seepage from PSR 2 will be addressed by a new license condition to ensure it is corrected. Otherwise, the NRC Staff review has not identified any new safety issues with respect to waste water management.

3.1.3.5.2 North Butte

The licensee described the waste water management North Butte Satellite facility in Section 3.6.3.3, “Waste Water Management,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated there are four primary waste water streams for the Smith Ranch CPP which include mine unit bleed, groundwater restoration waste water, well workover water and wash down water. The licensee reported that all of these waste water streams are disposed of in Class I deep disposal wells with ponds for storage before injection. The licensee provided a schematic of the waste water treatment in Figure 3.36 of the Technical Report.

The licensee stated that it has an existing WY WQD Class I UIC Permit for two deep disposal wells in Section 3.6.3.3, “Waste Water Management,” of the Technical Report. In the future, it stated it will have permits for two additional DDWs. The NRC staff review found the licensee now has a permit for four Class I deep disposal wells as shown in SER Table 16~~Table 16~~. One of these wells, DDW BY-2, is currently in use for operations at MU 1. The licensee also reported it has installed two storage ponds to hold waste fluids before injection. The surge ponds are described in SER Section 4.2.3.4.

NRC staff review has found the licensee has adequately described the waste water management at the Smith Ranch Highland facility. The licensee has not reported and as

discussed in Appendix A of this SER, the NRC staff has not found any performance issues with the waste water management to date at the North Butte Satellite. The NRC staff review has not identified any new safety issues with respect to waste water management.

3.1.3.5.3 Gas Hills

The licensee described the waste water management Gas Hills Satellite facility in Section 3.6.4.3, "Waste Water Management," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated there are four primary waste water streams for the Gas Hills CPP which include mine unit bleed, groundwater restoration waste water, well workover water and wash down water.

The licensee reported that all of these waste water streams will be combined and treated at the Carol Shop satellite. The methods to treat them will be: (1) volume reduction using RO, ultra-filtration, nano-filtration, electrodialysis, thermal concentration or a combination of these processes; (2) solar evaporation of the concentrated fluids produced from volume reduction in evaporation ponds which may include limited evaporation sprayers or forced evaporation or crystallization; and (3) injection of concentrated fluids from volume reduction into disposal wells.

The licensee also reported it will install two evaporation ponds for the disposal of bleed and process fluids during the first phase of development. The licensee provided the design of these ponds in Technical Report Section 3.6.4.3, "Waste Water Management." The NRC staff's review of these designs is documented in SER Section 4.2.3.4. The licensee also stated it plans to install four additional evaporation ponds, but did not provide a design or location for the NRC staff to review. This is further discussed in SER Section 4.2.3.4.

In Technical Report Section 3.6.4.3, "Waste Water Management," the liensee stated that it is pursuing the use of DDWs for waste water management at the Gas Hills facility. In its review, NRC staff determined that the licensee has a WDEQ UIC Class I DDW permit, #13-262, with three approved DDW as shown in Table 16~~Table 16~~ of SER Section 4.2.3.2. Of these three wells, the licensee stated it has installed two test DDWs as described in Section 3.10.4.2, "Natural and Manmade Migratory Pathways," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee reported these wells are in the Flathead Sandstone which will require hydraulic fracturing to achieve the necessary injectivity. The licensee, however, reported concerns with nearby faults. NRC staff therefore has limited evidence that the licensee will be able to use DDWs at the Gas Hills for waste water management.

NRC staff review has found the licensee has adequately described the waste water management at the Gas Hills facility for the two evaporation ponds; but not for the deep disposal wells. NRC staff observes that the deep disposal wells were not used in the waste water balance, so they are not needed for waste water management. The NRC staff review has not identified any new safety issues with respect to waste water management using the two planned evaporation ponds. The NRC staff's review of the engineering aspects of the planned evaporation ponds can be found in Section 4.2.3.4 of this SER.

3.1.3.5.4 Ruth

The licensee did not describe the waste water management for the Ruth Satellite facility in the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The NRC staff will therefore continue to retain the current license condition 10.2.1 in License SUA-1548 that

requires the licensee to provide a plan of operations which will include this information for the Ruth Site for NRC review and approval before operations begin.

3.1.3.6 Waste Water Balance and Schedule

3.1.3.6.1 Smith Ranch Highland

The licensee described the waste water balance and mine unit operation schedule for the Smith Ranch Highland facility in Section 3.9.1, “Smith Ranch and Satellites,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee provided an updated water balance for Smith Ranch, Reynolds Ranch and Highland mine units for the production, production and restoration and restoration only phases in Technical Report Tables 3-11, 3-12 and 3-13, respectively. The licensee stated that the water balance and schedule for the Smith Ranch Highland facility was based on an assumed average annual production rate of 907 metric tons (1,000 tons) of uranium. The licensee stated the Reynolds Ranch production would be processed at the Smith Ranch CPP. The production bleed rate for all mine units was assumed to be 1% and an additional mine unit control bleed was included for excursion control to be applied where needed (e.g. mine units in restoration). The restoration of each mine unit was assumed to require 8 pore volumes of permeate. The RO unit performance was assumed to return 80% permeate leaving 20% brine for disposal. The licensee stated the water balance assumed that 1,893 lpm (500 gpm) of RO would be installed at Smith Ranch CPP in year 17 and 946 lpm (250 gpm) and 1,893 lpm (500 gpm) of RO would be added to SR-2 in years 18 and 21, respectively. The RO capacity at Reynolds Ranch would be 3,785 lpm (1,000 gpm). The water balance also assumed the deep disposal well waste water volumes are those currently available and that the overall liquid waste disposal capacity will remain sufficient for the life of the project.

The NRC staff reviewed the waste water balances for the combined liquid wastes from the CPP, SR-1 and SR-2 at the Smith Ranch provided in Technical Report Table 3-11 for 28 years of mine unit operation. The mine units in production or restoration over this time were MUs 1, 2, 3, 4/4A, 15/15A, 7, 9, and 10. The licensee assumed four deep disposal wells with a disposal flow rate capacity of 795 lpm (210 gpm). The liquid waste streams included CPP elution, production bleed, and control bleed and restoration water. The elution waste rates ranged from 18.9 to 134 lpm (5 to 35.4 gpm). The production bleed rates ranged from 0 to 98.4 lpm (0 to 26 gpm). The control bleed was constant at 75.7 lpm (20 gpm) when applied in a year. The restoration waste rates ranged from 189 to 666 lpm (50 to 176 gpm). The NRC determined that maximum waste disposal capacity required was 795 lpm (210 gpm) and occurred in years 1, 6, 7, and 14. The NRC staff finds this water balance demonstrates the licensee has sufficient capacity in the four deep disposal wells to manage the expected liquid waste rates over the next 28 years.

The NRC reviewed the waste water balances for the combined liquid wastes from the CPP, SR-1 and SR-2 for the Highland side of the facility provided in Technical Report Table 3-13 for 24 years of mine unit operation. The mine units in production or restoration over this time were MUs C, D, Dext, E, F H, I, J and K. For the Highland waste water balance, the licensee assumed three deep disposal wells with a combined waste water rate capacity of 401 lpm (106 gpm); PSR 2 with a disposal rate capacity of 75.7 lpm (20 gpm); and the PSR 2 irrigation circle with a waste disposal capacity of 681 lpm (180 gpm). The liquid waste streams included Highland resin transfer, production bleed, control bleed and restoration water. The Highland resin transfer waste water rates ranged from 0 to 109 lpm (0 to 28.8 gpm). The production bleed rates ranged from 0 to 192 lpm (0 to 50.7 gpm). The control bleed was constant 151 lpm (40 gpm) when applied in a year. The restoration waste water rates ranged from 530 to 871 lpm

(140 to 230 gpm). The NRC determined that maximum waste water disposal capacity required was 1,153 lpm (304.7 gpm) and occurred in year 3. Disposal rates of 1,120 lpm (296 gpm) or greater were needed in years 14 through 16. The NRC staff finds this water balance demonstrates the licensee has sufficient capacity in the three deep disposal wells, PSR 2 and the PSR 2 irrigation circle to manage the expected liquid waste rates over the next 24 years.

In this license renewal, the licensee requested an increase in production rate at the Reynolds Ranch license area from 17,034 lpm (4,500 gpm) to 22,712 lpm (6,000 gpm). NRC staff therefore conducted a review of the impact of this requested 5,678 lpm (1,500 gpm) increase in production rate on the waste water balance at the facility from the previously reviewed and approved rate (NRC 2007a). Specifically, the NRC staff reviewed the updated waste water balances to evaluate the increased liquid production and restoration waste water rates for the RR mine units 21, 22, 23, 24, 25, 26, and 27 in Technical Report Table 3-12 for 28 years of operation expected from increased production.

In the Reynolds Ranch waste water balance in Technical Report Table 3-12, the licensee reported a maximum production rate of 22,144 lpm (5,850 gpm), just below the requested rate of 22,712 lpm (6,000 gpm). The licensee assumed four additional deep disposal wells at Reynolds Ranch with an assumed capacity of 189 lpm (50 gpm) each, for a total waste water disposal rate of 757 lpm (200 gpm). The liquid waste streams at Reynolds Ranch included production bleed, control bleed and restoration water. The production bleed rates ranged from 0 to 221 lpm (0 to 58.5 gpm). The restoration waste water rates ranged from 0 to 757 lpm (0 to 200 gpm). The NRC determined that maximum waste water disposal capacity required was in the range of 734 to 768 lpm (194 gpm to 203 gpm) and occurred in years 13, 14, 15, 17 and years 18 to 26.

The NRC staff finds the Reynolds Ranch waste water balance demonstrates the licensee has sufficient capacity to operate at the new requested production rate of 22,712 lpm (6,000 gpm) if the four planned deep disposal wells can achieve and maintain rates of 189 lpm (50 gpm) each over the next 28 years. The NRC staff reviews the waste water disposal flow rate capacity of the deep disposal wells at the Smith Ranch Highland facility during yearly inspections (e.g. NRC, 2016e). NRC staff has typically observed deep disposal well injection rates in the range of 151 to 322 lpm (40 to 85 gpm) for the DDWs in the targeted formations at Smith Ranch Highland. These formations are the same as those targeted for the four DDW at Reynolds Ranch. Therefore, NRC staff finds the request for the increased production rate of 22,712 lpm (6,000 gpm) at Reynolds Ranch should not be limited by the deep disposal well waste water capacity.

3.1.3.6.2 North Butte

The licensee described the waste water balance and mine unit operation schedule for the North Butte Satellite Facility in Section 3.9.2, “North Butte Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee provided an updated water balance for the North Butte mine units for the production, production and restoration and restoration only phases in Technical Report Table 3-14. The licensee stated that the waste water balance and schedule for the North Butte facility was based on an initial annual production rate of 227 metric tons (250 tons) of uranium which will be increased to the maximum production rate of 680 metric tons (750 tons). The production bleed rate for all mine units was assumed to be 1%. The restoration of each mine unit was assumed to require 8 pore volumes of permeate. The RO unit performance was assumed to return 80% permeate leaving

20% brine for disposal. The licensee stated the RO capacity at North Butte would be 2,271 lpm (600 gpm).

In this license renewal, the licensee requested an increase in production flow rate at the North Butte license area from 17,034 lpm (4,500 gpm) to 22,712 lpm (6,000 gpm). NRC staff therefore conducted a review of the impact of this requested 5,678 lpm (1,500 gpm) increase in production rate on the waste water balance at the facility from the previously reviewed and approved rate (NRC 1990b). Specifically, the NRC staff reviewed the updated waste water balances to evaluate the increased liquid production and restoration waste water rates for the North Butte mine units 1 through 5 in Technical Report Table 3-14 for 16 years of operation expected from increased production.

In the North Butte waste water balance in Table 3-14 of the Technical Report, the licensee reported a maximum production rate of 23,091 lpm (6,100 gpm), just above the requested rate of 22,712 lpm (6,000 gpm). The licensee assumed two DDWs are initially installed at North Butte and an additional DDW is installed at the beginning of restoration. A fourth DDW may also be installed if needed. The licensee assumed all of these wells would achieve disposal rates of 189 lpm (50 gpm). Table 3-14 in the Technical Report presented liquid waste streams at North Butte that included production bleed and restoration waste water. The production bleed rates ranged from 83.3 to 231 lpm (22 to 61 gpm) over the 16 years of operation. The restoration waste water rates ranged from 11.4 to 530 lpm (3 to 140 gpm). The NRC staff determined that maximum waste water disposal capacity required was 662 lpm (175 gpm) and occurred in year 10. The NRC staff noticed the licensee did not include a control bleed, which is an additional amount used to control excurions, in the waste water balance, as it had for all mine units at the Smith Ranch Highland facility. In its evaluation, the NRC staff therefore added the same amount of control bleed (75.7 lpm [20 gpm]) the licensee had used in other analyses, which increased the maximum disposal rate to 738 lpm (195 gpm). As explained below, the NRC staff used the disposal rate of 738 lpm (195 gpm) to assess whether sufficient disposal capacity will be installed.

The NRC staff finds the North Butte waste water balance demonstrates the licensee has sufficient capacity to operate at the new requested production rate of 22,712 lpm (6,000 gpm) if the licensee installs four deep disposal wells and can achieve and maintain the expected rates of 189 lpm (50 gpm) each over the next 16 years. The licensee recently reported a waste water disposal flow rate capacity of 170 lpm (45 gpm) for one of the two DDWs (BY-2) which is currently installed and in use at North Butte (Cameco, 2016a). The licensee also stated they anticipate this well will be able to achieve 284 lpm (75 gpm) if needed with the injection pressure allowed under the WDEQ Class I UIC permit. NRC staff therefore has evidence that the DDWs at the North Butte facility will meet the needed waste water disposal rate of 189 lpm (50 gpm) each. NRC staff finds the request for the increased production rate of 22,712 lpm (6,000 gpm) at North Butte should not be limited by the deep disposal well waste water capacity. To clarify the allowable flow rate at the North Butte remote satellite, the NRC staff is including the following new condition in license SUA-1548:

10.4.1 *The average monthly flow rate at the North Butte Satellite shall not exceed 6,000 gallons per minute, exclusive of restoration flow.*

3.1.3.6.3 Gas Hills

The licensee described the projected waste water balance and mine unit operation schedule for the Gas Hills Satellite Facility in Section 3.9.3; “Gas Hills Remote Satellite,” of the Smith Ranch

Renewal Technical Report (Cameco Resources 2012b). The licensee provided an updated water balance for Gas Hills mine units for the production, production and restoration and restoration only phases in Technical Report Table 3-10. The licensee stated that the waste water balance and schedule for the Gas Hills facility was based on an average annual production rate of 907 metric tons (1,000 tons) of uranium. The production bleed rate for all mine units was assumed to be 1% and an additional mine unit control bleed was included for excursion control to be applied where needed (e.g. mine units in restoration). The restoration of each mine unit was assumed to require 8 pore volumes of permeate. The licensee did not report the expected RO rate capacity at the Gas Hills satellite, but stated the water treatment rate, which NRC staff considers an approximation of RO rate capacity, would be 4,542 to 4,921 lpm (1,200 to 1,300 gpm).

In this license renewal, the licensee requested an increase in production flow rate at the Gas HIlls license area from 45,424 lpm (12,000 gpm) to 51,103 lpm (13,500 gpm). NRC staff therefore conducted a review of the impact of this requested 5,678 lpm (1,500 gpm) increase in production rate on the waste water balance at the facility from the previously reviewed and approved rate (NRC 2004b). Specifically, the NRC staff reviewed the waste water balances to evaluate the impact of increased liquid production and restoration waste water rates for the Gas Hills MUs 1 through 5 in Table 3-10 for 20 years of operation expected from increased production.

In the Gas Hills waste water balance in Table 3-10 of the Technical Report, the licensee reported a maximum production rate of 45,046 lpm (11,900 gpm), just below the currently approved rate of 45,424 lpm (12,000 gpm). The licensee assumed only evaporation ponds are initially installed at the Gas Hills remote satellite. The licensee stated it was considering the installation of deep disposal wells, but did not provide the design specifications necessary to evaluate their contribution to the waste water balance in the Technical Report. The licensee assumed the two ponds each had a combined disposal capacity of 79.5 lpm (21 gpm) by natural evaporation and that forced evaporation would add 473 lpm (125 gpm) additional capacity for each pond. The total waste water disposal rate capacity is therefore 1,026 lpm (271 gpm).

The licensee presented the liquid waste streams anticipated over time at the Gas Hills facility in Technical Report Table 3-10. These waste streams included production bleed, RO concentrate, and yellowcake slurry processing water. The production bleed rates ranged from 56.8 to 450.5 lpm (15 to 119 gpm) over the 20 years of operation. The RO concentrate waste rates ranged from 18.9 to 1,000 lpm (5 to 263 gpm). The yellowcake slurry processing waste water rate ranged from 0 to 83.3 lpm (0 to 22 gpm). The licensee reported in Technical Report Table 3-10 that the maximum waste water disposal capacity rated needed ranged from 1,063 to 1,079 lpm (281 to 285 gpm) in years 7 to 9 of operations. This rate exceeds the disposal rate capacity by 53 lpm (14 gpm). In addition the NRC staff determined the licensee did not include a control bleed in the waste water balance, as it had for all mine units at the Smith Ranch Highland and North Butte facilities. NRC therefore added an amount of 75.7 lpm (20 gpm) to the waste water volume, which would increase the max disposal rate required to 1,155 lpm (305 gpm), which exceeds the capacity by 129 lpm (34 gpm). However, the NRC staff recognizes that the actual volume of liquid waste streams is only projected at this time as the licensee has not performed detailed hydrologic testing of the individual mine units. Therefore, the NRC staff finds the Gas Hills waste water balance demonstrates the licensee has sufficient waste water disposal capacity to operate at the approved production rate of 45,414 lpm (12,000 gpm).

However, the licensee has requested an increased production rate of 51,103 lpm (13,500 gpm). NRC staff finds this additional production rate of 5,678 lpm (1,500 gpm) will produce 56.8 lpm

(15 gpm) of additional production bleed. By comparison to the waste water rates reported for a production rate of 10,600 lpm (2,800 gpm) in year 1 of Technical Report Table 3-10, the NRC staff can estimate the waste water rates for the 5,678 lpm (1,500 gpm) of additional production. This estimate is approximately 9.46 lpm (2.5 gpm) of RO concentrate waste and 20.8 lpm (5.5 gpm) of slurry processing waste water. Therefore the additional production of 5,678 lpm (1,500 gpm) will add 87.1 lpm (23 gpm) of additional waste water to produce a maximum waste water rate of 1,242 lpm (328 gpm). This waste water rate exceeds the capacity by 216 lpm (57 gpm).

In Technical Report Section 3.6.4.3, "Waste Water Management," the licensee stated it is considering installing DDWs for additional waste disposal capacity at the Gas Hills remote satellite. In its review, NRC staff determined that the licensee has a WDEQ UIC Class I DDW permit, #13-262, with three approved DDW as shown in Table 16~~Table 16~~ of SER Section 4.2.3.2. Of these three wells, the licensee has installed two test DDWs as described in Section 3.10.4.2, "Natural and Manmade Migratory Pathways," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee reported these wells are in the Flathead Sandstone which will require hydraulic fracturing to achieve the necessary injectivity. The licensee, however, reported concerns with nearby faults. NRC staff therefore has limited evidence that the licensee will be able to employ DDWs at the Gas Hills to provide additional waste disposal capacity. The licensee also stated it plans to install four additional evaporation ponds, but did not provide a design or location for the NRC staff to review.

NRC staff therefore concludes that it will not be able to approve the proposed increase in production rate from 45,424 lpm (12,000 gpm) to 51,103 lpm (13,500 gpm) at the Gas Hills remote satellite because the licensee has not provided the necessary information on waste water disposal capacity to demonstrate it is sufficient. As discussed in SER Section 4.3.2, the use of DDWs for liquid byproduct material at Gas Hills meets the requirements in 10 CFR 20.2002. The NRC staff's concern is that the licensee does not currently have a DDW permit allowing injection at Gas Hills. Therefore the NRC will limit the production capacity for Gas Hills to 45,424 lpm (12,000 gpm) with the following license condition:

10.3.3 *The average monthly flow rate at the Gas Hills Satellite shall not exceed 12,000 gallons per minute, exclusive of restoration flow. The average monthly flow rate at the Gas Hills Satellite can be increased to 13,500 gpm once the NRC staff has verified that the Class I DDW injection permits to operate have been obtained.*

3.1.3.6.4 Ruth

The licensee did not describe the water balance for the Ruth Satellite facility in the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated in Section 3.9.4, "Ruth Remote Satellite," of the Technical Report that it will provide the water balance and project schedule to NRC for review and approval when it is completed. The NRC staff will therefore continue to retain the current license condition 10.2.1 in License SUA-1548 that requires the licensee to provide a plan of operations which will include this information for the Ruth Site for NRC review and approval before operations begin.

3.1.4 Evaluation Findings

The staff reviewed the ISR process and equipment for use at the Smith Ranch Highland Uranium Project including the North Butte, and Gas Hills Satellites in accordance with Section 3.1.3 of the SRP (NRC 2003a). The licensee described the mine units, infrastructure, equipment, and ISR operations by providing:

- Site description and facility layout
- Mine unit and mineralized zone descriptions
- Well completion, mechanical integrity testing, and abandonment
- Mine unit design and operation
- Waste water management
- Waste water balance and schedule

The licensee demonstrated it can provide control of the migration of process fluids at the Smith Ranch Highland Uranium Project by providing:

- Satisfactory proposed mine unit and mineralized zone descriptions for the Smith Ranch Highland and North Butte facilities.
- Satisfactory mine unit well completion, mechanical integrity testing and abandonment procedures all Smith Ranch Highland Uranium Project mine units.
- Satisfactory resolution of performance issue with MIT failures in Smith Ranch Highland MUs C, D, and F.
- Satisfactory investigation of and corrective action for shallow aquifer contamination of MIT failures in Smith Ranch Highland MUs C, D, and F (aka Casing Leak Investigation).
- Acceptable ISR process description and lixiviant composition which is in compliance with existing license condition 10.1.4 for all Smith Ranch Highland Uranium Project mine units.
- Acceptable mine unit piping, header house design, equipment and instrumentation currently used in the existing mine units and to be employed in proposed mine units at the Smith Ranch Highland Uranium Project.
- Satisfactory description of mine unit well pattern, injection and extraction flow rates and excursion monitoring well placement for the Smith Ranch Highland and North Butte facilities.
- Satisfactory commitment to maintain maximum injection pressures below formation fracture pressures in all Smith Ranch Highland Uranium Project mine units.
- Satisfactory commitment to employ bleed rates sufficient to maintain inward gradient for hydraulic control in mine units. The licensee will be required by new license condition 10.1.14 to maintain inward gradient for all Smith Ranch Highland Uranium Project mine units
- Satisfactory description of and commitment to address special considerations for operations at Gas Hills mine units.
- Satisfactory mine unit spill and leak detection and corrective action commitments for all Smith Ranch Highland Uranium Project mine units.
- Satisfactory waste water management methods, design and no performance issue identified where applicable with the exception of Smith Ranch Highland East and West ponds and PSR 2.
- Satisfactory corrective action of Smith Ranch Highland East and West ponds leaks.
- Satisfactory continuing investigation of Smith Ranch Highland PSR 2 seepage issue and submission of corrective action plan for NRC review and approval. The NRC has issued a new license condition 10.1.17 to ensure the characterization and correction of the PSR 2 seepage and contamination will be conducted.
- Satisfactory waste water balance for approved production rates at Smith Ranch Highland mine units.

- Satisfactory waste water balance for requested increase in production flow rates at Reynolds Ranch and North Butte facilities.
- Acceptable description of drawdown from historical and predicted consumptive water use for all Smith Ranch Highland Uranium Project mine units.

The NRC staff found that for the Gas Hills remote satellite, the licensee was not able to specify the mine unit ore zones, mine unit well patterns, excursion monitoring well locations or special operating conditions to be employed to address faults and avoid interference with historical mining disturbances. The licensee also did not demonstrate the current proposed evaporation ponds nor the proposed DDWs to be sufficient to provide the additional waste disposal capacity to support the requested increase in production rate from 45,424 lpm (12,000 gpm) to 51,103 lpm (13,500 gpm) at the Gas Hills Satellite. Therefore, NRC staff made the following specific findings for Gas Hills Satellite:

- The licensee will be required by new license condition 10.3.2 to provide mine unit hydrologic testing documents for Gas Hills MUs 1 through 5 for NRC review and verification of the selection and characterization of the ore zones to be targeted.
- The licensee will be required by license condition to provide the mine unit hydrologic testing documents for Gas Hills MUs 1 through 5 for NRC review and verification of mine unit well patterns, excursion monitoring wells locations, and special operating conditions for faults and to avoid interference with historical mining disturbances.
- The licensee will be required by new license condition 10.3.3, to retain current approved production rate of 45,242 lpm (12,000 gpm) at Gas Hills until it receives approval from Wyoming DEQ to operate the DDWs.

The NRC staff found that for the Ruth Satellite, the licensee was not able to specify the mine unit ore zones, mine unit design and operations, mine unit waste water management, mine unit waste water balance and schedule or mine unit consumptive water use and drawdown. Therefore NRC staff will retain the current license condition 10.2.1 for the Ruth Satellite, which requires them to submit a plan or operations for all of these safety issues, before they begin construction and operations.

Based upon the review conducted by the staff as indicated above and the information provided in the application, and the requirements of the existing and new license conditions, the NRC staff finds the licensee's description and current and planned operation of its in situ recovery process and equipment meets the applicable acceptance criteria of Section 3.1.3 of the SRP and the requirements of 10 CFR 40.32(c), and 10 CFR 40.41(c).

3.2 Central Processing Plant and Other Facilities Equipment, Instrumentation and Control

3.2.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the central processing plant and ion exchange facility processes, equipment, instrumentation and control used and proposed for the operation of the Smith Ranch CPP, Highland CPF, Reynolds Ranch, North Butte, Gas Hills and Ruth Satellite facilities meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Sections 3.2.3 and 3.3.3 of the SRP (NRC 2003a).

3.2.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the existing and proposed ISR ion exchange and yellow cake production processes, equipment, instrumentation and control at the Smith Ranch Highland Uranium Project. Review areas addressed in this section include: site description and facilities layout; process and equipment for ion exchange, resin transfer, elution, yellow cake processing and drying and packaging circuits; process and equipment instrumentation and monitoring. Unless otherwise stated, the information reviewed in this section is from information, data, and figures submitted by the licensee in their Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The NRC staff also examined the inspection reports as described in SER Appendix A. The staff also visited the site on several occasions during the course of this review to confirm information presented by the licensee.

3.2.3.1 Smith Ranch Highland

The licensee provided the description of the Smith Ranch Highland CPP facility layout in Sections 3.2.1, "Smith Ranch," and 3.6.1.1, "General Facility Layout," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee provided the site map and floor plan of the CPP in Figure 3.18 and 3.19, respectively, of the Technical Report. The CPP houses the IX columns, resin transfer, elution, yellow cake processing and drying and packaging circuits. The licensee reported that the CPP has a design production capacity of 17,034 lpm (4,500 gpm); however, 5,678 lpm (1,500 gpm) of that capacity is currently in use for groundwater restoration. The facility has two Reverse Osmosis (RO) units with a capacity of 757 lpm (200 gpm) each for restoration.

The licensee stated that the pregnant lixiviant (uranium bearing solution) from the mine units is first passed through down- flow IX columns to remove the uranium. After the barren lixiviant leaves the IX column, a small bleed (0.5-1.5%) is taken and sent to the waste water treatment system for disposal. Carbon dioxide or carbonate /bicarbonate is added to the barren lixiviant. The oxidant is added as the lixiviant leaves the CPP or in the header houses.

The licensee stated that once the IX resin is sufficiently loaded, the resin is removed from the column. The uranium is then eluted off of the resin with a strong sodium chloride/sodium carbonate solution. The eluted resin is returned to the column and the eluate is pumped to the precipitation circuit tanks. In the precipitation process, hydrochloric or sulfuric acid is first added to the eluate to break down the uranyl carbonate. Next, hydrogen peroxide is added to precipitate uranyl peroxide. A base such as sodium hydroxide or ammonia is added to optimize crystallization of the precipitate. The eluate is separated from the precipitate and the majority is refortified for future use. Storage tanks or the east and west storage ponds are used to collect and store process water from the precipitation circuit, including spent eluate, prior to disposal by deep well injection.

The licensee reported that the resulting slurry from the elution/precipitation circuit is transferred to a thickener. The yellowcake slurry is dewatered and excess eluate is decanted and returned

to the eluate circuit or sent for disposal. The yellowcake slurry is then routed to a filter press for washing to remove contaminants and final dewatering prior to drying. The yellowcake is dried using a rotary vacuum dryer and packaged in 208 l (55 g) steel drums. The off gases from the dryer are filtered to remove entrained particles. The drummed yellowcake is stored in an enclosed secure room prior to shipping.

The licensee provided the description of the Smith Ranch Highland CPP facilities layout in Sections 3.2.1, “Smith Ranch,” and 3.6.1.1, “General Facility Layout,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee provided the site map and floor plan of the Highland CPF in Figures 3.20 and 3.21, respectively, of the Technical Report. The former Highland CPF was refurbished in 2013 to resume IX processing and yellow cake drying. The uranium processing circuit at the Highland CPF includes the ion exchange columns, uranium elution circuit, yellowcake precipitation, dewatering, drying and packaging. This process will be the same as was described for the Smith Ranch CPP. The facility will also be used for third party toll processing. The licensee reported Highland CPF is currently on standby status.

The licensee provided the description of the Smith Ranch Highland Satellite facilities layout in Section 3.6.2.1, “General Facility Layout,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee stated that there are five satellite IX facilities at the Smith Ranch Highland Facility. The licensee reported that Satellites 1, 2, and 3 are located on the Highland portion of the license area. The licensee stated that satellites SR-1 and SR-2 are located on the Smith Ranch portion of the license area. The licensee reported that Satellites 2, 3, SR-1 and SR-2 are in use and capable of supporting production or restoration activities.

The site map of Satellite 1 was provided by the licensee in Figure 3.22 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). As described in SER Section 3.1.3.1.1, the licensee reported that Satellite 1 is no longer in operation so no interior equipment layout was provided. When in operation, Satellite 1 had a design production capacity of 6,813 lpm (1,800 gpm).

The site map of Satellite 2 was provided by the licensee in Figure 3.23 and the floor plan in Figure 3.24 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Satellite 2 has a design production capacity of 12,113 lpm (3,200 gpm). Satellite 2 has IX columns, resin transfer facilities, a CO_2 and O_2 storage and supply system, and restoration circuit and employee offices. In addition, Satellite 2 has one operating RO unit and the radium and selenium treatment circuit. There are several pumps, associated piping, and an emergency generator. The satellite floor has a sump which collects water into the process water tank, which is then treated and sent to PSR 2.

The site map of Satellite 3 was provided by the licensee in Figure 3.25 and the floor plan in Figure 3.26 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Satellite 3 has a design production capacity of 6,000 gpm. Satellite 3 has IX columns, resin transfer facilities, a CO_2 and O_2 storage and supply system, and employee offices. There are several pumps, associated piping and an emergency generator. The satellite floor has a sump which collects water in a tank which is then treated and sent to a deep disposal well.

The site map of Satellite SR-1 was provided by the licensee in Figure 3.27 and the floor plan in Figure 3.28 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Satellite SR-1 has a design production capacity of 22,712 lpm (4,500 gpm). Satellite SR-1 has IX columns, resin transfer facilities, a CO_2 and O_2 storage and supply system, restoration circuit,

on site lab and employee offices. The restoration circuit at Satellite SR-1 has RO units with 1,893 lpm (500 gpm) capacity. There are several pumps, associated piping and an emergency generator. The satellite floor has a sump which collects water into the process water tank which is then treated and sent to a deep disposal well.

The site map of Satellite SR-2 was provided by the licensee in Figure 3.29 and the floor plan in Figure 3.30 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). Satellite SR-2 has a design production capacity of 18,927 lpm (5,000 gpm). Satellite SR-2 has IX columns, resin transfer facilities, a CO_2 and O_2 storage and supply system, restoration circuits, on site lab and employee offices. The restoration circuit at Satellite SR-2 has RO units with 1,893 lpm (500 gpm) capacity. There are several pumps, associated piping and an emergency generator. The satellite floor has a sump which collects water in the process water tank which is then treated and sent to a deep disposal well.

The licensee reported that a sixth satellite facility is planned for Reynolds Ranch, but has not yet been constructed. The site map of the proposed Reynolds Ranch satellite facility was provided by the licensee in Figure 3.31 and the floor plan in Figure 3.32 of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). This satellite will have a design production flow rate capacity of 22,712 lpm (6,000 gpm), therefore, the licensee has requested approval for this flow rate increase over the currently licensed flow rate of 17,034 lpm (4,500 gpm). The proposed Reynolds Ranch Satellite will have IX columns, resin transfer facilities, a CO_2 and O_2 storage and supply system, a restoration circuits and on-site lab and employee offices. The restoration circuit is planned to have RO units with 3,785 lpm (1,000 gpm) capacity. There are several pumps, associated piping and an emergency generator. The satellite floor has a sump which collects water in into the process water tank which is then treated and sent to a deep disposal well.

The licensee provided an updated production and waste water balance schematic to address the increase in production flow rate from 17,034 lpm (4,500 gpm) to 22,712 lpm (6,000 gpm) in Table 3.12 of the Technical Report. The NRC staff review found this production and waste water balance to be acceptable in terms of the facility providing the necessary capacity to process the increased production and bleed rate at the Reynolds Ranch Satellite in SER Section 3.1.3.6.1.

The NRC staff has verified the licensee's approach to instrumentation and control during inspections of Smith Ranch Highland. The NRC staff has observed continuous, real-time monitoring and control of the total production and injection flow rates; and pressure on the injection and recovery trunk lines for the CPP and satellite facilities which are in use. The licensee has installed instrumentation in the plant to continuously monitor the total flow into the plant and the total waste water flow leaving the plant on a real-time basis. The header house injection manifolds are equipped with sensors to alert the operator in the case of leak or rupture in the injection system. The licensee is capable of measuring tank levels in chemical storage and process tanks. Automatic monitoring systems are in place for the dryer system and drum logging.

NRC staff have reviewed the licensee description of the ISR processing facilities, equipment, instrumentation and control in the Technical Report. In addition, NRC staff have conducted inspections of the CPP, CPF and satellite processing facilities. These reviews included a visual inspection of equipment associated with the CPP, CPF, satellites, mine unit (header) houses and the yellowcake dryer along with their associated instrumentation and controls and a comparison of plant operating parameters (e.g., flow, pressure) with licensed limits. Staff

provided its review of the NRC inspection reports and violations in its performance review in SER Appendix A. Based on the review of the description and the performance review, NRC staff has determined that the licensee was and is conducting its in situ recovery processing at these facilities consistent with its license requirements has found no new safety issues. In addition, NRC staff has found no safety issue with the requested increase in production flow rate ISR with respect to the satellite ion exchange processing facilities, equipment, instrumentation and control Smith Ranch Highland in the Technical Report.

3.2.3.2 North Butte

The licensee provided the description of the North Butte Satellite facility in Section 3.6.3.1, "General Facility Layout," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The North Butte main facility was constructed in 2013. The North Butte facility was originally licensed for a production flow rate of 15,141 lpm (4,000 gpm). The licensee has requested approval of a production flow rate of 22,712 lpm (6,000 gpm).

The licensee provided the floor plan for the North Butte facility in Figure 3.1 of the Technical Report. The North Butte satellite has IX columns, resin transfer facilities, a CO_2 and O_2 storage and supply system, restoration circuit, on site lab and employee offices. The restoration circuit at North Butte will have RO units. There are several pumps, associated piping and an emergency generator. The satellite floor has a sump which collects water into the process water tank which is sent to the surge ponds and injected in the deep disposal well.

The licensee provided an updated process water and waste water balance schematic to address the increase in production flow rate from 15,141 to 22,712 lpm (4,000 to 6,000 gpm) in Figure 3.36 of the Technical Report. The NRC staff found this water and waste water balance to be acceptable in terms of the facility providing the necessary capacity to process the increased production and bleed rate. The NRC staff provides its review of other aspects of this requested production increase in SER Section 3.1.3.5.2 and 3.1.3.6.2.

The NRC staff has verified the licensee's approach to instrumentation and control during inspections at the North Butte remote satellite. The NRC staff has observed continuous, real-time monitoring and control of the total production and injection flow rates; and pressure on the injection and recovery trunk lines for the satellite facility. The licensee has installed instrumentation in the plant to continuously monitor the total flow into the plant and the total waste water flow leaving the plant on a real-time basis. The header house injection manifolds are equipped with sensors to alert the operator in the case of leak or rupture in the injection system. The licensee is capable of measuring tank levels in chemical storage and process tanks.

NRC staff have reviewed the licensee description of the ISR processing facilities, equipment, instrumentation and control for North Butte Satellite in the Technical Report. In addition, NRC staff have conducted inspections North Butte satellite facilities. These reviews included a visual inspection of equipment in the satellite building, mine unit (header) houses and the associated instrumentation and controls and a comparison of plant operating parameters (e.g., flow, pressure) with licensed limits. Staff provided its review of the NRC inspection reports and violations in its performance review in SER Appendix A. Based on the review of the description and this performance review, NRC staff has determined that the licensee was and is conducting its in situ recovery processing at North Butte remote satellite consistent with its license requirements has found no new safety issues. In addition, NRC staff has found no safety issue with the requested increase in production flow rate ISR with respect to the satellite ion exchange

processing facilities, equipment, instrumentation and control for North Butte remote satellite in the Technical Report.

3.2.3.3 Gas Hills

The licensee provided the description of the Gas Hills Satellite facility in Section 3.6.4.1, "Genreal Facility Layout," and 3.6.4.4, "Remote Satellite Plant Equipment, Instrumentation, and Controls of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The processing facility include the Carol Shop Satellite Building as shown in Figure 1.11 of the Technical Report. It will also include the Gas Hills Alternative Satellite Building in one of two possible locations as shown in Figure 1.11 and 1.12 of the Technical Report. The Gas Hills facility was originally licensed for a production flow rate of 45,424 lpm (12,000 gpm). However, the licensee has requested approval for the design production flow rate of 51,103 lpm (13,500 gpm). The licensee stated this production will be split as 34,069 lpm (9,000 gpm) at the Carol Shop Satellite and 17,034 lpm (4,500 gpm) at the Alternative Satellite facility. However, the licensee stated that in the case they choose not to build the Alternative Satellite facility, the Carol Shop will be constructed to operate with a maximum production flow of 51,103 lpm (13,500 gpm).

The licensee provided the floor plan for the Carol Shop in Figure 3.2 of the Technical Report. The Carol Shop satellite facility will house IX columns, resin transfer facilities, a CO_2 and O_2 storage and supply system, a restoration circuit, on site lab and employee offices. The Carol Shop facility will also include a yellow cake slurry circuit. Therefore the process and equipment to produce yellow cake slurry will include those described for the Smith Ranch Highland CPP facility in SER Section 3.2.3.3, with the exception that there will be no yellow cake drying or drumming. The restoration circuit at the Carol Shop will have RO units. There are several pumps, associated piping and an emergency generator. The satellite floor has a sump which collects water into the process water tank which is sent to the evaporation ponds.

The licensee provided the floor plan for the Alternative Satellite facility in Figure 3.3 of the Technical Report. The licensee stated the Alternative Satellite may be installed to house IX columns, resin transfer facilities and additional RO units for restoration. There are several pumps, associated piping and an emergency generator. The satellite floor has a sump which collects water into the process water tank which is sent to the evaporation ponds.

The licensee provided an updated production and waste water balance schematic to address the increase in production flow rate from 45,424 lpm (12,000 gpm) to 51,103 lpm (13,500 gpm) in Table 3-10 of the Technical Report. The NRC staff provides its review of this requested production increase in SER Section 3.1.3.5.3 and 3.1.3.6.3. The NRC staff found the waste water balance was not acceptable in terms of the facility providing the necessary waste disposal capacity to process the increased waste water flow rate. Therefore, NRC staff included a new license condition 10.3.3, that states the licensee must retain a production rate of 45,424 lpm (12,000 gpm), until sufficient waste disposal capacity is demonstrated.

NRC staff have reviewed the licensee's description of the ISR processing facilities, equipment, instrumentation and control for Gas Hills Satellite in the Technical Report. NRC staff has found no safety issue with with respect to the satellite ion exchange and yellowcake slurry processing facilities, equipment, instrumentation and control for Gas Hills Satellite in the Technical Report. However, the NRC staff did find the waste water balance for the requested increase in production rate to 51,103 lpm (13,500 gpm) was not acceptable, as it did not demonstrate the facility could provided the waste disposal capacity required to handle the increased waste water

flow rate. Therefore, NRC staff included a new license condition 10.3.3, that states the licensee must retain a production rate of 45,424 lpm (12,000 gpm), until sufficient waste disposal capacity is demonstrated.

3.2.3.4 Ruth

The licensee provided the description of the Ruth Satellite facility Section 3.6.5.1, “General Facility Layout,” of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b). The licensee reported that the facility currently has three buildings, two evaporation ponds and three monitoring wells. All existing facilities at the Ruth Satellite are non-operational. The current licensed production rate is 3,785 lpm (1,000 gpm).

The licensee stated it does not plan to extract uranium at Ruth in the next 10 years. The licensee stated that the design of the Ruth satellite facility, including the IX circuit, resin transfer, restoration circuit and other details has not been developed. The NRC staff therefore finds that the licensee has not provided sufficient information on the ISR process, equipment, instrumentation and control to operate the Ruth Satellite site. NRC staff will retain the current license condition 10.2.1 in License SUA-1548 that will require that the licensee provide a plan of operations for the Ruth Site for NRC review and approval before operations begin.

3.2.4 Evaluation Findings

The licensee described the Central Processing Plant and other facilities equipment, instrumentation and control that will be used to protect health and minimize danger to life or property. Based on the information provided in the license renewal application and the NRC staff detailed review of Smith Ranch Highland Uranium Project facility as noted above, NRC staff concludes,the information provided in the application meets the acceptance criteria of Section 3.2.3 and 3.2.4 of the SRP (NRC, 2003a) as well as the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c), which requires licensee proposed equipment, facilities, instrumentation andcontrol to be adequate to protect health and minimize danger to life or property.

4.0 EFFLUENT CONTROL SYSTEMS

4.1 Gaseous and Airborne Particulates

This SER section describes the NRC staff's evaluation of the licensee's description of the design of effluent control systems for gaseous and airborne particulates at the Smith Ranch Highland Uranium Project. The licensee provided information on gaseous and airborne particulates control systems at the Smith Ranch Highland Uranium Project in Section 4.1, "Gaseous and Airborne Particulates," of the Smith Ranch Renewal Technical Report (Cameco 2012b). The purpose of the effluent control systems is to prevent and minimize the spread of gaseous and airborne particulate contamination to the atmosphere by the use of emission controls and to ensure compliance with radiation dose limits for the public.

4.1.1 Regulatory Requirements

For gaseous and airborne particulates generated at the Smith Ranch Highland Uranium Project, the NRC staff determines if the licensee has demonstrated compliance with Criterion 8 of Appendix A to 10 CFR Part 40, which requires that milling operations be conducted so that all airborne effluent releases are reduced to ALARA levels. Criterion 8 states, "Milling operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. The primary means of accomplishing this must be by means of emission controls." Although Criterion 8 focuses on effluent releases from a yellowcake dryer and tailings, it does not exclude radon releases from ISRs. The licensee must also demonstrate that releases of gaseous and airborne particulates comply with other relevant sections of 10 CFR Part 20 and 10 CFR Part 40.

4.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the NRC staff reviewed the Smith Ranch Renewal Technical Report (Cameco Resources 2012b) for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria presented in SRP Section 4.1.3 and SRP Section 5.7.1.3 (NRC 2003a).

4.1.3 Staff Review and Analysis

The licensee described effluent controls for gases and particulate matter in Section 4.1, "Gaseous and Airborne Particulates," of the Smith Ranch Renewal Technical Report (Cameco Resources 2012b).

4.1.3.1 Radon Effluent Controls

With regard to air effluents of radon-222 gas from satellite facilities, the licensee described the following effluent controls in Section 4.1.1, "Site Location and Layout," of the Smith Ranch Renewal Technical Report:

1. A satellite facility design based on pressurized downflow ion exchange columns, which are designed to retain radon-222 gas in process solutions and reduce the release of radon-222 gas to occupied spaces in the satellite building and the environment.

2. Process vessel vents, which direct radon-222 gas that does escape from process solutions to the environment outside the satellite building.

3. Satellite building ventilation systems, which ensure fresh air is supplied to occupied spaces in the satellite building to reduce concentrations of radon-222 gas that escape process equipment.

The licensee explained that because the on-site and remote satellites of the Smith Ranch Highland Uranium Project do not process yellowcake, it does not anticipate radioactive particulate matter effluent. The licensee also explained that the design of the ventilation system will be adequate to ensure radon-222 progeny concentrations remain below 25 percent of the derived air concentration (DAC) from 10 CFR 20, Appendix B, Table 1. The NRC staff determined this was acceptable because it meets design objectives described in Regulatory Position 3.3 of Regulatory Guide 8.31 (NRC 2002c).

The NRC staff agrees that because the Smith Ranch Highland Uranium Project on-site and remote satellites process dissolved uranium in water and uranium attached to wet ion exchange resin or yellowcake slurry (at the Gas Hills remote satellite) and will not have drying circuits, the Smith Ranch Highland Uranium Project on-site and remote satellites will not produce a dried and finely-divided uranium yellowcake product that can become airborne. Therefore, the NRC staff agrees that radon-222 and its short-lived progeny are the principal radionuclides in air effluent from the Smith Ranch Highland Uranium Project satellites. The NRC staff also agrees that the use of pressurized downflow ion exchange columns that are not open to the atmosphere tends to keep radon-222 dissolved in process groundwater and minimizes gaseous radon-222 releases to the atmosphere.

4.1.3.2 Yellowcake Dryer Effluent Controls

In Section 4.1.2, “Smith Ranch Central Processing Plant,” of the Smith Ranch Renewal Technical Report, the licensee described air effluent controls on the low-temperature vacuum dryer used to produce dried yellowcake (Cameco 2012b). The licensee described the general design and normal operation of the low-temperature vacuum dryers, including components of air effluent controls such as the filter bag house, condenser, and liquid ring vacuum pumps. However, the licensee did not describe how it would comply with 10 CFR Part 40, Appendix A, Criterion 8, including: any checks that must be made during operation of the dryers; hourly log entries of all parameters; retention of hourly logs; prescribed ranges of emission control performance; or corrective actions that would be taken when emission control performance is outside of prescribed ranges. Acceptance criterion 5.7.1.3(2) states effluent control techniques are acceptable if emissions from yellowcake drying operations are properly controlled, and acceptable control is achieved by meeting the criteria of 10 CFR 40, Appendix A, Criterion 8, and Regulatory Guide 3.56, Section C.1 (NRC 1986).

The NRC staff previously evaluated and found acceptable the dryer controls described in the licensee’s May 6, 2003, submittal (PRI 2003c). This submittal is incorporated by reference in the current license in license condition 10.1.2. There are three dates listed in license condition 10.1.2 of materials license SUA-1548. The NRC staff observed that the relevant portions of the correspondence dated September 27, 2000 was superceded in its entirety by the May 6, 2003, submittal. The NRC staff also observed the May 6, 2000, date in license condition 10.1.2 is incorrect and should be May 6, 2003. Also, the NRC staff determined that the July 9, 2003, submittal listed in license condition 10.1.2 contains no information relevant to yellowcake dryer controls. Because the licensee did not address dryer controls in its renewal application, the NRC staff will retain license condition 10.1.2, modified to remove reference to the license application materials dated September 27, 2000, and July 9, 2003, and with the correct date for

the May 6, 2003, submittal. The NRC staff will also revise the existing citation to Section 4.1 of the license application to specifically cite the relevant sub-section on vacuum dryers described in Section 4.1.3. In addition, the NRC staff will delete license conditions 10.1.2.a and 10.1.2.b because these requirements pertain to a natural gas fired rotary hearth at Highland that has been removed and replaced with two vacuum dryers (NRC 2012f).

10.1.2 The licensee shall maintain effluent control systems as specified in Section 4.1.3 of the license application dated May 6, 2003 (ML031390126). ~~with the following additions:~~

a. ~~If during yellowcake drying operations any emission control equipment for the yellowcake drying or packaging areas is not performing within the operational specifications, the licensee shall not: (1) unload the dryer as part of the routine operations until the emission control equipment has been returned to service within operational specifications; or (2) reload the dryer with yellowcake until the emission control system has been returned to service within its operational specifications.~~

~~b. The licensee shall, during all periods of yellowcake drying operations, ensure that the specified operating pressure differential is maintained in the drying chamber. This shall be accomplished by either: (1) performing and documenting checks of air pressure differential approximately every 4 hours during operation; or (2) installing instrumentation that will signal an audible alarm if air pressure falls below the specified operating levels. If an audible alarm is used, its operation shall be checked and documented daily during dryer operations. Air pressure differential gauges for other emission control equipment shall be read and the readings documented at least once per shift during dryer operations.~~

~~c.~~ The NRC shall be notified prior to restart of the Highland dryer.

4.1.3.3 Additional Effluent Controls at the Gas Hills Satellite

In Section 3.6.4.3, “Wastewater Management” of the Smith Ranch Renewal Technical Report, the licensee stated it would use evaporation sprayers or forced evaporation and crystallization of the solids in solution to concentrate “reject concentrated fluid in evaporation ponds.” The licensee described its proposed forced evaporation and crystallization system, including the use of a crystallizer that would drive off residual moisture and reduce waste brine to a dry solid which can be stored for disposal as 11e.(2) byproduct material. The licensee did not describe the potential for air emissions from either sprayers or the crystallizer, or any air emissions controls required to ensure that air effluents remain as low as is reasonably achievable. Therefore, the NRC staff will include a license condition to ensure the licensee adequately considers these potential air effluent sources at the Gas Hills Satellite in its annual demonstration that public dose limits in 10 CFR 20.1301 are met, and that the licensee is using, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to the members of the public that are as low as is reasonably achievable, in accordance with 10 CFR 20.1101(b).

10.3.7 *Prior to operation of evaporation sprayers or forced evaporation and crystallization systems at the Gas Hills Satellite, the licensee shall assess whether additional air effluent monitoring and/or environmental monitoring is required in accordance with Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities.” The licensee’s documented assessment shall be available for inspection.*

4.1.4 Evaluation Findings

The NRC staff has completed its review of the effluent control systems for gaseous and airborne particulates proposed for use at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 4.1.2, “Review Procedures,” and the acceptance criteria outlined in SRP Section 4.1.3, “Acceptance Criteria.”

The licensee has acceptably described the types of vents and estimated composition of effluents released to the atmosphere. The licensee has designated monitoring and control systems (e.g., confinement and ventilation) for the types of effluents generated. The licensee has demonstrated that ventilation systems are acceptable to prevent radon gas buildup where recovery solutions enter the plant and tanks are vented during the extraction process. By providing information on the health and safety impacts of system failures and identifying contingencies for such occurrences, the licensee has acceptably shown that effluent control systems will limit radiation exposures under both normal and accident conditions.

Based on the information provided in the Smith Ranch Renewal Technical Report (Cameco 2012b) and the detailed review conducted of the effluent control systems for gaseous and airborne particulates for the Smith Ranch Highland Uranium Project, the NRC staff concludes that the proposed effluent control systems for gaseous and airborne particulates are acceptable and are in compliance with 10 CFR 20.1101, which requires that an acceptable radiation protection program that achieves as low as is reasonably achievable goals is in place and that a constraint on air emissions, excluding radon and its progeny, will be established to limit doses from these emissions; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluent releases. The related reviews of the 10 CFR Part 20 radiological aspects of the effluent control systems for gaseous and airborne radionuclides in accordance with SRP Sections 5.0, “Operations;” and 7.0, “Environmental Effects” are addressed in SER Section 5.7.7.

4.2 Liquids and Solids

This section describes the NRC staff’s evaluation of the licensee’s description of the design of effluent control systems for liquid and solid effluents at the Smith Ranch Highland Uranium Project. The licensee provided information on liquid and solid effluent control systems in the Smith Ranch Renewal Technical Report (Cameco 2012b). The purpose of liquid and solid effluent control systems is to prevent and minimize the spread of liquid and solid contamination of the environment by the use of engineered controls and to ensure compliance with radiation dose limits for the public.

4.2.1 Regulatory Requirements

For liquid and solid effluents generated at the Smith Ranch Highland Uranium Project, the NRC staff determines whether the licensee has demonstrated compliance with 10 CFR 20.1301; 10 CFR 20.2002, “Method for Obtaining Approval of Proposed Disposal Procedures” and 10 CFR 20.2007, “Compliance with Environmental and Health Protection Regulations”; 10 CFR Part 40, Appendix A, Criterion 2; and 10 CFR Part 40, Appendix A, Criterion 5A (1) through 5A (5), Criterion 5E, and Criterion 5F. In addition to the aforementioned regulations, the NRC staff determines whether the licensee is following the guidance contained in RG 3.11, “Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities” for storage or evaporation ponds (NRC 2008h).

4.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis in the Smith Ranch Renewal Technical Report were reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Section 4.2.3 of the SRP. Section 4.2.3 of the SRP incorporates the guidance in NRC Regulatory Guide 3.11 "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities" for storage or evaporation ponds (NRC 2008h). Additionally, the NRC staff reviewed the information for compliance with the requirements of 10 CFR Part 20 using Acceptance Criterion (13) of Section 6.1.3 of the SRP (NRC, 2003a).

4.2.3 Staff Review and Analysis

4.2.3.1 Liquid Byproduct Material

NRC staff observes the licensee has several disposal options for liquid wastes based on the type of waste, its source and chemical constituents. For liquid byproduct material, the disposal options include direct injection of the material into deep disposal wells (DDWs), land application, or evaporation into the atmosphere from storage or evaporation ponds. All of these options are used at Smith Ranch Highland, while the remote satellite facilities use a combination of DDWs and storage or evaporation ponds. The NRC staff review of the different disposal options follows below.

4.2.3.2 Deep Disposal Wells

The licensee described its use of underground injection control (UIC) Class I wells, or deep disposal wells (DDWs), for liquid byproduct material disposal throughout several sections of the Smith Ranch Renewal Technical Report, as follows:

- Section 3.6.1.5, "Wastewater Management," (Smith Ranch CPP)
- Section 3.6.2.3, "Wastewater Management," (Smith Ranch satellite facilities),
- Section 3.6.3.3, "Wastewater Management," (North Butte remote satellite),
- Section 3.6.4.3, "Wastewater Management," (Gas Hills remote satellite)
- Section 3.10.4, "UIC Deep Disposal Wells"
- Section 4.2.2.1, "Smith Ranch Central Processing Plant Liquid Waste Disposal"
- Section 4.2.2.2, "Highland Central Processing Facility"
- Section 4.2.2.3, "Smith Ranch Satellite Facilities"
- Section 4.2.2.4, "North Butte Remote Satellite Facility,"
- Section 4.2.2.5, "Gas Hills Remote Satellite"
- Section 4.2.2.6, "Ruth Remote Satellite Facility"
- Section 5.10.4.5, "Waste Disposal Well Monitoring"
- Section 6.1.8, "Groundwater Restoration Improvements"

To issue UIC permits, the Wyoming Department of Environmental Quality (WDEQ) verifies that injected fluids will remain isolated from the human environment, including potential sources of drinking water, in accordance with Wyoming Quality Rules and Regulations, Chapter 27, "Underground Injection Control Program, Class I and V Wells." (WDEQ 2015a). Disposal of liquid byproduct material in DDWs also requires NRC approval under 10 CFR 20.2002, which requires the licensee to include in its request:

- A description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal.
- An analysis and evaluation of pertinent information on the nature of the environment.
- The nature and location of other potentially affected licensed and unlicensed facilities.
- Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits of 10 CFR Part 20, including those in 10 CFR 20.1301.

4.2.3.2.1 Description of the Waste and Conditions of Disposal

In its renewal application, the licensee did not provide a description of liquid byproduct material disposed of in permitted DDWs. However, the characteristics of this type of ISR waste was previously described by the licensee in its 2003 license application for consolidation of the separate licenses for the Smith Ranch, Highland, and Ruth/North Butte facilities (PRI 2003b and 2003c). For example, in its 2003 application, Table 5-14, "Summary of Injectate Quality at Smith Ranch Waste Disposal Wells WDW #1 and WDW #2 for the Period 1998 through 2002," and Table 5-15, "Summary of Injectate Quality at Highland Waste Disposal Well Morton 1-20 for the Period 1998 through 2002," the licensee provided estimated concentrations of radium-226 that ranged from as low as 0.5 Bq/L (13.7 pCi/L) up to 137 Bq/L (3,710 pCi/L). Likewise, natural uranium concentrations ranged from 0.0003 mg/L to 73.4 mg/L.

With regard to conditions of disposal, the NRC staff examined information contained in the Wyoming Department of Environmental Quality (WDEQ) Graduated Environmental Management (GEM) database, a web-based UIC permitting database. The NRC staff reviewed the Smith Ranch Highland Uranium Project permits and recent related submittals to WDEQ. As shown in Table 16~~Table 16~~, as of April 2018, the UIC Class I permits are: Wyoming UIC Class I Permit Number 14-293, for the Smith Ranch, Highland, and Reynolds Ranch DDWs; Wyoming UIC Class I Permit Number 11-468 for the North Butte remote satellite; and Wyoming UIC Class I Permit Number 13-262 for the Gas Hills remote satellite. As discussed in SER Section 3.1.x, the licensee has a total of nine DDWs installed at Smith Ranch Highland to provide sufficient disposal capacity for operations. The NRC staff observed that information contained in the permits includes, among other things, location of permitted DDWs, total depth, and the name of the injection interval (e.g., DDW SRHUP #8 is located about 1.6 km (1 mi) north of Mine Unit 10 at the Smith Ranch site, is 2,900 m (9,600 ft) deep, and waste is injected into the Teckla Member of the Lewis Shale and Teapot and Parkman Members of the Mesaverde Formation). The NRC staff also observed the existing UIC Class I permits described above contain general descriptions of permitted wastes. For example, UIC Class I Permit Number 14-293, for the Smith Ranch-Highland-Reynolds DDWs, states that wastes shall be generated by uranium extraction using in-situ leaching including operation bleed streams, yellowcake wash water, sand filter and ion exchange wash water, on-site laboratory waste water, reverse osmosis brine, groundwater restoration and groundwater sweep solutions, plant wash down water, wash waters used in cleaning or servicing the waste disposal systems equipment, and storm water at the mine facilities. All three UIC Class I permits require the licensee to monitor and report to WDEQ the quality of the injectate by analyzing quarterly samples. However, there are no radionuclide concentration limits in any of the Smith Ranch Highland Uranium Project UIC Class I permits. The NRC staff observed that only the Gas Hills permit, in Table 6, included a description of the expected concentrations of chemical species in the waste, including radionuclides radium-226 and natural uranium. For example, Table 6 of the Gas Hills UIC Class I permit shows a range of 50 mg/L to 4,000 mg/L uranium, and 0.2 to 20 Bq/L (5 to 500 pCi/L)

radium-226 (WDEQ 2018). Nevertheless, this information is not needed for the NRC staff's review.

Table 16. Smith Ranch Highland Uranium Project Deep Disposal Wells (April 2018)

Location	UIC Permit	Name	Total Depth, m (ft)	Status
Smith Ranch	14-293	SR DDW #1	3,077 (10,097)	Active
		SR DDW #2	3,047 (9,996)	P & A[1]
		SRHUP #6	3,043 (9,984)	Active
		SRHUP #7	3,055 (10,022)	Active
		SRHUP #8	2,926 (9,600)	Inactive
		SRHUP #10	2,996 (9,831)	Active
Highland		SRHUP #9	2,951 (9,681)	Active
		Vollman 33-27	4,393 (14,412)	Active
		Morton 1-20	2,802 (9,195)	Active
Reynolds Ranch		RR DDW #1	3,033 (9,950)	Active
North Butte	11-468	Federal BY-2	2,637 (8,650)	Active
		North Butte No. 3	2,702 (8,685)	Proposed
		North Butte No. 4	2,687 (8,815)	Proposed
		North Butte No. 5	2,663 (8,738)	Proposed
Gas Hills	13-262	DDW #1	1,156 (3,794)	Active
		DDW #2	1,643 (5,389)	Active
		DDW #3	1,156 (3,794)	Proposed

[1] "P & A" means plugged and abandoned.

The NRC staff reviewed liquid byproduct material injectate monitoring data reports available in the GEM database and verified that concentrations of radium-226 and natural uranium are generally within the ranges previously described by the licensee. On the basis of the information described above, the NRC staff determined that the licensee provided an adequate description of the waste containing licensed material to be disposed of in accordance with 10 CFR 20.2002(a).

4.2.3.2.2 Pertinent information on the nature of the environment

For purposes of this evaluation, the NRC staff determined that the pertinent information is required to determine that liquid byproduct material disposed of in a UIC Class I DDW will remain isolated from the human environment is the following: the minimum depth of disposal; a description of engineered features and procedures which ensure emplaced waste remains at depth; and measures which are ultimately taken to properly decommission and abandon a DDW.

The NRC staff evaluated the depth to the top of the perforated interval for each permitted DDW and determined that the shallowest permitted well is the Gas Hills DDW #1, for which the top of the discharge zone is 1,050 m (3,444 ft) below ground surface. This means that liquid byproduct material emplaced in geologic strata using a DDW would be covered by over 1,000 m (3,300 ft) of soil and rock. For two of its current permits, the NRC staff determined the smallest vertical distance between the top of the perforated interval (injection zone) and the lowermost non-exempted underground source of drinking water (USDW) above the injection zone. These distances are 180 m (600 ft) at Smith Ranch-Highland and 120 m (400 ft) at North Butte remote satellite.

With regard to engineered features and procedures, UIC Class I DDWs are designed and operated to ensure safe emplacement of liquid byproduct material in the intended deep injection zone. For example, an application for a Wyoming UIC Class I DDW requires the applicant to describe, among other things, fault characteristics of the regional geology, upper confining zones, the presence of nearby underground sources of drinking water (USDWs) and design characteristics of the DDW casing and other components. The NRC staff observes that an important operational parameter is the limiting surface injection pressure for each well, which are an upper limit for operational injection pressures are maintained to ensure casing integrity for the life of the DDW. The licensee described in Section 3.6.3.3, "Waste Management," of the Smith Ranch Renewal Technical Report, that instrumentation and control systems on wells are used to monitor well integrity and to shut the well pumps if problems, such as excess well pressure, are indicated.

With regard to well decommissioning and abandonment, the individual UIC Class I permits specify the required well plugging and abandonment procedures after permit expiration, final cessation of injection activities, or removal of equipment required for operation of the well. These requirements are contained in Wyoming Quality Rules and Regulations (WQRR) Chapter 26, Section 6 for sealing the well annulus and Chapter 26, Section 9 for sealing within the casing. On the basis of the information described above, the NRC staff determined that the licensee provided an analysis and evaluation of pertinent information on the nature of the environment in accordance with 10 CFR 20.2002(b).

4.2.3.2.3 Other potentially affected licensed and unlicensed facilities

In Section 3.10.4, "UIC Deep Injection Wells," of the Smith Ranch Renewal Technical Report, the licensee described the potential for: (1) interaction between UIC Class I DDWs and nearby oil and gas wells; (2) improperly abandoned or sealed wells to result in leakage of emplaced waste to the surface or USDWs; and (3) induced seismicity to result in damage to surface facilities. With regard to the requirements in 10 CFR 20.2002(c), the NRC staff focused its evaluation on the licensee's assessment of nearby oil and gas wells and improperly abandoned or sealed wells, which could be pathways for migration of emplaced radioactive waste either back to the surface or to overlying USDWs. The NRC staff review of induced seismisity from the proposed or existing DDWs at the license areas presented by the licensee in Section 3.10.4.3, "Induced Seismicity," of the Technical Report did not lead staff to conclude there was a significant risk of development of a migratory pathway which would be a safety concern at the Smith Ranch, Highland or North Butte license areas. However, for the Gas Hills license area which is known to have several faults, the licensee committed to evaluate the potential for a migratory pathway in a fault from induced seismicity as part of their DDW implementation plan.

The licensee explained that there are three plugged and abandoned oil and gas wells inside the Smith Ranch licensed area and producing wells are more than 1.6 km (1 mi) outside the licensed boundary. At the North Butte and Gas Hills remote satellites, there are no onsite or nearby offsite oil and gas wells in the injection formations (i.e., Teckla, Teapot, and/or Parkman for Smith Ranch and North Butte; and Flathead Sandstone for Gas Hills). With regard to whether the DDWs could, if improperly designed and operated, become manmade migratory pathways, the licensee explained: WQRR requirements for Area of Review analysis and DDW design; Smith Ranch Highland Uranium Project injection zone geology; and its historical annual pressure falloff tests (APFTs) to demonstrate the high reliability of correct and durable waste emplacement. On the basis of the information described above, the NRC staff determined that

the licensee provided the nature and location of other potentially affected licensed and unlicensed facilities in accordance with 10 CFR 20.2002(c).

4.2.3.2.4 Doses are Maintained ALARA and Less than 10 CFR 20 Limits

The licensee did not provide information in its renewal application which compares radiation doses attributable to disposal by DDW to the radiation protection standards in 10 CFR 20. However, the NRC has previously evaluated disposal of byproduct material using DDW and determined that there would be no detectable direct radiation attributable to emplaced radioactive waste at the surface (NRC 2011f). Furthermore, as described in SER Section 4.2.2.2, the licensee provided sufficient information to demonstrate that emplaced waste would not migrate back to the human environment or USDW by any foreseeable pathway. Therefore, the NRC staff has reasonable assurance that doses will be maintained ALARA and within the dose limits of 10 CFR Part 20. On the basis of the information described above, the NRC staff determined that the licensee's analysis and procedures ensure that doses are maintained ALARA and within the dose limits in 10 CFR Part 20, in accordance with 10 CFR 20.2002(d).

4.2.3.3 Land Application

The licensee described its two land application facilities in several sections of the Smith Ranch Renewal Technical Report and Smith Ranch Renewal Environmental Report, as described in more detail in SER Section 4.2.1.1 (Cameco 2012b). The licensee's two land application facilities, referred to as the Satellite 1 land application facility and the Satellite 2 land application facility, are located near Purge Storage Reservoir No. 1 (PSR 1) at the eastern side of the original Highland site (Wyoming, T36N, R72W, Section 21) and near Purge Storage Reservoir No. 2 (PSR 2) located at the northern boundary of the original Highland site (Wyoming, T36N, R73W, Section 12), respectively. The licensee has not requested the ability to use land application at any of its remote satellite facilities.

NRC approval of waste disposal by land application is addressed in NUREG-1569, Acceptance Criteria 4.2.3(1) and 6.1.3(12), which both incorporate the requirements of 10 CFR 20.2002, "Method for obtaining approval of proposed disposal procedures" (NRC 2003a). The regulations in 10 CFR 20.2002 require the licensee to apply to the Commission for approval of proposed disposal procedures. As stated in SRM-SECY-06-0143, the NRC staff's general practice is to authorize proposed disposal procedures for onsite disposal that result in doses not exceeding a "few millirem" per year (NRC 2006a). For in situ uranium recovery land application facilities, acceptance criterion 4.2.3(1) states, "the applicant must analyze and assess projected (i) concentrations of radioactive contaminants in the soils to show that the concentration of radium and other nuclides in soil will not exceed the standard in 10 CFR Part 40, Appendix A, Criterion 6(6)." Acceptance Criterion 6.1.3(12) states, "The applicant should also address whether the proposed land applications methodologies will comply with 10 CFR Part 40, Appendix A, Criterion 6(6), at the time of decommissioning" (NRC 2003a). In the following SER subsections, the NRC staff organized its evaluation into four parts corresponding to the subparagraphs of 10 CFR 20.2002 (i.e., §20.2002(a) through §20.2002(d)).

4.2.3.3.1 Description of the waste (10 CFR 20.2002(a))

10 CFR 20.2002(a) requires the licensee to include a description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal. As described by the licensee, the waste to be disposed of onsite at the two land application facilities is

contaminated soil and vegetation resulting from application of treated liquid source and byproduct material waste. The licensee described the Satellite 1 land application facility and the Satellite 2 land application facility in the following sections of its renewal application:

Smith Ranch Renewal Technical Report (Cameco 2012b)
- Section 3.6.1.5, "Wastewater Management"
- Section 3.6.2.3, "Wastewater Management"
- Section 3.10.3.2, "Purge Storage Reservoir 2"
- Section 4.2.2.3, "Smith Ranch Satellite Facilities"
- Section 5.10.4, "Wastewater and Land Application Monitoring Program"
- Section 6.1.8, "Groundwater Restoration Improvements"

Smith Ranch Renewal Environmental Report (Cameco 2012b)
- ER Section 3.12.1.2.3, "Purge Storage Reservoir No. 1"
- ER Section 3.12.1.2.6, "Selenium Treatment Facility"

The NRC staff prepared the following summaries from the information provided by the licensee.

4.2.3.3.1.1 Satellite 1 Land Application Facility

The Satellite 1 land application facility is a 23.5 ha (58 ac) circular land area and center pivot irrigator that received treated wastewater from PSR 1 that resulted from restoration activities in Mine Units A and B. (NRC, 1987c). Disposal operations began in January 1988 and continued until August 1994, when the licensee discovered a leak in the natural clay liner of PSR 1. As discussed in Section 3.1.3.5.1 of this SER, the licensee took corrective action to address the leak. In ER Section 3.12.1.2.3, "Purge Storage Reservoir 2," the licensee stated that on November 9, 1994, the treated excess water in PSR 1 was diverted to PSR 2 to facilitate repairs to PSR 1 (Cameco 2012b).

The licensee described its ongoing soil and vegetation monitoring program for the Satellite 1 land application facility in Table 3-8, "Purge Storage Reservoir No. 1 Land Application Monitoring Program," of the Smith Ranch Renewal Technical Report (Cameco 2012b). The licensee stated that PSR 1 and the Satellite 1 Land Application Facility will both be either decommissioned and reclaimed after the NRC has approved the Mine Unit B restoration, or used again to provide additional waste water disposal capacity.

Concentration of Radionuclides in Soil at PSR 1 Land Application Facility

The licensee summarized the results of its ongoing soil monitoring program in Table 5-19, "Mean U-Nat and Radium-226 in Soil at the Satellite No. 1 Irrigation Area 1 for Period 2000-2010," of the Smith Ranch Renewal Technical Report (Cameco 2012b). In its evaluation, the NRC staff prepared Table 17~~Table 17~~, which provides a summary of the licensee's data for both the five-year period from 2006-2010 contained in Table 5-19 of the Smith Ranch Renewal Technical Report, and a recent five-year period from 2013-2017 from the licensee's semi-annual reports (Cameco, 2014a, 2015a, 2016b, 2017a, 2018c, and NRC 2018c). The NRC staff determined the most recent 5 years of annual monitoring data are likely to be representative of current conditions at the land application area.

In the Smith Ranch Renewal Technical Report, the licensee stated that the concentration of natural uranium in soils at the PSR 1 land application facility has been increasing in the top

15.2 cm (6 in) of soil, as compared to background. The licensee also evaluated the radium-226 concentrations in both the 0 to 15.2 cm (0 to 6 in) and 15.2 to 30.4 cm (6 to 12 in) depths, before reaching a conclusion in Section 5.10.4.1, "Soil and Vegetation Monitoring at Land Application Areas," that "no problems are therefore anticipated in meeting soil radionuclide release criteria." (Cameco 2012b). With regard to elevated uranium concentrations, the licensee stated, "If deemed necessary at decommissioning, it would be possible to reduce the near surface concentrations [of uranium] by deep plowing and mixing the soil."

Table 17. Average Radionuclide Concentrations in soil at PSR 1 (pCi/g) [1]

Radionuclide	5-year Period	0 - 15.2 cm (0-6 inches)		15.2 - 30.4 cm (6-12 inches)	
		Application area	Background	Application area	Background
Natural Uranium	2006-2010	10.8 ± 1.0	1.3 ± 0.15	3.07 ± 0.50	1.15 ± 0.14
	2013-2017	20.5 ± 3.2	1.06 ± 0.14	2.83 ± 0.86	0.83 ± 0.05
Radium-226	2006-2010	2.83 ± 0.62	2.80 ± 0.57	2.81 ± 0.59	2.64 ± 0.66
	2013-2017	1.20 ± 0.06	1.20 ± 0.14	1.17 ± 0.09	1.22 ± 0.07

[1]Average ± 95% confidence interval standard error of the mean

The NRC staff observes that intentional mixing of soil to meet decommissioning requirements was addressed by the NRC for licensees that need to meet the requirements in 10 CFR 20, Subpart E, "Radiological Criteria for License Termination." For example, SECY-04-0035, "Results of the License Termination Rule Analysis of the Use of Intentional Mixing of Contaminated Soil," and NUREG-1757, Volume 1 "Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees," Section 15.13, "Use of Intentional Mixing of Contaminated Soil," contains guidance for licensees that must meet 10 CFR 20, Subpart E. Though ISR licensees are not required to meet 10 CFR 20, Subpart E, the licensee may wish to consider this guidance in development of future reclamation plans and decommissioning plans.

Concentration of Radionuclides in Vegetation at PSR 1 Land Application Facility

The licensee summarized the results of its ongoing vegetation monitoring program in Table 5-21, "Mean U-Nat and Radium-226 Concentrations in Vegetation at the Satellite No. 1 Irrigation Area for the Period 2000-2010," of the Smith Ranch Renewal Technical Report (Cameco 2012b). The NRC staff evaluated this data by comparing the average results presented by the licensee for the period 2000-2010 to a more recent 5-year average presented in the licensee's semi-annual reports. The licensee's estimate of the average vegetation concentration of natural uranium at the Satellite 1 land application facility and a nearby background area for the period 2000 to 2010 were 0.057 Bq/g (1.55 pCi/g) and 0.012 Bq/g (0.32 pCi/g), respectively. The licensee's estimate of the average vegetation concentration of radium-226 at the land application facility and a nearby background area for the period 2000 to 2010 were 0.025 Bq/g (0.68 pCi/g) and 0.0063 Bq/g (0.17 pCi/g), respectively. By comparison, the NRC staff calculated average vegetation concentration of natural uranium at the land application facility and a nearby background area for the period 2013 to 2017 were 0.025 Bq/g (0.68 pCi/g) and 0.0063 Bq/g (0.17 pCi/g), respectively. The NRC staff calculated average vegetation concentration of radium-226 at the land application facility and a nearby background area for the period 2013 to 2017 were 0.00074 Bq/g (0.02 pCi/g) and 0.00037 Bq/g (0.01 pCi/g), respectively.

4.2.3.3.1.2 Satellite 2 Land Application Facility

The licensee explained PSR 2 was originally constructed in 1979 for use by TVA as a wastewater settling pond prior to discharge in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. In 1994, the licensee refurbished PSR 2 and received NRC authorization to use the storage pond for the Satellite 2 land application facility (NRC 1994). The Satellite 2 land application facility is comprised of a center pivot irrigator and a single 46 ha (116 ac) circular plot of land used for the disposal of purge and groundwater restoration fluids. The purge and restoration fluids are from mine units served by Satellites 2 and 3 and are first treated at the Selenium Treatment Facility near Satellite 2 to reduce concentrations of radium and selenium in the wastewater.

The Selenium Treatment Facility includes two treatment circuits in series. In the radium removal circuit, the licensee adds water-soluble barium chloride to the liquid byproduct material stream to precipitate insoluble barium-radium sulfate. The barium-radium sulfate solids are removed by settling and are de-watered using a filter press. The partially-treated waste water then proceeds to the selenium removal columns. Both the solid barium-radium sulfate and solid spent selenium media are transported for disposal at an offsite solid byproduct disposal facility. The licensee samples the suction line for the pivot irrigator during its March-to-October operating season to ensure average selenium concentrations remain below 0.1 milligrams per liter (mg/L). The licensee stated the upper limit on radium concentration is the 10 CFR 20, Appendix B, effluent concentration of 6×10^{-8} µCi/mL, or 60 pCi/L. At the PSR 2 land application facility, the licensee stated that the average radium concentration since the Selenium Treatment Facility began operation in July 2010 is 4.37×10^{-9} µCi/mL, or about 7% of the 10 CFR 20, Appendix B, effluent concentration.

The licensee described its ongoing monitoring program for soil and vegetation at the Satellite 2 land application facility in Table 3-9, “Purge Storage Reservoir No. 2 Land Application Monitoring Program.”

Concentration of Radionuclides in Soil at Satellite 2 Land Application Facility

The licensee summarized the results of its ongoing monitoring program in Table 5-20, “Mean U-Nat and Radium-226 in Soil at the Satellite No. 2 Irrigation Area 2 for Period 2000-2010,” of the Smith Ranch Renewal Technical Report. In its evaluation of this data, the NRC staff prepared Table 18~~Table 18~~, which provides a summary of the licensee’s data for both the five-year period from 2006-2010 contained in Table 5-20 of the Smith Ranch Renewal Technical Report, and a recent five-year period from 2013-2017 from the licensee’s most recent semi-annual reports (NRC 2018c). The NRC staff determined the most recent 5 years of annual monitoring data would be representative of current conditions at the land application area.

The licensee explained that data collected from 2000 to 2010 shows increasing concentrations of natural uranium in soil depths of 0 to 15 cm (0 to 6 in). The difference in natural uranium concentrations between the land application area and a background location is also shown in Table 18~~Table 18~~, where the NRC staff calculated natural uranium in soil concentrations for two 5-year periods. In Section 5.10.4 of the Smith Ranch Renewal Technical Report, the licensee stated that “because no discernible increase in radium-226 is evident Cameco expects to be able to meet soil radionuclide release limits.”

Table 18. Average Radionuclide Concentrations in soil at PSR 2 (pCi/g) [1]

Radionuclide	5-year Period	0-15.2 cm (0-6 in)		15.2 - 30.4 cm (6-12 in)	
		Application area	Background	Application area	Background
Natural Uranium	2006-2010	7.81 ± 1.47	3.01 ± 1.19	3.01 ± 0.45	1.88 ± 0.35
	2013-2017	8.20 ± 0.46	1.08 ± 0.10	4.37 ± 0.37	1.04 ± 0.10
Radium-226	2006-2010	2.70 ± 0.75	2.28 ± 0.85	2.30 ± 0.47	2.18 ± 0.77
	2013-2017	1.04 ± 0.09	1.08 ± 0.16	1.15 ± 0.07	0.92 ± 0.11

[1]Average ± 95% confidence interval standard error of the mean

On the basis of its examination of the monitoring data, the NRC staff agrees that there is no discernible increase in radium-226 concentration in soil at the Satellite 2 land application facility. The NRC staff also observed that the concentrations of radium-226 in liquid byproduct material applied at the facility were not sufficiently high over the facility's operating history to result in detectable concentrations of radium-226 in soil. However, the NRC staff observes that after a 24-year operating history, the concentration of natural uranium in soil in the Satellite 2 land application facility is trending upward and is discernably higher than background concentrations. The NRC staff's evaluation of soil concentration limits for natural uranium and radium-226 is addressed in SER Section 4.2.3.3.4.

Concentration of Radionuclides in Vegetation at PSR 2 Land Application Facility

The licensee summarized the results of its ongoing vegetation monitoring program in Table 5-22, "Mean U-Nat and Radium-226 Concentrations in Vegetation at the Satellite No. 2 Irrigation Area for the Period 2000-2010," of the Smith Ranch Renewal Technical Report. The NRC staff evaluated this data by comparing the average results presented by the licensee for the period 2000-2010 to a more recent 5-year average presented in the licensee's semi-annual reports. The licensee's estimate of the average vegetation concentration of natural uranium at the land application facility and a nearby background area for the period 2000 to 2010 were 0.20 Bq/g (5.37 pCi/g) and 0.0033 Bq/g (0.09 pCi/g), respectively. The licensee's estimate of the average vegetation concentration of radium-226 at the land application facility and a nearby background area for the period 2000 to 2010 were 0.0011 Bq/g (0.03 pCi/g) and 0.00037 Bq/g (0.01 pCi/g), respectively. By comparison, the NRC staff calculated average vegetation concentration of natural uranium at the land application facility and a nearby background area for the period 2013 to 2017 were 0.575 Bq/g (15.56 pCi/g) and 0.016 Bq/g (0.44 pCi/g), respectively. The NRC staff calculated average vegetation concentration of radium-226 at the land application facility and a nearby background area for the period 2013 to 2017 were 0.011 Bq/g (0.29 pCi/g) and 0.0044 Bq/g (0.12 pCi/g), respectively.

4.2.3.3.2 Analysis and evaluation of pertinent information on the environment (10 CFR 20.2002(b))

10 CFR 20.2002(b) requires the licensee to include an analysis and evaluation of pertinent information on the nature of the environment. The licensee provided pertinent information required to assess future public doses from disposal of natural uranium and radium-226 at the PSR 2 land application area in its 1994 application (NRC 1994). Though the previous information was provided for Satellite 2 land application area, the NRC staff has determined that, because the Satellite 1 and 2 land application areas are in the same geographic region, and in the same licensed area separated by just a few miles, the pertinent environmental

information relevant to completing a public dose assessment would be the same for both Satellite 1 and Satellite 2 land application facilities. In 1994, the NRC staff used RESRAD Version 5.05 to perform confirmatory calculations that considered soil contamination levels, future potential land use by farmers, and site environmental conditions appropriate for Wyoming. The NRC staff has found nothing new regarding pertinent information on the nature of the environment to invalidate the NRC staff's previous findings; therefore, the original findings stand and previous NRC staff conclusions that there would be no significant impact from land application remain valid.

4.2.3.3.3 Nature and location of other licensed and unlicensed facilities (10 CFR 20.2002(c))

10 CFR 20.2002(c) requires the licensee to include the nature and location of other potentially affected licensed and unlicensed facilities. As stated in SER Section 4.2.3.3.2, the licensee provided pertinent information regarding the nature and location of other licensed and unlicensed facilities near the Smith Ranch Highland site in its 1994 application (NRC 1994). The NRC staff's evaluation and approval of the licensee's 1994 application included consideration of nearby licensed and unlicensed facilities that are relevant and applicable to completing a dose assessment. Specifically, the NRC staff found that there are no other licensed and unlicensed facilities sufficiently close in proximity to either the Satellite 1 or Satellite 2 land application facility, such that dose from those nearby facilities should be considered in an estimate of public dose demonstrating compliance with 10 CFR 20.2002(d). The NRC staff has found nothing to invalidate the NRC staff's previous findings regarding the nature and location of other potentially affected licensed and unlicensed facilities; therefore, the original findings stand and previous NRC staff conclusions discussed earlier in this paragraph remain valid.

In this current evaluation for license renewal, the NRC staff also considered the extent to which ongoing disposal operations at the PSR 2 land application area contribute to annual public dose from licensed operations at the Smith Ranch Highland Uranium Project. As stated in SER Section 4.2.3.3.1.2, only natural uranium is present in the PSR 2 land application area soils above natural background concentrations (see SER Table 18~~Table 18~~). The NRC staff determined that because land application of PSR 2 wastewater sustains vegetation in the land application area, which completely covers the soil, there is very little potential for resuspension of contaminated soil and public inhalation of contaminated soil particles downwind. As a result, the NRC staff determined the principal pathway for public dose from ongoing disposal operations is intermittent direct public exposure to contaminated soil, such as when the licensee allows visitors on or near the land application area. To estimate direct doses at the land application facility, the NRC staff used Federal Guidance Report No. 12 (FGR-12), Table III.7, "Dose Coefficients for Exposure to Soil Contaminated to an Infinite Depth," for the radionuclides uranium-234 and uranium-238 (EPA 1993). Using FGR-12 dose coefficients, and the maximum soil concentrations shown in SER Table 18~~Table 18~~, the NRC staff estimated maximum direct public doses from continuous occupancy of less than 2 mrem/year. Given that occasional public visitors would be present no more than a few days per year, the NRC staff determined that public doses from ongoing operations of the land application facility are less than about 0.02 mrem/year, or about 0.02 percent of the public dose limit. Therefore, the NRC staff determined that the contribution of PSR 2 land application facility operations to annual public dose is so minimal as to not be included in calculations.

4.2.3.3.4 Analysis and procedures to ensure doses are ALARA and within limits (10 CFR 20.2002(d))

10 CFR 20.2002(d) requires the licensee to include analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in 10 CFR Part 20. As stated in SER Sections 4.2.3.3.2 and 4.2.3.3.3, in 1994, the licensee provided its assessment of potential future public dose resulting from disposal of treated wastewater at the Satellite 2 land application facility. (NRC 1994). In the 1994 application, the licensee calculated that potential future public doses to a resident farmer on the Satellite 2 land application facility site would be 0.037 mSv/year (3.7 mrem/year) total effective dose equivalent (TEDE), which is consistent with the NRC staff's practice to authorize proposed disposal procedures for onsite disposal that result in doses not exceeding a "few millirem" per year (NRC 2006a). For this safety evaluation of the licensee's renewal application, the NRC staff reviewed its June 1994 safety evaluation (NRC 1994), to evaluate whether the assumptions used in the licensee's prior analysis remain valid. For example, the licensee assumed in its 1994 license amendment application that the facility would operate for 8 years, rather than the 24 years it has since operated. After reviewing this information, the NRC staff determined that the important parameters of the 1994 dose assessment are the final soil concentrations of natural uranium and radium-226 at the time of facility decommissioning, regardless of the duration over which the licensee disposes of liquid byproduct material. In its 1994 analysis, the licensee assumed that soil concentrations averaged over the first 12 inches of soil depth would not exceed 24 pCi/g natural uranium and 0.38 pCi/g radium-226. In its 1994 SER, the NRC staff determined, among other things:

> "The licensee's commitment to perform post-operations surveys of soil (and vegetation) for uranium and radium-226 is discussed in Section 2.6 of the [Satellite 2 Wastewater Land Application Facility] SWLA and will be required by revision to License Condition No. 11.4. This radionuclide data would be required to verify soil concentration levels are not above the levels used as the source term in the application. If the radionuclide levels were found to exceed the source term levels or pose a risk to public health, the licensee would be required to (a) reevaluate dose assessments to demonstrate that TEDE to the public is still below the 10 CFR Part 20 dose limit, or (2) propose remediation to soil and vegetation to eliminate any potential health or environmental risk."

The NRC staff determined that there is currently no license condition in source material license SUA-1548, Amendment 24, which requires the licensee to monitor soil concentration levels at either the Satellite 1 or Satellite 2 land application facility for the express purpose of ensuring radionuclide concentrations are not above the levels used as the source term in the licensee's 1994 application, and which formed the basis for the NRC's approval. For this reason, the NRC staff will include a condition in the renewed license requiring the licensee to compare its ongoing annual soil monitoring program results to the concentrations previously analyzed.

10.1.10 *The licensee shall monitor soil concentrations of natural uranium and radium-226 at the Satellite 1 and 2 land application facilities. In its semiannual effluent and environmental report due within 60 days after January 1 of each year, the licensee shall compare annual average soil concentrations of soil depths zero to 30.4 cm (zero to 12 in) to the concentration limits of 24 pCi/g natural uranium and 0.38 pCi/g radium-226. If these limits are exceeded, the licensee shall submit to NRC for approval, within 1 year of the last sample collected, a remediation plan that addresses the licensee's proposed plan to ensure the limits in 10 CFR 20.1301 and 10 CFR 40, Appendix A, Criterion 6(6) shall be met.*

4.2.3.4 Storage or Evaporation Ponds

The licensee described its use of storage or evaporation ponds to aid in liquid 11e.(2) byproduct material disposal throughout several sections of the Smith Ranch Renewal Technical Report (Cameco 2012b), as follows:

- Section 3.6.1.5, "Wastewater Management," (Smith Ranch CPP)
- Section 3.6.2.3, "Wastewater Management," (Smith Ranch satellite facilities),
- Section 3.6.3.3, "Wastewater Management," (North Butte remote satellite),
- Section 3.6.4.3, "Wastewater Management," (Gas Hills remote satellite)
- Section 3.10.3, "Pond Leaks,"
- Section 4.2.2.1, "Smith Ranch Central Processing Plant Liquid Waste Disposal"
- Section 4.2.2.2, "Highland Central Processing Facility"
- Section 4.2.2.3, "Smith Ranch Satellite Facilities"
- Section 4.2.2.4, "North Butte Remote Satellite Facility,"
- Section 4.2.2.5, "Gas Hills Remote Satellite"
- Section 4.2.2.6, "Ruth Remote Satellite Facility"

The licensee described the existing storage or evaporation ponds within the footprint of the Smith Ranch Highland license area. At the Smith Ranch CPP, the licensee uses two storage ponds, the east and west storage ponds, to help manage liquid 11e.(2) byproduct material generated at the CPP. According to the licensee, these ponds date to the original research and development operations at Smith Ranch in 1981. The east and west storage ponds each have dimensions of approximately 30 m by 30 m (100 ft by 100 ft) and a depth of 2.4 m (8 ft). Each pond is lined with a 0.8 mm (30-mil) thick Hypalon liner. A leak detection layer is present beneath the liner. The NRC staff last evaluated the east and west storage ponds during the previous license renewal (NRC, 2001a). At that time, the NRC staff determined that the east and and west storage ponds met the regulations in 10 CFR Part 40, Appendix A, Criteria 5A(1) through 5A(5). In this license renewal request, the licensee did not request any changes to the design of the east and west storage ponds. The NRC staff's review did not identify any changes to the design of the east and west storage ponds. The NRC staff's review of leaks from the east and west storage pond is discussed in Appendix A and Section 3.1.3.5.1 of this SER.

In its previous license renewal review for Smith Ranch, the NRC staff concluded that the east and west storage pond designs were consistent with the regulations in 10 CFR Part 40, Appendix A, Criteria 5A(1) through 5A(5). In reviewing the current license renewal application, the NRC staff considered the information contained in Sections 3.6.1.5 and 4.2.2.1 of the Smith Ranch Renewal Technical Report (Cameco, 2012b). Based on this review, as described above, the NRC staff finds that the conclusions reached in the prior license renewal review remain valid for this license renewal application.

While not explicitly discussed in the Smith Ranch Renewal Technical Report (Cameco 2012b), the NRC staff is aware of an old process pond that was used to contain solvent extraction overflow when the Highland CPF operated as a conventional mill. The solvent extraction pond is located approximately 220 m (750 ft) southwest of the Highland CPF, adjacent to a storm water management pond that controls runoff from the parking area around the Highland CPF. The solvent extraction pond is no longer in use, and the licensee has included costs to complete decommissioning and reclamation activities at the solvent extraction pond in its financial assurance estimate for license SUA-1548 (Cameco, 2015d)

Near Satellite 1, which is located on the eastern side of the Smith Ranch Highland property, the licensee identified two radium settling basins and a purge storage reservoir (PSR 1) that were previously used to manage liquid byproduct material. The licensee stated that it has initiated decommissioning and reclamation activities by removing the clay liner from the radium settling basins. The radium settling basins are no longer used to hold liquid byproduct material. The licensee has not completed final decommissioning and reclamation activities related to the radium settling basins at this time. As the licensee has initiated decommissioning and reclamation of the radium settling basins, portions of condition 10.1.6 are no longer needed. Existing condition 10.1.6 is modified as shown below. The italicized portion of 10.1.6 will become a part of condition 11.2.

10.1.6 ~~Radium settling ponds for HUP shall have at least 3 feet of freeboard.~~ *The Satellite 1 and Satellite 2 purge storage reservoirs shall have at least 4 feet of freeboard.* ~~The licensee shall at all times maintain sufficient capacity in the Satellite 1 purge storage reservoirs to enable transferring the contents of any one radium settling pond to the reservoir. In the event of a radium settling pond leak and subsequent transfer of liquid, the freeboard requirements for the purge storage reservoir may be suspended during the repair period.~~

As discussed in Section 4.2.3.3.1.1 of this SER, PSR 1 was used to hold wastewater from groundwater restoration activities at Mine Units A and B. The NRC authorized operations at PSR 1 when it issued the license for commercial operations at the Highland Project in July 1987 (NRC 1987c). PSR 1 is not currently in use; however, the licensee does maintain an interceptor trench and pump back system to control seepage from the south side of PSR 1. The licensee continues to sample seepage water from PSR 1. The licensee stated that it may decide to put it back into service to provide additional liquid disposal capacity. The licensee did not request any changes to PSR 1 in its license renewal application. As discussed in Appendix A of this SER, the NRC staff did not identify any operational issues related to PSR 1. The NRC staff observes that the interceptor trench will be able to collect seepage from PSR 1 if the licensee decides to return it to service. As the NRC staff's review has found nothing to invalidate previous review of PSR 1; the original findings stand and previous NRC staff conclusions that PSR 1 was consistent with the applicable requirements in 10 CFR Part 40 remain valid.

As discussed in Section 4.2.3.3.1.2 of this SER, PSR 2 was used to hold wastewater from operation and restoration activities at Satellite 2. In 1994, the licensee refurbished PSR 2 and received NRC authorization to use the storage pond for the Satellite 2 land application facility (NRC 1994). As discussed in Appendix A to this SER, the NRC staff identified potential seepage from PSR 2 during the renewal period. The licensee has developed a corrective action plan to minimize the impacts of seepage from PSR 2 (Cameco, 2015e). The corrective action plan is discussed in SER Section 3.1.3.5.1.

The North Butte remote satellite was initially licensed by the NRC in 1990 (NRC, 1990a, 1990b, and 1990c). The initial design for North Butte included two storage ponds. Cameco's Smith Ranch Renewal Technical Report (Cameco 2012b) included an updated storage pond design for the North Butte remote satellite. After the licensee submitted the license renewal request, it decided to proceed with construction of the North Butte remote satellite facility. Prior to construction of the storage ponds, the licensee compared the updated storage pond design contained in the Smith Ranch Renewal Technical Report to the previously approved storage pond design for the North Butte remote satellite using the safety and environmental review panel process (SERP). The NRC staff observes that the SERP process is as allowed by

condition 9.4 of license SUA-1548. Further discussion of the SERP process can be found in Section 5.2 of this SER. In its SERP evaluation, the licensee concluded that that the changes in the pond design at the North Butte remote satellite did not require a license amendment. During the August 2012 inspection of license SUA-1548, the NRC staff reviewed the licensee's SERP evaluation (NRC, 2012d). The NRC staff observed that the updated storage pond design falls within the envelope previously approved because it: (i) has a similar footprint; (ii) is designed with more freeboard capacity and flatter slopes; and (iii) has a double liner system that reflects advances in lining technology. Therefore, the NRC staff agreed with the licensee's SERP evaluation. As the NRC staff has agreed with the licensee's evaluation that no license amendment is required for the updated pond design, no further analysis is presented in this SER. The NRC staff's evaluation of the disposal capacity for North Butte can be found in SER Section 3.1.3.6.2.

The Ruth remote satellite was initially licensed by the NRC in 1990 (NRC, 1990a, 1990b, 1990c). Two evaporation ponds have been constructed at Ruth, they were previously used to support research and development operations at the facility. These ponds are not currently in use as the Ruth remote satellite remains non-operational.

The Gas Hills remote satellite facility was initially licensed by the NRC in January 2005 (NRC, 2004b). In the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee identified that it had provided an updated design for the evaporation ponds at Gas Hills. The NRC staff observes that the licensee plans to construct two evaporation ponds at the Gas Hills remote satellite initially and that ultimately, up to six evaporation ponds may be needed to provide sufficient disposal capacity. The NRC staff compared the design of the initially approved ponds at Gas Hills to the revised design in the Smith Ranch Renewal Technical Report. Table 19~~Table 19~~ below compares the main design features.

The pond designs are similar; however, there are differences in the number of ponds, size, and configuration of the pond embankments. The NRC staff's review of the revised design follows below. Unless otherwise stated, the NRC staff's review is based on information contained in Figure 1.11, Section 3.6.4.3, "Waste Water Management," and Appendix E of the Smith Ranch Renewal Technical Report (Cameco, 2012b).

The licensee stated it plans to construct two storage ponds to contain liquid byproduct material generated at the Gas Hills Remote Satellite. The location of the ponds is shown on Figure 1.11 of the Smith Ranch Renewal Technical Report and on Figure 1 of 4 in Appendix E of the Smith Ranch Renewal Technical Report (Cameco, 2012b). Each pond will have a series of leak detection sumps. Depending on the ability to use DDWs at the remote satellite, the licensee may need to construct an additional 4 evaporation ponds (brining the total at the Gas Hills remote satellite to six). However, the licensee stated that the detailed engineering design has not been completed for the remaining four ponds. Therefore, the NRC staff's evaluation is for the first two evaporation ponds. Condition 10.1.5 will remain in place requiring the licensee to submit future pond design and site characterization information for NRC review and approval. The NRC staff's review included an assessment of: (a) information from the subsurface investigation documenting soil conditions near the evaporation ponds, (b) design and construction details of the evaporation ponds, and (c) closure and decommissioning of the evaporation ponds.

Table 19. Comparison of Design Features for Gas Hills Evaporation Ponds

Design Feature	Original Gas Hills Design	Revised Gas Hills Design
Reference	PRI, 1998	Cameco, 2012b
Number of ponds	2	2 for now, up to 6 (Cameco includes commitment to provide detailed design for remaining 4 ponds, if they are needed, at a later date
Shape	Square	Square
Primary liner	1.5 mm (60 mil) HDPE	1.5 mm (60 mil) HDPE Drain Liner
Leak detection	Sand and piping network, 15.2 m (50 ft) spacing for pipes, 2 percent slope	Synthetic drainage layer and piping network,
Secondary liner	Compacted clay, 0.8 mm (30 mil PVC), or equivalent	0.8 mm (30 mil) PVC, or equivalent
Available Storage Pond Capacity (0.6 m (2 ft freeboard maintained))	21,586 m^3 (17.5 Acre-ft) (one pond); 43,172 m^3 (35 Acre-ft) (combined)	24,670 m^3 (20 Acre-ft) (one pond); 49,339 m^3 (40 Acre-ft) (combined)
Top of Berm Available Storage Pond Capacity	25,410 m^3 (20.6 Acre-ft) (one pond); 50,819 m^3 (41.2 Acre-ft) (combined)	32,071 m^3 (26 Acre-ft) (one pond) 64,141 m^3 (52 Acre-ft) (combined)
Calculated Maximum Wave Height	0.08 m (0.25 ft)	0.23 m (0.75 ft)
Direct Precipitation	100 year, 6 hour maximum precipitation is 0.05 m (2.1 in). Corresponding increase in water level is 0.07 m (0.23 ft)	6 hour probable maximum precipitation is approximately 0.3 m (1 ft). Corresponding increase in water level is 0.3 m (1 ft)
Maximum Pond Depth	Approximately 6.1 m (20 ft)	Approximately 3 m (10 ft)
Height of above grade berm	1.5 m (5 ft)	4.6 m (15 ft)
Slope Stability	Not analyzed	Minimum Factor of Safety of 2.2

Pond Site Characterization

The licensee completed a subsurface investigation to support construction of the evaporation ponds. The investigation included a series of 13 borings in the immediate vicinity of the evaporation ponds. The borings were advanced to depths of approximately ranging from 4.6 to 14.6 m (15 to 48 ft). According to the licensee, groundwater was not encountered in any of the boreholes during drilling. The licensee obtained soil samples from a variety of depths and performed laboratory tests to determine the engineering properties of the soil. Engineering properties determined from the laboratory tests included: natural moisture content and dry density, gradation characteristics, liquid limit, plastic limit, plasticity index, and permeability characteristics. The licensee described the subsurface conditions as generally consisting of 15.2 cm (6 in) of topsoil, a layer of silty sand, a layer of sandy lean clay overlying sandstone and bedrock.

Soil properties were determined at various depths from borings in the vicinity of the evaporation ponds. The NRC staff reviewed the boring logs and finds the licensee's description of the subsurface soil layers acceptable. The engineering properties of the soils were determined using laboratory techniques that followed appropriate American Society for Testing and Materials (ASTM) standards. Because the licensee determined soil properties near the evaporation ponds using appropriate ASTM standards, the NRC staff finds that the licensee has adequately characterized the subsurface conditions at the planned location of the evaporation ponds. Therefore, the staff finds that the licensee's characterization is sufficient to support engineering assessments related to the performance of the evaporation ponds. The NRC staff's review of the disposal capacity for Gas Hills can be found in SER Section 3.1.3.6.3.

Pond Slope Stability

The licensee performed a static slope stability analysis of the evaporation ponds. The licensee identified the north side of the south cell as being the location of the critical cross section. At this location, the top of the evaporation pond embankment is approximately 3.7 m (12 ft) above the surrounding ground surface. The NRC staff observes that while the eastern side of the northern evaporation pond has a slightly higher embankment height, the presence of the embankment around the southern pond counteracts the higher embankment height. Therefore, based on its review of the evaporation pond configurations and the surrounding topography of each pond, the NRC staff agrees that the north side of the southern evaporation pond represents the highest embankment height and the critical cross section. The NRC staff reviewed the material properties and critical cross section geometry and finds them representative of area in the vicinity of the evaporation pond. The licensee performed the slope stability analysis using the STABL6 software package, which is a widely available computer program. The licensee evaluated the stability of the exterior facing slope and the interior facing slope under both post construction and steady state seepage conditions. The licensee's minimum factor of safety result of 2.2 exceeds the 1.3 factor of safety value for static slope stability analysis for a post construction condition.

The NRC staff concludes that the licensee has demonstrated that the evaporation ponds will be stable under the post construction condition. By demonstrating stability of the evaporation ponds, the NRC staff finds that the licensee has shown that this approach is consistent with Acceptance Criterion (4) of SRP Section 4.2.3. This acceptance criterion states that the design of surface impoundments used in the management of byproduct material meets or exceeds the requirements in 10 CFR Part 40, Appendix A, Criterion 5A, and in RG 3.11, Section 2, (NRC 2008h), which outlines acceptable methods for slope stability and settlement analyses.

Pond Settlement

The licensee's engineering drawings for the evaporation ponds call for placement of up to approximately 4.6 m (15 ft) of fill above the existing ground surface along the east side of the north evaporation pond. Based on the subsurface soil conditions, the licensee does not anticipate any significant settlement of the embankment. The NRC staff reviewed the subsurface soil conditions as well as the anticipated amounts of fill placed in the pond embankments and agrees with the licensee's assessment. The NRC staff reviewed the licensee's approach for evaluating potential settlement of the pond embankments and observed that the licensee considered the subsurface conditions and the planned embankment construction. For these reasons, the NRC staff finds the licensee's approach meets Acceptance Criterion (4) of SRP Section 4.2.3 (NRC 2003a).

Pond Liquefaction Potential

The licensee's subsurface investigation included a number of soil borings in the vicinity of the evaporation ponds. The subsurface investigation information shows that the soils present at the site have some cohesion. Additionally, no groundwater was present near the surface and that the collected soil sampled had relatively low moisture content. The areas of Wyoming that may be susceptible to liquefaction are generally located in the northwestern portion of the State (Wyoming Office of Homeland Security 2014). Based on this information, the NRC staff determined that the soils present at the evaporation pond locations are not typically susceptible to liquefaction; therefore, no further analysis is warranted. Because the licensee's subsurface investigation indicated that liquefaction is not a concern, the NRC staff finds that this aspect of the evaporation pond design meets Acceptance Criterion (3) of SRP Section 4.2.3 (NRC 2003a).

Pond Freeboard

The licensee evaluated the potential for overtopping of the evaporation ponds. The licensee's engineering design and drawings for the evaporation pond depict a configuration where a portion of the evaporation ponds have a perimeter embankment and a portion is excavated from the surrounding topography. As a result, the licensee considered both storm water run-on and wave run up when evaluating freeboard in the evaporation ponds.

The NRC staff reviewed the licensee's design and observes that the evaporation ponds have been designed to prevent run-on from storm water. Where the evaporation ponds are excavated into the existing slope, the licensee's design includes a channel to divert storm water around the embankment. Therefore, the NRC staff recognizes that the only liquids entering the ponds would be: (a) liquid byproduct material that is intended to be evaporated; or (b) precipitation that falls directly into the ponds. The licensee determined that the amount of rainfall that would occur during a 6 hour probably maximum precipitation event would be 0.3 m (1 ft). The licensee used guidance developed by Linsley (Linsley et al., 1992) to estimate the amount of wave runup. Based on the windspeed and fetch, the licensee anticipates wave runup of up to 0.23 m (0.75 ft). The NRC staff reviewed the rainfall event selected by the licensee as well as the proposed wave runup calculation method. The NRC staff observes that the licensee followed the guidance contained in Section 2.2 of NRC Regulatory Guide 3.11 (NRC 2008h). The licensee designed the pond to have 0.6 m (2 ft) of freeboard, which is greater than the amount of runup anticipated from wave action and direct precipitation falling on the evaporation ponds. Therefore, the staff finds that the licensee has met SRP Acceptance Criterion (2) of SRP Section 4.2.3.

Pond Liner and Leak Detection

The licensee's proposed engineering drawings for the liner system of the evaporation ponds show a double geosynthetic liner. The licensee's proposed liner system for the evaporation ponds will consist of the following components from top to bottom:

- a 1.5 mm- (0.06-in) thick (minimum) high density polyethylene primary geosynthetic liner with studs on one side. The studs provide a gap between the primary and secondary liner.
- a 1 mm (0.04-in) thick (minimum) PVC secondary liner
- a minimum of 0.91 meters (3 ft) of compacted soil with a hydraulic conductivity of no greater than $1x10^{-7}$ cm/sec ($4x10^{-8}$ in/sec).

- native soil

The NRC staff observes that, in the licensee's design, the studs on the bottom of the primary liner will create in a space between the primary and secondary liners. This space serves as a drainage layer. The NRC staff observes that the engineering drawings show that the drainage layer is sloped to drain towards perimeter monitoring sumps. Therefore, any liquid that leaks through the primary liner will be directed to one of the sumps, where it can be easily detected and collected. The staff finds that the proposed liner system meets the regulations in 10 CFR Part 40, Appendix A, which require that a synthetic liner have a leak detection system. The staff also finds that the storage pond has been designed to prevent migration of wastes to the subsurface, which is consistent with Acceptance Criterion (2) of SRP Section 4.2.3. Additionally, as discussed in the DDW and land application sections earlier in this chapter of the SER, the licensee has identified the anticipated chemical composition of the liquid byproduct material. By providing this information, the staff finds that the licensee has satisfied Acceptance Criterion (4) of SRP Section 4.2.3.

The licensee described its proposed operational inspection plan for the evaporation ponds. The inspection plan focuses on daily inspections, with additional actions taken when a leak is detected.

The licensee's daily inspections will include visual inspections of the piping, berms, diversion ditches, freeboard, liner integrity, leak detection systems. The licensee plans to test the leak detection sump pumps every two weeks. If a leak is detected, the licensee plans to sample and test for chloride, bicarbonate, and alkalinity.

The staff reviewed the licensee's proposed inspection plan and observed that it includes items related to integrity of the liner system, freeboard, integrity of the embankment slopes, and sampling of the leak detection sumps when they contain liquids. The staff finds that the licensee's inspection plan is consistent with Acceptance Criterion (2) of SRP Section 4.2.3. The NRC staff also concludes that the existing License Condition 11.4 (condition 11.2 of the renewed license) of the Smith Ranch license (SUA-1548) addresses inspections of the ponds at the Smith Ranch Highland Uranium Project. The NRC staff is removing existing condition 10.3.3 as the condition has been satisfied.

10.3.3 ~~Prior to the onset of commercial *in situ* leach activities, the licensee shall propose plans for the conduct of daily visual inspections of the Gas Hills Project evaporation pond embankments, fences, and liners, including measurements of pond freeboard and checks of the leak detection system. The licensee shall also describe the actions it will take for fluid detected in the leak detection system standpipe, including the sampling and analysis of standpipe fluids and plans for the transfer of the evaporation pond contents to an alternate cell for the conduct of evaporation pond repairs.~~

Condition 12.1 of license SUA-1548 will remain with the renewed license. This license condition relates to initial reporting of excursions, spills, or pond leaks. The condition also addresses follow up reports. The NRC staff finds that the licensee has developed adequate inspection procedures to prevent migration of waste from the evaporation ponds to the subsurface, which is consistent with the SRP Acceptance Criterion (2) of SRP Section 4.2.3. As described in SER Section 4.2.4 and shown in SER Table 2~~Table 2~~, the NRC staff will revise License Condition 11.4 (11.2 in the renewed license) in the Smith Ranch Material License SUA-1548 to clarify that the condition applies to all storage or evaporation ponds authorized under the license.

Evaporation Ponds Monitoring Program

The licensee did not describe a groundwater detection monitoring program for the evaporation ponds. The requirements for a detection monitoring program are found in 10 CFR Part 40, Appendix A Criterion 7A. This regulation applies because the evaporation ponds will be used to retain 11e.(2) byproduct material.

During its site characterization of the area surrounding the evaporation ponds, the licensee stated it did not encounter any groundwater. The licensee's statement was based on an evaluation of soil borings that were drilled to a depth of approximately 15.2 meters (50 feet).

The NRC staff does not find the lack of groundwater in borings is sufficient justification to not provide groundwater monitoring around the evaporation ponds. Additionally, the licensee did not request an exemption from the requirements of Criterion 7A. While the licensee does plan to monitor the leak detection zone between the primary and secondary liner, the intent of a groundwater monitoring program is to provide a redundant monitoring method in the event that the primary and secondary liners are compromised.

In conclusion, the NRC staff finds that the licensee has not addressed Criterion 7A in the Smith Ranch Renewal Technical Report (Cameco, 2012b). Therefore, the NRC staff will require installation of groundwater monitoring wells in the vicinity of the evaporation ponds to address the requirements in 10 CFR Part 40 Appendix A Criteria 7A and 5B(1). The NRC staff observes that the recommended groundwater monitoring for impoundments can be found in Regulatory Guide 4.14 (NRC 1980a). The guidance states samples of groundwater should be collected from at least three wells located hydrologically down gradient from impoundments and from one background well located hydrologically up gradient. The guidance states the samples should be collected monthly through the first year of operation and quarterly thereafter. Because groundwater has not been encountered near the evaporation ponds, the monitoring wells should be placed on all sides of the ponds. The NRC staff recognizes that it may not be possible to obtain groundwater samples from these wells. The NRC staff will include a new License Condition 10.3.4 to require the licensee to install four groundwater monitoring wells surrounding the evaporation ponds.

10.3.4 *The licensee shall install four groundwater monitoring wells surrounding the evaporation ponds at the Gas Hills remote satellite. The monitoring wells shall be completed at a depth sufficient ability to monitor for potential seepage from the evaporation ponds. If no groundwater is detected after installation of the wells, they shall be checked for the presence of groundwater on a quarterly basis. If groundwater is found in a well, it shall be sampled and analyzed for the excursion indicator parameters of conductivity, chloride and alkalinity. If any of these indicators demonstrate levels which reflect similar water quality to the evaporation pond liquid waste, the licensee shall inform NRC in 30 days and conduct an investigation to determine if the source of elevated excursion indicator parameters is from the evaporation pond.*

Construction Considerations

The licensee provided a set of engineering drawings that provide details related to construction of the evaporation ponds. The NRC staff reviewed the drawings, which provide information on the location of the evaporation ponds, liner system, details associated with the leak detection

system, as well as the related pond infrastructure. With respect to engineering quality control for construction of the evaporation ponds, the licensee provided construction specifications in its submittal.

The licensee provided a description of a potential liner failure at an evaporation pond in Section 7.5.1.4, "Potential Lined Pond Failure," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). As discussed earlier in this section of the SER, the licensee has designed the evaporation ponds to prevent overtopping. Additionally, the ponds have been designed to include a leak detection system. The leak detection system will allow pond leaks to be quickly identified. Condition 12.1 of license SUA-1548 requires a 24-hour notification in the event of a pond leak followed by a submitted written report to the NRC headquarters' Project Manager, detailing the conditions leading to the spill or incident, corrective actions, and results achieved within 30 days of initial notification. As discussed above, these procedures are acceptable to the staff. The staff finds that, consistent with Acceptance Criterion (5) of SRP Section 4.2.3, the licensee has provided plans and procedures for addressing contingencies for all reasonably expected system failures.

SRP Acceptance Criterion 4.2.3(1) states that common liquid effluents generated from the process bleed, process solutions, wash down water, well development water, pumping test water, and restoration waters are properly controlled. Acceptable control methods include diversion of liquid byproduct material to surface impoundments for evaporation or storage, deep well injection, and land application/irrigation. The NRC staff finds that the licensee has met Acceptance Criterion (1) of SRP Section 4.2.3 for liquid byproduct material disposal at the Smith Ranch Highland Uranium Project.

4.2.3.5 Liquid Non Byproduct Material

The licensee stated that liquid non-11e.(2) byproduct material includes storm water runoff, erosion and sediment control, and domestic liquid wastes. These wastes are not regulated by the NRC, but may be regulated by other Federal or State government agencies. The licensee stated that it plans to control these liquids in a manner consistent with its permits issued by the WDEQ. This includes a WYPDES permit for stormwater and a Class V UIC permit for domestic liquid wastes.

4.2.3.6 Solid Waste

At SRHUP, solid waste can be generated from maintenance or non-routine activities, routine operations, and general housekeeping. The types of waste can include, but not be limited to, spent resin, resin fines, sludge in the storage ponds, empty reagent containers, miscellaneous piping and fittings, and domestic trash.

4.2.3.6.1 Solid Byproduct Material

The licensee described its procedures for storage, packaging, transport, and disposal of solid 11e.(2) byproduct material in Section 4.2.3, "Solid Wastes," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee's plans for disposal of solid 11e.(2) byproduct material are the same for all areas authorized for uranium recovery under license SUA-1548. Therefore, the NRC staff's analysis applies to the entire project. The licensee's plans include collection of solid 11e.(2) byproduct material and storage in a fenced area with restricted access for storage of solid 11e.(2) byproduct material prior to off site disposal. The licensee committed to maintain signed contracts for off-site disposal at a facility authorized to receive solid 11e.(2)

byproduct material. The licensee also committed to notify the NRC within 7 days if the disposal agreement expires or is terminated. If the agreement expires, the condition requires the licensee to submit a new agreement be submitted to the NRC within 90 days. This approach is consistent with Acceptance Criteria (6) in SRP section 4.2.3.

Based on its review of the licensee's production schedules, the NRC staff anticipates that solid 11e.(2) byproduct material will be generated at approximately the same rate as it has been historically. One previously unaccounted for source of solid 11e.(2) byproduct material will come from the use of forced evaporation at the Gas Hills remote satellite. In section 3.6.4.3 of the technical report, the licensee states that the use of forced evaporation may generate as much as 3,500 m^3 (4,600 yd^3) of solid 11e.(2) byproduct material per year. The licensee has a viable disposal option via its solid 11e.(2) byproduct material disposal agreement.

Condition 9.6 of license SUA-1548 formalizes the requirements for disposal of solid 11e.(2) byproduct material. The license condition requires that 11e.(2) byproduct material is disposed of at an appropriately licensed NRC or Agreement Facility that is authorized to receive such material. The condition also requires that the licensee maintain a copy of its disposal agreement on-site. Finally, the condition requires that the licensee notify the NRC within 7 days of expiration or termination of the agreement. If the agreement expires, the condition requires the licensee to submit a new agreement be submitted to the NRC within 90 days. This condition will remain in the renewed version of license SUA-1548.

4.2.3.6.2 Solid Non-Byproduct Material

Solid waste other than 11e.(2) byproduct material is not regulated by NRC. The licensee discussed its plans for disposal of solid non-11e.(2) byproduct material in Section 4.2.3, "Solid Wastes," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated that examples of this kind of material includes domestic trash, uncontaminated parts or equipment, or other waste that was decontaminated to unrestricted release criteria. The licensee stated that it disposes of sold non 11e.(2) byproduct material at the nearest sanitary landfill. This approach is consistent with the NRC staff's previous review (NRC, 2001a).

4.2.4 Evaluation Findings

The NRC staff reviewed the type, disposal and monitoring of liquid and solid effluents at the Smith Ranch Highland Uranium Project facility in accordance with Section 4.2.3 of the SRP. The licensee described the solid and liquid effluents that are generated at the facility. An acceptable disposal method was identified for liquid byproduct material including the following: a series of deep disposal wells approved through a Wyoming UIC permit; storage or evaporation ponds; and land application. At Smith Ranch Highland, the disposal methods for liquid byproduct material include: use of DDWs, the east and west storage ponds near the Smith Ranch CPP, PSR1 and its associated land application area, and PSR 2 and its associated land application area. At the North Butte remote satellite, the disposal methods for liquid byproduct material include: use of two storage ponds and DDWs. At the Gas Hills remote satellite, the disposal methods for liquid byproduct material include: use of DDWs (pending WDEQ approval) and storage ponds. At the Ruth remote satellite, the disposal method for liquid byproduct material is the use of storage ponds. The NRC staff is revising condition 10.1.8 (re-numbered 10.1.7 in the renewed license) to clarify the disposal options for Smith Ranch Highland. This condition will now read as follows:

10.1.7 *At Smith Ranch Highland,* ~~A~~*a*ll liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, discharged to the ~~solution evaporation~~ *storage* ponds, pumped to the purge storage reservoirs for disposal via land application or deep well injected.

To clarify the disposal options at the remote satellite facilities, the NRC staff is including new conditions 10.2.3 (Ruth), 10.3.5 (Gas Hills), and 10.4.2 (North Butte). These conditions will read as follows:

10.2.3 *At the Ruth remote satellite, all liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, or discharged to the storage ponds.*

10.3.5 *At the Gas Hills remote satellite, all liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, discharged to the evaporation ponds, or deep well injected.*

10.4.2 *At the North Butte remote satellite, all liquid effluents stemming from commercial uranium recovery units, process buildings and process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit, discharged to the storage ponds, or deep well injected.*

Acceptable methods of disposal were also provided for solid byproduct material and appropriate agreements are in place. The monitoring of disposal of liquid and solid wastes was also found to be acceptable. The NRC staff is retaining conditions 10.1.5, 10.1.7 (10.1.6 in the renewed license), 10.1.8 (10.1.7 in the renewed license), 10.2.2, and 11.4 (11.2 in the renewed license). Additionally, to avoid duplication of license conditions, the NRC staff is removing condition 10.3.3 and modifying condition 11.4 (11.2 in the renewed license) to clarify where it applies.

The licensee has shown that effluent control systems, procedures, and required training will limit radiation exposures under both normal and accident conditions by providing information on the health and safety impacts of system failures and identifying preventive measures and mitigation for such occurrences. The licensee has committed to maintaining occupational radiation doses and doses to the general public at ALARA levels and within applicable 10 CFR Part 20 exposure limits.

Based upon the review conducted by the NRC staff as indicated above, the information provided in the application as supplemented by information submitted in accordance with the noted license conditions, meets the applicable acceptance criteria of Section 4.2.3 of the SRP (NRC, 2003a) and the requirements of 10 CFR Parts 20 and 40.

5.0 OPERATIONS

In this section, the NRC staff evaluates the licensee's description of its corporate organization, administrative procedures, and various safety programs as presented in the Smith Ranch Renewal Technical Report (Cameco 2012b). Where the NRC staff observed that the program descriptions appear essentially unchanged from previously reviewed and approved licensee programs, the NRC staff evaluated the performance of the program as part of determining that the NRC staff had the requisite adequate assurance that the program would meet the applicable requirements for the Smith Ranch Highland Uranium Project.

5.1 Corporate Organization and Administrative Procedures

In this section, the NRC staff evaluates the licensee's proposed organization and administrative procedures.

5.1.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its corporate organization and administrative procedures for the Smith Ranch Highland Uranium Project are consistent with the requirements of 10 CFR 20.1101, which contains radiation protection requirements; and 10 CFR 40.32(b), (c), and (d), which require that the licensee is qualified through training and experience to use source materials.

5.1.2 Regulatory Acceptance Criteria

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

5.1.3 Staff Review and Analysis

Unless otherwise stated, the NRC staff's review is based on information contained in Section 5.1, "Corporate Organization and Administrative Procedures," and Figure 5.1, "Cameco Organizational Chart," of the Smith Ranch Renewal Technical Report (Cameco 2012b).

The licensee described its corporate organization, which includes the following positions: Board of Directors; President; Vice President; General Manager of U.S. Operations; Manager, Safety, Health, Environment, and Quality - Division; Mine Manager, North Butte/Smith Ranch Highland Operation; Manager, Safety, Health, Environment, and Quality – Site; Radiation Safety Officer; and Health Physics Technician. The radiation safety officer has the responsibility to develop and implement the as low as reasonably achievable (ALARA) program; enforce regulations and policies related to the Health Physics Program; maintain equipment; assist with the annual ALARA audit as well as other management audits; and to conduct inspections of the facilities authorized under the license.

The NRC staff observes that the organizational chart in Figure 5.1 and responsibilities described in the Smith Ranch Renewal Technical Report provide for integration between groups supporting operation and maintenance of the facility. The organizational structure and responsibilities also allow for sufficient independence to raise significant safety issues to senior management.

The licensee described its approach for the Safety and Environmental Review Panel (SERP) in Section 5.2.2, "Performance-Based License Condition," of the Smith Ranch Renewal Technical Report. The SERP will consist of a minimum of three individuals with responsibilities for management/financial aspects of the facility; operations; and radiation safety. SERP composition is consistent with condition 9.4d of license SUA-1548. This license condition will not change as a result of this renewal.

During its review, the NRC staff observed that the licensee's administrative procedures are generally consistent with the guidance contained in NRC Regulatory Guide 8.2, Revision 1, "Administrative Practices in Radiation Surveys and Monitoring," (NRC, 2011d). The NRC staff's evaluation of quality assurance practices can be found in Section 5.8 of this SER.

Based on the NRC staff's review, as described above, the NRC staff determined that the licensee has provided information to satisfy Acceptance Criteria (1) through (5) in Section 5.1.3 of the SRP. Therefore, the information provided by the licensee is acceptable.

The NRC staff last reviewed the licensee's management audit and inspection program in 2001 and 2007 (NRC, 2001a and NRC, 2007a). The licensee did not request any changes from the previously reviewed and approved management audit and inspection program. During the renewal period, the NRC staff's oversight of operations of License SUA-1548 have not identified any persistent issues related to the licensee's corporate organization (see Appendix A of this SER). The NRC staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and NRC staff's prior conclusions that the licensee's corporate organization and administrative procedures met 10 CFR Part 20.1101 and 10 CFR 40.32 (b), (c), and (d) remain valid.

5.1.4 Evaluation Findings

The NRC staff reviewed the corporate organization and administrative procedures of the Smith Ranch Highland Uranium Project. The NRC staff's review included an evaluation using the review procedures in SRP section 5.1.2 and the acceptance criteria outlined in SRP Section 5.1.3 of the SRP (NRC, 2003a).

The licensee has an acceptable corporate organization that defines management responsibilities and authority at each level. The licensee's definition of the responsibilities and procedures with respect to development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and ground-water monitoring programs, quality assurance programs, routine/non-routine maintenance activities, and changes to any of these is acceptable. The licensee has successfully implemented the SERP process with at least three individuals representing expertise in management/financial, operations, and radiation safety matters. The licensee has demonstrated that specific technical issues will be dealt with by the SERP, with support from other qualified staff members, or consultants, as appropriate. Based on the information provided by the licensee and the detailed review conducted of the corporate organization and administrative procedures for the Smith Ranch Highland Uranium Project, the NRC staff concludes that the proposed corporate organization and administrative procedures are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements. In addition, the requirements of 10 CFR 40.32(b), (c), and (d) are also met as they relate to the proposed corporate organization and SERP functions.

5.2 Management Control Program

In this section, the NRC staff evaluates the licensee's proposed management control program and administrative procedures to ensure that activities affecting health, safety, and the environment will be conducted in accordance with written standard operating procedures, including record keeping and reporting.

5.2.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the management control program for the Smith Ranch Highland Uranium Project is consistent with the requirements of 10 CFR Part 20, Subpart L, Subpart M and with 10 CFR 40.61. The staff also determines whether or not the licensee has demonstrated compliance with the health and safety requirement of 10 CFR 40.32(c).

5.2.2 Regulatory Acceptance Criteria

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

5.2.3 Staff Review and Analysis

Unless otherwise stated, the NRC staff's review is based on information contained in Section 5.2, "Management Control Program," and Section 5.3.3, "Record Keeping and Retention," of the Smith Ranch Renewal Technical Report (Cameco 2012b).

The NRC staff last reviewed the licensee's management audit and inspection program in 2001 and 2007 (NRC, 2001a and NRC, 2007a). The licensee did not request any changes from the previously reviewed and approved management audit and inspection program.

The licensee's management control program is based on its Safety, Health, Environment, and Quality Management System (SHEQMS). The NRC staff understands that the licensee's SHEQMS is a formalized, structured approach to review the safety, health, environment, and quality of operational activities. The licensee stated that the SHEQMS includes occupational safety activities, radiological safety activities, and environmental monitoring. Additionally, the licensee stated that the SHEQMS is documented in a series of operating procedures, which are contained in eight volumes. The NRC staff observes that Section 5.2.3, "Safety and Environmental Review Panel," of the Smith Ranch Renewal Technical Report (Cameco 2012b) provides more detail about the operating procedures used by the licensee. The NRC staff understands that the licensee has established operating procedures for routine work and also has a radiation work permit program for non-routine work. Based on the NRC staff's review, acceptance criteria (1), (2), and (3) of Section 5.2.3 of the SRP (NRC, 2003a) have been satisfied.

The licensee described its approach to the safety and environmental review panel (SERP) in Section 5.2.3, "Safety and Environmental Review Panel,"of the Smith Ranch Renewal Technical Report (Cameco 2012b). As discussed in Section 5.1.3 of this SER, the SERP will consist of a minimum of three individuals with responsibilities for management/financial aspects of the facility; operations; and radiation safety. The NRC staff compared the licensee's description of its SERP process to condition 9.4d of license SUA-1548 and determined that the licensee's

SERP process is consistent with the requirements in the license. This license condition will not change as a result of this renewal. The NRC staff determined that the licensee has met acceptance criteria (4) in Section 5.2.3 of the SRP (NRC, 2003a).

The licensee described its approach to posting in Section 5.2.5, “Radiation Work Permit,” of the Smith Ranch Renewal Technical Report (Cameco 2012b). The licensee has posted entrances to the facility with signs that state “Any area within this facility may contain radioactive material.” The NRC staf observes that this approach is consistent with acceptance criteria (5) in Section 5.2.3 of the SRP (NRC, 2003a).

With respect to cultural resource inventory, condition 9.9 of license SUA-1548 contains the requirement that the licensee perform a cultural resource inventory before engaging in any development activities not previously assessed by the NRC. Additionally, this condition requires that any work resulting in discovery of previously unknown cultural artifacts would cause work to stop. In such a situation, the condition requires NRC approval to proceed. This condition will not change as a result of this license renewal request. As this condition is present in the license, the NRC staff has determined that acceptance criteria (6) in Section 5.2.3 of the SRP (NRC, 2003a) has been met.

The licensee discussed its approach to record keeping and reporting in Section 5.3.3, “Record Keeping and Retention,” of the Smith Ranch Renewal Technical Report (Cameco 2012b). The NRC staff observed that licensee’s description of its record keeping and retention program meets the requirements of 10 CFR 20 Subpart L and with 10 CFR 40.61 (d) and (e). The licensee plans to retain records for surveys, calibrations, personnel monitoring, disposal of byproduct material, spills, and excursions. The licensee will also maintain records related to site and aquifer characterization efforts. The NRC staff observes that in meeting the requirements of 10 CFR Part 40.61(e), the licensee will make records available to a new owner in the event of a change of control. Based on the NRC staff’s review, the licensee’s approach is consistent with acceptance criteria (7), (8), (9), and (11) of Section 5.2.3 of the SRP (NRC, 2003a) and is therefore acceptable to the NRC staff. The staff observes that acceptance criteria (10) is intended for new licenses or owners. As Cameco is an existing licensee for license SUA-1548, this acceptance criteria does not apply for this review.

The NRC staff observes that condition 12.1 of license SUA-1548 requires that spills, leaks, or excursions be reported to the NRC project manager within 24 hours. The condition requires a written follow up report within 30 days. This condition will not change as a result of this license renewal request. As this condition is present in the license, the NRC staff has determined that acceptance criteria (12) in Section 5.2.3 of the SRP (NRC, 2003a) has been met.

The NRC staff observes that condition 12.2 of license SUA-1548 requires submission of an annual report, which includes one of the semi-annual effluent monitoring reports as well as the SERP information required under condition 9.4(d). As discussed in Appendix B to this SER, the NRC staff has changed the language of condition 12.2 slightly to better clarify its intent.

During the renewal period, the NRC staff’s oversight of operations of License SUA-1548 have not identified any persistent issues related to the licensee’s management control program (see Appendix A of this SER). The NRC staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and NRC staff’s prior conclusions that the licensee’s management control program meet 10 CFR Part 20, Subpart L, Subpart M and 10 CFR 40.61 remain valid.

5.2.4 Evaluation Findings

The NRC staff has completed its review of the management control program proposed for use at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.2.2 and the acceptance criteria outlined in SRP Section 5.2.3 (NRC 2003a).

The licensee has an acceptable management control program, SHEQMS, which assures that all safety related operating activities can be conducted while following written operating procedures. The licensee has developed acceptable operating procedures. The licensee has demonstrated that non-routine work or maintenance activity will comply with radiation safety requirements and that radiation work permits will be issued for activities where standard operating procedures do not apply.

As required by license condition, the licensee will administer a cultural resources protection program in compliance with the National Historic Preservation Act, the Archeological Resources Protection Act, and their implementing regulations. The licensee will cease any work resulting in the discovery of previously unknown cultural artifacts until such artifacts are inventoried and evaluated and authorization has been obtained from the NRC to proceed.

The licensee has acceptable record keeping and retention and reporting programs that will be adequate to ensure that the licensee is able to track, control, and demonstrate control over the source and byproduct materials that are processed, produced, or stored at the facility during its operating life, through decommissioning, and to license termination. The record keeping and retention plans will assist in ensuring that both on-site and off-site exposures are kept within regulatory limits and in documenting compliance with NRC regulations. The licensee has demonstrated an acceptable program to maintain records on spills, likely contamination events, and unusual occurrences for use in calculating annual surety amounts and to ensure acceptable decommissioning. The licensee will maintain records for decommissioning, on-site and off-site disposal, personnel exposure, and off-site releases of radioactivity, as permanent records for the facility that will be transferred to any new owner or licensee, and ultimately to NRC, before license termination. Reports will be made to the NRC as required by regulations and license condition.

Based on the information provided by the licensee and the detailed review conducted of the management control program for the Smith Ranch Highland Uranium Project, the NRC staff concludes that the proposed management control program is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criteria 8 and 8A, which specify documentation requirements for airborne effluents and waste retention systems; 10 CFR 20.1101, which defines radiation protection program requirements; the National Historic Preservation Act and the Archeological Resources Protection Act, which define requirements for the protection of cultural resources; 10 CFR Part 20, Subpart L and Subpart M, which define requirements for record keeping and reporting; and 10 CFR 40.61(d) and (e), which also define requirements for record keeping.

5.3 Management Audit and Inspection Program

In this section, the NRC staff reviews the licensee's proposed management audit, inspection, and as low as reasonably achievable program. This includes the frequencies, types, and scopes of reviews and inspections; action levels; corrective action measures; and the responsibilities of each participant.

5.3.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that it meets the requirements of 10 CFR 40.32(b) and (c) for the Smith Ranch Highland Uranium Project as it relates to the acceptability of management audits to ensure protection of health and minimize danger to life and property.

5.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 5.3.3 of the SRP (NRC, 2003a).

5.3.3 Staff Review and Analysis

Unless otherwise stated, the NRC staff's review is based on information contained in Section 5.3, "Cameco Management Audit and Inspeciton Program," of the Smith Ranch Renewal Technical Report (Cameco 2012b). The licensee's Management Audit and Inspection Program includes daily, weekly, and monthly inspections by the radiation safety officer, or a trained designee.

The licensee described type and scope of the inspections. The NRC staff last previously reviewed the licensee's management audit and inspection program in 2001 and 2007 (NRC, 2001a and NRC, 2007a). The licensee did not request any changes from the previously reviewed and approved management audit and inspection program.

The NRC staff observes that the licensee's internal inspection program includes corrective measures. The NRC staff observes this will allow the licensee to identify and fix problems. With respect to the as low as is reasonably achievable (ALARA) audit, the licensee described the scope of the audit and identified the type of personnel that would be retained to perform the audit. The licensee committed to conducting the ALARA audit in a manner that is consistent with the recommendations in NRC Regulatory Guide 8.31 (NRC, 2002c). Finally, the licensee provided examples of recommendations that were implemented as a result of the annual ALARA audits.

During the renewal period, the NRC staff's oversight of operations of License SUA-1548 have not identified any persistent issues related to the licensee's management audit and inspection program (see Appendix A of this SER). The NRC staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and NRC staff's prior conclusions that the licensee's management audit and inspection program meet 10 CFR 40.32 (b) and (c) remain valid.

5.3.4 Evaluation Findings

The NRC staff has completed its review of the management audit and inspection program for the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP section 5.3.2 and the acceptance criteria outlined in SRP section 5.3.3.

The licensee has an acceptable management audit and inspection program that provides frequencies, types, and scopes of reviews and inspections; action levels; and corrective action measures sufficient to implement the proposed actions.

Based on the information provided by the licensee and the detailed review conducted of the management audit and inspection program for the Smith Ranch Highland Uranium Project, the NRC staff concludes that the proposed programs are acceptable and are in compliance with 10 CFR 20.1702, which requires the use of process or other engineering measures to control the concentrations of radioactive material in the air; and 10 CFR 20.1101 which contains requirements for maintaining radiation exposure limits as low as is reasonably achievable. In addition, the requirements of 10 CFR 40.32(b), (c), and (d) are met as they relate to the acceptability of management audits to ensure protection of health and minimize danger to life and property.

5.4 Qualifications for Personnel Conducting the Radiation Safety Program

5.4.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the personnel conducting the radiation safety program meet the requirements of 10 CFR Part 20.1101 and 10 CFR 40.32(b).

5.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the NRC staff evaluated the Smith Ranch Renewal Technical Report (Cameco 2012b) for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Section 5.4.3 of the SRP (NRC 2003a). Regulatory Guide 8.31, Regulatory Position 2.4, provides recommendations for technical qualifications of radiation safety staff (NRC 2002c). The licensee is required by license condition 9.7 to follow the recommendations of Regulatory Guide 8.31.

5.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its renewal application (Cameco 2012b). In Section 5.4, "Qualifications of Personnel Conducting the Radiation Safety Program," of its Smith Ranch Renewal Technical Report, the licensee described the qualifications of three positions: (1) Manager, Safety Health, Environment and Quality (SHEQ); (2) Radiation Safety Officer (RSO); and (3) Health Physics Technician (HPT). The NRC staff evaluated the licensee's description of qualifications for the radiation safety staff positions of RSO and HPT, for which minimum standards are provided in Regulatory Guide 8.31 (NRC 2002c).

The NRC staff observed that the education requirements for the RSO stated by the licensee in Section 5.4.2, "Radiation Safety Officer," of the Smith Ranch Renewal Technical Report are not consistent with Regulatory Guide 8.31, Regulatory Position 2.4.1. The licensee stated the RSO requires a minimum education of a "Bachelor's Degree or an Associate's Degree in the physical sciences, industrial hygiene, environmental technology or engineering from an accredited college or university or an equivalent combination of training and relevant experience in uranium mill/ISR radiation protection" (emphasis added). However, the licensee is required by license condition 9.7 to follow the guidance set forth in Regulatory Guide 8.31, which supersedes the commitments, representations, and statements contained in the renewal application. Regulatory Guide 8.31, Regulatory Position 2.4.1, states that the minimum education requirement is a

"bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in UR facility radiation protection." Despite the apparent error in the application, because license condition 9.7 will remain in the renewed license and the licensee has an acceptable performance history on this requirement (see SER Table A-4, "Violations of NRC Requirements, July 2006 through November 2016"), the NRC staff finds the licensee's qualifications of the RSO are acceptable.

The NRC staff also evaluated the licensee's description of the qualifications of the HPT. In Section 5.4.3, "Health Physics Technician," of the Smith Ranch Renewal Technical Report, the licensee described the education requirements for the HPT. The NRC staff observed that the education requirements for the HPT stated by the licensee in Section 5.4.3, "Health Physics Technician," of the Smith Ranch Renewal Technical Report are not consistent with Regulatory Guide 8.31, Regulatory Position 2.4.2, "Health Physics Technicians." The licensee stated the HPT requires a minimum education and training of an "Associate's Degree or two years or more of study in the physical sciences, engineering or a health-related field, or a high school diploma and a combination of experience and training" and "at least a total of four weeks of generalized training in radiation health protection applicable to uranium mill/ISR operations." However, the licensee is required by license condition 9.7 to follow the guidance set forth in Regulatory Guide 8.31, which supersedes the commitments, representations, and statements contained in the renewal application. Regulatory Guide 8.31, Regulatory Position 2.4.2, states the minimum combination of education and training is either: (1) an associate degree or 2 or more years of study in the physical sciences, engineering, or a health-related field and 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to UR facilities; or (2) a high school diploma and a total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to UR facilities. The licensee's statement would allow an individual with a high school diploma and four weeks of generalized training to qualify as an HPT, which does not meet the minimum standards in Regulatory Guide 8.31. Nevertheless, because license condition 9.7 will remain in the renewed license and the licensee has an acceptable performance history on this requirement (see SER Table A-4, "Violations of NRC Requirements, July 2006 through November 2016"), the NRC staff finds acceptable the licensee's qualification requirements for HPTs.

In Section 5.3.1.1, "Daily Inspections," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee stated "the RSO, HPT, trained designated operator conducts daily facility inspection." This is consistent with Regulatory Guide 8.31, Regulatory Position 2.3.1, "Daily and Weekly Inspections," which states that the RSO or designated HPT should conduct this daily inspection, except there is no provision in Regulatory Guide 8.31 for a "trained designated operator" to conduct this inspection. However, the licensee described the qualifications of a "trained designated operator" (also referred to as a "Designated Operator") in Section 5.5.4.1, "Minimum Qualifications for Designated Operators," of the Smith Ranch Renewal Technical Report. The licensee's program for qualification of Designated Operators includes a minimum education requirement of a high school diploma, general radiation safety training and function-specific training on daily inspections; and a minimum of three months' work experience in operations or maintenance at a UR facility, including procedures that involve health physics, industrial safety, or industrial hygiene. The NRC staff determined that this is similar to qualification requirements for other NRC-approved programs for Designated Operators at ISR facilities (NRC 2013a, NRC 2014h, NRC 2015e, NRC 2017a) and is, therefore, acceptable.

5.4.4 Evaluation Findings

NRC has completed its review of the qualifications of facility personnel conducting the radiation safety program at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.4.2 and the acceptance criteria outlined in SRP Section 5.4.3.

Based on the information provided in the application and the detailed review conducted of the qualifications of the personnel conducting the radiation safety program for the Smith Ranch Highland Uranium Project, the NRC staff concludes that the qualifications of the personnel are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for licensee qualifications. The qualifications of personnel conducting the radiation safety program are acceptable consistent with NRC Regulatory Guide 8.31 (NRC 2002c).

5.5 Radiation Safety Training

5.5.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that their radiation safety training program for Smith Ranch Highland Uranium Project meets the requirements of 10 CFR 20.1101 and 40.32(b).

5.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Section 5.5.3 of the SRP (NRC 2003a).

5.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its renewal application (Cameco 2012b). In Section 5.5, “Training,” of the Smith Ranch Renewal Technical Report, the licensee described its training programs for visitors, contractors and permanent employees. The NRC staff evaluated the licensee’s training program against the guidance in Regulatory Guide 8.13, “Instruction Concerning Prenatal Radiation Exposure, Revision 3” (NRC 1999), Regulatory Guide 8.29, “Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1” (NRC 1996), and Regulatory Guide 8.31, “Information Relevant to Ensuring the Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Is Reasonably Achievable” (NRC 2002c), consistent with the acceptance criteria in Section 5.5.3 of the SRP (NRC 2003a).

In Section 5.5.1, “Radiation Safety Training Program Content,” of the Smith Ranch Renewal Technical Report, the licensee described a graded approach to training for visitors, contractors and permanent employees, with contract workers performing work on heavily-contaminated equipment and permanent employees receiving the most extensive initial radiation safety training and testing and annual refresher training. The NRC staff determined the licensee’s training program description includes the same elements identified in Regulatory Guide 8.31, Regulatory Position 2.5 and is, therefore, acceptable.

In Section 5.5.4.2, “Additional Training for Designated Operators” of the Smith Ranch Renewal Technical Report, the licensee described its training program for Designated Operators who perform daily visual inspections work and storage areas in the temporary absence of the RSO and HPT. The NRC staff determined that the training, proficiency testing, document, and annual refresher training Designated Operators are similar to qualification requirements for other NRC-approved programs for Designated Operators at ISR facilities (NRC 2013a, NRC 2014h, NRC 2015e, NRC 2017a) and is, therefore, acceptable.

5.5.4 Evaluation Findings

NRC has completed its review of the radiation safety training program at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.5.2 and the acceptance criteria outlined in SRP Section 5.5.3.

The radiation safety training program at the Smith Ranch Highland Uranium Project is consistent with the guidance contained in NRC Regulatory Guides 8.31 (NRC 2002c), 8.13 (NRC 1999), and 8.29 (NRC 1996). The content of the training material, testing, on-the-job training, and the extent and frequency of retraining are acceptable. Radiation safety instructions for employees are acceptable.

Based on the information provided in the application and the detailed review conducted of the radiation safety training program for the Smith Ranch Highland Uranium Project, the NRC staff concludes that the radiation safety training program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), as it relates to licensee qualifications through training.

5.6 Security

In this section, the NRC staff evaluates the licensee’s proposed security measures to prevent unauthorized entry into restricted and controlled areas.

5.6.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its security program for the Smith Ranch Highland Uranium Project meets the requirements of 10 CFR Part 20.1801 and 20.1802.

5.6.2 Regulatory Acceptance Criteria

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

5.6.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Cameco in the Smith Ranch Renewal Technical Report (Cameco 2012b). The licensee’s discussion of security measures is presented in Section 5.7, “Security,” of the Technical Report.

The licensee stated that all areas containing source or byproduct material are fenced, including active mine unit areas. The licensee has also equipped main access points to the Smith Ranch CPP and Highland CPF with locking or automatic gates. The licensee staffs operating portions of SRHUP 24 hours a day, 7 days a week. In controlled or unrestricted areas, the licensee does conduct surveillance. The licensee has installed continuous video surveillance covering areas around the Smith Ranch CPP and main office complex.

The licensee stated that at the beginning of each shift, operators perform a visual inspection to confirm proper storage and security of NRC licensed source and byproduct material. The licensee stated that if NRC licensed material is found outside a restricted or controlled area, the operator will ensure that the material is secured, locked, and moved to a restricted area. In the event the material cannot immediately moved to a restricted area, the licensee committed to maintain direct observation of the material by site personnel until the material can be moved to a restricted area.

The licensee stated that incoming and outgoing shipments of materials meeting the U.S. Department of Transportation's definition of hazardous materials are a part of routine operations at the Smith Ranch Highland Uranium Project. The licensee identified that shipments of ion exchange resin, yellowcake slurry, or contaminated equipment between company facilities as typical hazardous material shipments. The licensee has developed a security plan, as required by 49 CFR 172, Subpart I. Guidelines identified in the licensee's security plan include: securing access to materials with locks and/or tamper indicators at trailer openings; securing vehicles when left unattended; and maintaining visual surveillance of vehicles at all times when left unattended outside a restricted area.

The NRC staff previously reviewed and approved the licensee's security measures during the previous renewal of license SUA-1548 (NRC, 2001a) and during the Reynolds Ranch amendment (NRC, 2007a). The NRC staff observes that the licensee's security measures are similar to those previously reviewed and approved. As discussed in Appendix A to this SER, the NRC staff has inspected the facilities authorized under license SUA-1548 several times over the course of this renewal period. The NRC staff's inspections have not identified any persistent security issues at the Smith Ranch Highland Uranium Project. The NRC staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and the NRC staff's prior conclusions that the licensee's security program meets 10 CFR Part 20 Subpart I remain valid.

5.6.4 Evaluation Findings

The NRC staff has completed its review of the security measures at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in section 5.6.2 and acceptance criteria in section 5.6.3 of the SRP (NRC, 2003a). The security measures at the Smith Ranch Highland Uranium Project demonstrate that the licensee has acceptable active and passive controls on entry to the licensed and restricted areas. This includes the use of fences, locked gates, and video surveillance. The NRC staff determined that the licensee has adequately described security measures for stored material and control measures for material within the restricted area.

Based upon the information provided in the Smith Ranch Renewal Technical Report (Cameco 2012b) and the review conducted by the NRC staff as indicated above, the NRC staff concludes that the licensee's security measures meet the acceptance criteria of Section 5.6.3 of the SRP and are in compliance with the requirements of 10 CFR Part 20, Subpart I.

5.7 Radiation Safety Controls and Monitoring

5.7.1 Effluent Control Techniques

The NRC staff determined that areas of review and acceptance criteria presented in Section 5.7.1 of the SRP (NRC 2003a), which addresses effluent control techniques, are covered in other sections of this SER. The NRC staff's evaluation of the licensee's proposed effluent control techniques is provided in Section 4.1 and Section 5.7.7 of this SER.

5.7.2 External Radiation Exposure Monitoring Program

5.7.2.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its external radiation exposure monitoring program for the Smith Ranch Highland Uranium Project meets the requirements of 10 CFR Part 20, Subpart C, 10 CFR 20.1501(c), 10 CFR 20.1502, 10 CFR Part 20, Subpart L, 10 CFR Part 20, Subpart M, and 10 CFR 40.61.

5.7.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the NRC staff evaluated the Smith Ranch Renewal Technical Report (Cameco, 2012b) for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Section 5.7.2.3 of the SRP (NRC 2003a). Regulatory Guides 8.30 (NRC 2002d) and 8.31 (NRC 2002c) provide guidance on how compliance with the regulations can be demonstrated.

5.7.2.3 Staff Review and Analysis

The licensee described the locations of external radiation exposure measurements in Section 5.8.1.1, "Personnel Dosimetry" of the Smith Ranch Renewal Technical Report (Cameco 2012b). Specifically, the licensee stated gamma exposure rate surveys are performed in accordance with standard operating procedures. The licensee also stated existing survey locations for the Smith Ranch CPP and satellites are shown on Figures 5.2 through 5.6, and Figures 5.6A and 5.6B of the Smith Ranch Renewal Technical Report. The NRC staff examined these figures and determined that Figures 5.2 through 5.6, which depict floor plans and survey locations in the CPP, Selenium Treatment Plant, and satellites 2, 3, SR-1, and SR-2, respectively, show locations of external radiation exposure measurements. Figures 5.6A and 5.6B also show the locations of external radiation exposure measurements at the North Butte and Gas Hills satellite buildings. As a result, the NRC staff determined that acceptance criteria 5.7.2.3(1) and 5.7.2.3(9) of the SRP regarding drawings that depict facility layout and monitoring locations is met.

The licensee described its criteria for determining which employees are monitored for external dose. In Section 5.8.1.1, "Personnel Dosimetry," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee explained that it conservatively chooses to monitor more workers than required to comply with 10 CFR 20.1502(a)(1), which requires monitoring for adults likely to receive, in one year from source external to the body, a dose in excess of 10 percent of the limits in 10 CFR 20.1201(a). The licensee monitors workers in the satellites and CPP workers. The licensee provided historical data in Table 5-2, "Average Annual Radiation Dosimeter Reading," of the Smith Ranch Renewal Technical Report, which shows that annual

average external doses measured from the year 2002 through 2010 for seven worker groups is less than 5 mSv (500 mrem). The NRC staff determined that the licensee has an effective program to monitor employee groups that might receive external doses above 10 percent of the regulatory limits. As a result, the NRC staff determined that acceptance criteria 5.7.2.3(2) of the SRP regarding criteria for establishing which employees are monitored for external dose is met.

The licensee stated in Section 5.8.1.1, "Personnel Dosimetry" of the Smith Ranch Renewal Technical Report (Cameco, 2012b), that its uses external dosimeters which are provided by a vendor that is accredited to National Voluntary Laboratory Accreditation Program of the National Institutes of Standards and Technology and are changed quarterly and which have a measurement range of 0.01 to 10 mSv (1 to 1,000 mrem). The NRC staff determined that these external dosimeters meet acceptance criteria 5.7.2.3(3) and 5.7.2.3(4) regarding dosimeters with appropriate sensitivity and frequency.

In Section 5.8.5, "Administrative Action Levels," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee stated that it has an action level of 312 mrem per quarter above which the RSO will investigate, determine the reason, and initiate corrective measures to prevent recurrence. The license also stated that external doses are documented and reviewed annually to ensure annual doses are maintained less than 5 mSv (500 mrem). The NRC staff determined that these program elements meet the acceptance criteria 5.7.2.3(5) and 5.7.2.3(6) regarding documenting radiation exposures and taking appropriate corrective action below the 10 CFR 20 regulatory limits.

In Section 5.3.2, "Annual ALARA Audits," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee explained its program to conduct annual ALARA audits using qualified outside personnel that meet the minimum qualifications for education and experience as an RSO. The NRC staff determined this program will review the external exposure records for employees and observe trends and recommend ways to further reduce personnel exposures. Therefore, the NRC staff determined that these program elements meet the acceptance criteria 5.7.2.3(7) regarding keeping radiation doses ALARA.

5.7.2.4 Evaluation Findings

NRC has completed its review of the external radiation exposure monitoring program at the Smith Ranch Highland Uranium Project facility. This review included an evaluation using the review procedures in SRP Section 5.7.2.2 and the acceptance criteria outlined in SRP Section 5.7.2.3.

The licensee has proposed an acceptable external radiation exposure monitoring program at the Smith Ranch Highland Uranium Project. The licensee has provided an acceptable drawing(s) that depicts the facility layout and the location of external radiation monitors. The external radiation monitors are acceptably placed. The licensee has established appropriate criteria to determine which employees should receive external radiation monitoring. The licensee has demonstrated that the range, sensitivity, and calibration of external radiation monitors will protect health and safety of employees during the full scope of facility operations. Planned radiation surveys are adequate. Planned documentation of radiation exposures is acceptable. The licensee's monitoring program is acceptable to protect workers from beta and gamma radiation.

Based on the information provided in the application and the detailed review conducted of the external radiation exposure monitoring program at the Smith Ranch Highland Uranium Project,

the NRC staff concludes that the external radiation exposure monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines a radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1201(a), which defines occupational dose limits; 10 CFR 20.1501, which provides requirements of surveying and radiation monitoring; 10 CFR 20.1502, which defines conditions requiring individual monitoring of external dose; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and 10 CFR Part 20, Subpart M, which defines reporting requirements.

5.7.3 Airborne Radiation Monitoring Program

5.7.3.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its in-plant airborne radiation monitoring program for Smith Ranch Highland Uranium Project meets the requirements of 10 CFR Part 20, Subparts B and C, 10 CFR 20.1501, and 10 CFR 20.1702.

5.7.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.3.3 of the SRP (NRC 2003a). Regulatory Guide 8.30 (NRC 2002d) provides guidance on how compliance with the regulations can be demonstrated.

5.7.3.3 Staff Review and Analysis

There are two primary occupational airborne radiological hazards at an ISR facility: (1) natural uranium, as a result of dried yellowcake processing; and (2) radon-222 progeny. In the two sub-sections that follow, the NRC staff evaluates the licensee's program for each hazard.

5.7.3.3.1 Airborne Uranium Particulate Monitoring

The licensee described the locations of in-plant air sample measurements in Section 5.8.2.1, "Airborne Uranium Particulate Monitoring," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated air sample locations for the CPP are shown on Figure 5.2, "Radiological Sampling Locations at the CPP," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The NRC staff examined Figure 5.2, which depicts the CPP floor plan and survey locations in five different areas of the CPP, including three in areas where yellowcake slurry and dried yellowcake are processed (i.e., precipitation area, yellowcake dryer room, and yellowcake storage area). The NRC staff determined these locations are reasonable because they focus on areas where yellowcake is processed and is most likely to be an airborne hazard. Therefore, the NRC staff determined that Figure 5.2 meets the acceptance criteria 5.7.3.3(1) regarding providing a drawing that depicts facility layout and location of air samplers.

The NRC staff observed that data in Appendix I, Addendum 2, Table 3, of the Smith Ranch Renewal Technical Report shows the results of air samples collected over 31 months in areas throughout the Smith Ranch Highland site, including satellite buildings, but not the Selenium Treatment Plant. The NRC staff observed that the air sample results for the Satellite 2 building, a facility located a few meters east and downwind of the Selenium Treatment Plant, show that radium-226 accounts for between 33 percent and over 95 percent of the combined activity of natural uranium and radium-226 in all samples collected (NRC 2018c). Furthermore, the

guidance in Regulatory Position C.1.1, "When to Evaluate the Need for Air Sampling," states, "As a general rule, any licensee who handles or processes unsealed or loose radioactive materials in quantities that during a year will total more than 10,000 times the ALI for inhalation should evaluate the need for air sampling." During an inspection in November 2016, the NRC staff learned that the licensee processes approximately two 9.9 m^3 (13 yd^3) containers per year, with each container holding approximately 2E+09 Bq (0.05 Ci) of radium-226 as barium-radium sulfate solids (Cameco 2016d). The ALI for radium-226 is 2220 Bq (0.6 µCi). Therefore, the NRC staff estimates the Selenium Treatment Plant processes about 90,000 times the ALI of radium-226 annually, and the licensee should evaluate the need for air sampling.

For the reasons described above, the NRC staff will add a license condition requiring the licensee to collect representative air samples in occupied spaces of the Selenium Treatment Facility during operation of the barium-radium sulfate sludge filter press to determine, in accordance with guidance in Regulatory Guide 8.25, whether routine air sampling should be performed, and if so, what the correct DAC should be for determining occupational internal dose in the Selenium Treatment Plant.

10.1.11 *The licensee shall collect air samples in five occupied spaces inside the Selenium Treatment Plant during operation of the barium-radium sulfate sludge filter press, analyze the samples for natural U, Th-230, Ra-226, and Pb-210, and determine whether routine air sampling is warranted in accordance with Regulatory Guide 8.25. If routine air sampling is warranted, the licensee shall determine the appropriate derived air concentration (DAC) for the mixture in accordance with 10 CFR 20.1204. The minimum detectable concentration for air samples shall be less than 10% of the DAC for Th-230.*

The licensee stated that it collects monthly air samples using an Eberline RAS-I or equivalent regulated air sampler and passes a sufficient volume of air through a glass fiber filter, and uses a sufficiently long counting time on the filters to ensure a lower level of detection of less than 10 percent of the site-specific derived air concentration (DAC). The NRC staff determined that the licensee's description of equipment and sampling procedures meets the the acceptance criteria 5.7.3.3(2) regarding the identification of monitoring equipment.

In Appendix I, "Smith Ranch Analysis of Day, Week, and Year Classification Smith Ranch Radionuclide Mixture Assessment," of the Smith Ranch Renewal Technical Report, the licensee provided the results of its analysis of its dried yellowcake to determine which pulmonary retention class (i.e., Class D, W, or Y), or mixture thereof, should be applied in calculating internal dose from airborne radioactive material (Cameco 2012b). After analyzing ten samples of yellowcake, the licensee concluded that its dried yellowcake is properly categorized as Class D, with a small component of type W material. As a result, the licensee calculated allowable limits on intake (ALI) and derived air concentration (DAC) values of 1 µCi and 5E-10 µCi/mL, respectively, for natural uranium.

With regard to whether other long-lived radionuclides, other than natural uranium, may also be present as airborne contaminants, the license stated,

> "Addendum [2] to Appendix I provides sampling data and analysis to support that radionuclides (except U-nat) contributing to human dose at the Smith Ranch-Highland site are present at concentrations that are less than the 10 CFR 20.1204(g) limits, which allows licensees to disregard them. For that reason, no adjustment to the DAC is required to address radionuclide mixtures."

The NRC staff evaluated the licensee's analysis in Appendix I, Addendum 2, "Smith Ranch Radionuclide Mixture Assessment." In its analysis, the licensee collected air samples from 39 buildings over a 31-month period throughout the Smith Ranch Highland area, including the CPP, mine units, and five satellites. The licensee analyzed each air sample for natural uranium, thorium-230, radium-226, and lead-210. The licensee then averaged the 39 results for each radionuclide. To evaluate the licensee's analysis, the NRC staff used the raw data provided by the licensee in Table 3, "In-Plant Isotopic Data from Smith Ranch-Highland," of Appendix I, Addendum 2, to verify the licensee's calculations. The licensee's calculations, and the NRC staff's confirmatory calculations, show that the conditions in the following regulations were met over the 31-month sample period: (1) 10 CFR 20.1204(g)(2), regarding disregarding any radionuclide for which the concentration is less than 10 percent of its DAC; (2) 20.1204(g)(3), regarding whether the sum of the DAC percentages for all radionuclides disregarded exceeds 30 percent. In addition to verifying the licensee's analysis of the average concentrations of radionuclides at all 39 locations, the NRC staff verified that all individual locations also met the mixture rule in 10 CFR 20.1204(g).

The licensee did not describe in the Smith Ranch Renewal Technical Report how it would ensure future operations would remain in compliance with the mixture rule in 10 CFR 20.1204(g). However, in correspondence dated July 30, 2018, the licensee committed to perform periodic isotopic analysis of air samples to ensure the requirements of the 10 CFR 20.1204(g) mixture rule are met (Cameco Resources, 2018f). The NRC staff will add a license condition which captures the licensee's committment:

10.1.18 *Where air samples are taken to comply with 10 CFR 20.1204(a), the licensee shall perform isotopic analysis of air samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 at a frequency of once every 6 months for the first two years, and annually thereafter to ensure compliance with 10 CFR 20.1204(g).*

In applying the mixture rule, the regulation in 10 CFR 20.1204(g)(1) states the licensee should use the total activity of the mixture in determining compliance with dose limits in 10 CFR 20.1201 and in complying with the monitoring requirements of 10 CFR 20.1502(b). The licensee stated it uses gross alpha measurements to analyze air samples, which detects all alpha-emitting radionuclides in air samples. However, the additional activity that might be contributed by short-lived beta-emitting radionuclides of natural uranium, namely thorium-234 (half life is equal to 24 days) and protactinium-234m (half-life is equal to 1.17 minutes), would not be detected by gross alpha measurements. This means the licensee would not be detecting the total activity of the mixture because it is not accounting for short-lived beta-emitting daughter radionuclides of natural uranium that could be present in air samples.

The licensee addressed this issue in Appendix I, Addendum 2, of its Smith Ranch Revised Technical Report (Cameco, 2012b), and showed by calculation that the additional dose from short-lived beta-emitting daughter radionuclides is minimal and can be omitted. This is because the ALI and DAC for natural uranium already includes the dose from these short-lived beta-emitting daughter radionuclides that are produced in the body after an intake of natural uranium, and the additional dose that would be caused by intake of these radionuclides, were they present in inhaled air at the time of intake, is insignificant. For example, in the following conservative scenario evaluated by the NRC staff, the NRC staff considered that uranium-238, an alpha-emitting radionuclide that is a component of natural uranium, and its short-lived beta-emitting daughters thorium-234 and protactinium-234m could be in secular equilibrium in air. In this scenario, the concentrations of all three radionuclides in air would be the same. The DAC

for natural uranium (Class D) is 5E-10 µCi/mL; the most restrictive DAC for thorium-234 (Class Y) is 6E-8 µCi/mL; and the applicable DAC for protactinium-234m is 1E-7 µCi/mL (Note: see the end of 10 CFR 20, Appendix B, Table 1, for the DAC for protactinium-234m, a radionuclide not listed in the table). The DAC fraction for this example mixture, in which natural uranium concentration is at its DAC value, and the short-lived beta-emitting daughters are also present in equilibrium with uranium-238, is:

$$\frac{Unat, conc}{DAC_{Unat}} + \frac{^{234}Th\ , conc}{DAC_{Th-234}} + \frac{^{234m}Pa, conc}{DAC_{Pa-234m}} = \frac{5x10^{-10}}{5x10^{-10}} + \frac{2.45x10^{-10}}{6x10^{-10}} + \frac{2.45x10^{-10}}{1x10^{-7}} = 1.0065$$

This calculation demonstrates that the additional occupational dose from the short-lived beta-emitting daughters would add less than 0.65 percent of the occupational dose from natural uranium alone. The NRC staff determined that this additional fractional dose is insignificant and the contribution from short-lived beta-emitting daughters of natural uranium can be safely disregarded.

The licensee stated that the radiation detection equipment is a Ludlum Model 2000 or equivalent counter with a Ludlum Model 43-10 detector or equivalent. The NRC staff verified that this equipment is appropriate for this purpose by examining information available on Ludlum's website. For example, the NRC staff observed that the Ludlum Model 43-10 is a radiation detector that is sensitive to alpha radiation and has a sufficiently low background count rate to ensure that, combined with sufficiently large air samples, the lower level of detection of air samples will be less than 10 percent of the site-specific DAC.

The licensee presented historical results in Section 5.8.1.1, "Airborne Uranium Particulate Monitoring," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). Specifically, in Table 5-3, "Natural Uranium Concentrations in Air as a Percent Derived Air Concentration," the licensee presented results for calendar years 1999 through 2010. The licensee explained that it took action in 1999 to improve housekeeping practices in the yellowcake dryer area. The NRC staff agrees that this improvement is shown in the data in Table 5-3, which shows a marked decrease in average and maximum air concentrations from 1999 to 2001.

In Section 5.8.5, "Administrative Action Levels," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee stated that it has action levels for uranium intake of 2.5 milligrams per week of soluble uranium and uranium exposure of 125 DAC-hours per quarter of insoluble uranium above which the RSO will investigate, determine the reason, and initiate corrective measures to prevent recurrence.

Therefore, the NRC staff determined that air sample equipment meets the acceptance criteria 5.7.3.3(2), 5.7.3.3(3), and 5.7.3.3(4) regarding type, sensitivity, and planned use of air sampling equipment in a manner sufficient to adequately protect workers from yellowcake dust. The NRC staff determined the monthly frequency of air samples is also consistent with Regulatory Guide 8.30, Table 3, values for sampling yellowcake process areas that are not airborne radioactivity areas (as defined in 10 CFR 20).

5.7.3.3.2 Radon daughter monitoring

In Section 5.8.2.2, "Radon daughter monitoring," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its program to survey radon daughters on a monthly frequency at the CPP and satellites. The licensee depicted sample locations on floor plan

drawings in Figures 5.2 through 5.6 of the Smith Ranch Renewal Technical Report, which are for the CPP and four currently-operating satellites: Satellite 2, Satellite 3, SR-1, and SR-2. The licensee stated the sample locations for future satellites will include the control room, RO area, IX columns, and process tank/trailer bay areas. The NRC staff determined these locations are reasonable because they focus on areas where radon leakage is possible and where its daughters would most likely pose an airborne hazard. Therefore, the NRC staff determined that the licensee's description of sample locations meets the acceptance criteria 5.7.3.3(1) regarding providing drawings that depicts layout of facilities and location of air samples.

The licensee stated that it uses the modified Kuznetz method to measure radon daughters as described in ANSI-N13.8-1978. The NRC staff determined this method is acceptable because it meets the guidance in Regulatory Position 2.3 of Regulatory Guide 8.30 (NRC 2002d).

The licensee provided results of historical measurements at its facilities in Table 5-4, "Radon-222 Progeny Concentrations in Air for Smith Ranch Facility Structures as a Percent of Derived Air Concentration," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The NRC staff examined this table and determined that average radon progeny concentrations were below 10 percent of the applicable DAC for the period 1999 through 2010 at nine different facility structures throughout the Smith Ranch Highland site. The NRC staff also observed that average radon progeny concentrations at all locations trended toward lower values over the same period. The NRC staff determined that this meets acceptance criteria 5.7.3.3(7) of the SRP, regarding a description of historical results and long-term trends.

In Section 5.8.5, "Administrative Action Levels," the licensee stated that it has action levels for radon progeny exposure of 125 DAC-hours per quarter above which the RSO will investigate, determine the reason, and initiate corrective measures to prevent recurrence. The NRC staff determined that this meets acceptance criteria 5.7.3.3(3) of the SRP, regarding planned surveys of airborne radiation consistent with guidance in Regulatory Guide 8.30.

In Section 5.8.3.6, "Respiratory Protection Program," of the Smith Ranch Renewal Technical Report, the licensee described its use of respiratory protection equipment and its commitment to a program which implements Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," and Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Is Reasonably Achievable." This commitment meets acceptance criterion 5.7.3.3(6) of the SRP, regarding a respiratory protection program. The NRC staff's evaluation of the licensee's bioassay program is described in SER Section 5.7.5. The licensee's bioassay program demonstrates the ongoing effectiveness of both the licensee's engineered controls (e.g., ventilation) and respiratory protection program in reducing internal occupational dose.

5.7.3.4 Evaluation Findings

NRC has completed its review of the airborne radiation monitoring program at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.7.3.2 and the acceptance criteria outlined in SRP Section 5.7.3.3.

The licensee has an acceptable airborne radiation monitoring program at the Smith Ranch Highland Uranium Project. The licensee has provided an acceptable drawing(s) that depicts the facility layout and the locations of airborne radiation monitors. The airborne radiation monitors are acceptably placed. The licensee demonstrated that the range, sensitivity, and calibration of monitors of airborne radiation will enable accurate determinations of the concentrations of

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

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

5.7.4 Exposure Calculations

5.7.4.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its exposure calculations for the Smith Ranch Highland Uranium Project facility meet the requirements of Subparts C, F, L, and M of 10 CFR Part 20. Specific regulations that must be followed include: 10 CFR 20.1201(e), 10 CFR 20.1204(f), 10 CFR 20.1204(g), and 10 CFR 20.1502.

5.7.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.4.3 of the SRP (NRC 2003a).

5.7.4.3 Staff Review and Analysis

In Section 5.8.3, "Exposure Calculations," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee explained its procedures for evaluating employee exposure to airborne natural uranium and radon progeny. The NRC staff examined the procedures described in Section 5.8.3.1, "Natural Uranium Exposure," and 5.8.3.2, "Radon Progeny Exposure," and determined these procedures are consistent with guidance in Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses" (NRC 1992d), and Regulatory Guide 8.30 (NRC 2002d). The NRC staff determined that the licensee exposure calculation procedures meet acceptance criteria 5.7.4(1), 5.7.4(2), 5.7.4(3), 5.7.4(5), 5.7.4(6), and 5.7.4(7).

In Section 5.8.3.4, “Prenatal and Fetal Exposure,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee explained its procedures for prenatal and fetal radiation exposure. The licensee committed to use the procedures in Regulatory 8.36, “Radiation Dose to the Embryo/Fetus,” which the NRC staff determined meets acceptance criteria 5.7.4.3(4) regarding calculation and guidance for prenatal and fetal radiation exposure. For example, the licensee committed to increasing the frequency of evaluation of external dosimeters of the dose to the embryo/fetus approaches the regulatory limit.

The licensee presented its historical results of exposure monitoring in Technical Report Table 5-5, “Annual Total Effective Dose Equivalent for CPP Workers,” and Table 5-6C, “Component Contributions to Average TEDE.” The licensee reported, for the period 2003 through 2011, site-wide annual average and annual maximum results for: (1) committed effective dose equivalent (CEDE) from uranium exposure, (2) CEDE from radon progeny exposure, (3) effective dose equivalent (EDE) from external sources of gamma radiation, and (4) total effective dose equivalent (TEDE). The NRC staff evaluated this data. Using the data provided by the licensee in Table 5-5, the NRC staff calculated that less than 1 percent of the average annual occupational TEDE is attributable to intakes of airborne uranium (NRC 2018c). This is consistent with NRC staff’s experience and the general nature of modern ISR operations, in which engineered controls, including the use of low-temperature vacuum dryers and other ventilation controls, provide adequate protection against airborne radioactive particulate matter. About 83 percent of the average annual occupational TEDE is attributable to external gamma radiation and 17 percent is attributable to exposure to airborne radon progeny. The maximum TEDE during the period 2003 through 2011 was 7.74 mSv (774 mrem) in 2006, which is below the regulatory limit of 0.05 Sv (5 rems) in 10 CFR 20.1201. The NRC staff determined that the historical results meet acceptance criteria 5.7.4(9) regarding the effectiveness of the exposure monitoring program to demonstrate that occupational dose limits have been met.

5.7.4.4 Evaluation Findings

NRC has completed its review of the exposure calculations at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.7.4.2 and the acceptance criteria outlined in SRP Section 5.7.4.3.

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

Based on the information provided in the application and the detailed review conducted of the exposure calculations at the Smith Ranch Highland Uranium Project, the NRC staff has

concluded that the exposure calculations are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR 20.1201(a), which specifies individual occupational dose limits; 10 CFR 20.1201(e), which defines allowed intake of soluble uranium; 10 CFR 20.1202, which describes the means of compliance when summing internal and external doses; 10 CFR 20.1203, for determination of dose from airborne external radiation; 10 CFR 20.1204, which provides requirements for determination of internal exposure; and 10 CFR 20.1208, which specifies the exposure limits for a fetus.

5.7.5 Bioassay Program

5.7.5.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that their bioassay program for Smith Ranch Highland Uranium Project meets the requirements of Subparts C, L, and M of 10 CFR Part 20.

5.7.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.5.3 of the SRP (NRC 2003a). Regulatory Guides 8.9 (NRC 1993b), 8.22 (NRC 1988e), 8.30 (NRC 2002d) and 8.34 (NRC 1992d) provide guidance on meeting the applicable regulations.

5.7.5.3 Staff Review and Analysis

In Section 5.8.4, “Bioassay Program,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee stated that its bioassay program meets the regulatory positions in Regulatory Guide 8.22, “Bioassay at Uranium Mills” (NRC 1988e). The NRC staff confirmed that the licensee continues to monitor workers routinely exposed to yellowcake at a monthly frequency, and the licensee uses sample quality assurance procedures and action levels as described in Regulatory Guide 8.22. The licensee also described its historical results in Technical Report Table 5-7, “Bioassay Results for Smith Ranch from 1999 through 2010.” The licensee stated that only 32 out of 4,804 samples exceeded the action level of 15 µg/L. The NRC staff examined Technical Report Table 5-7 and observed a decreasing trend in positive results above the method detection limit. The NRC staff determined that the bioassay program remains acceptable.

5.7.5.4 Evaluation Findings

The NRC staff has completed its review of the bioassay program at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.7.5.2 and the acceptance criteria outlined in SRP Section 5.7.5.3.

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

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

5.7.6 Contamination Control Program

5.7.6.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that their contamination control program for Smith Ranch Highland Uranium Project meets the requirements of Subparts B, C, and F of 10 CFR Part 20.

5.7.6.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.6.3 of the SRP (NRC 2003a). Regulatory Guide 8.30 (NRC 2002d) provides guidance on how compliance with the applicable regulations can be demonstrated.

5.7.6.3 Staff Review and Analysis

In Section 5.8.6, “Contamination Control Program,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described several elements of its contamination control program, including: (1) surface contamination control; (2) personnel contamination control; (3) survey and release of potentially-contaminated equipment and materials to unrestricted areas; (4) protective equipment and procedures; and (5) conditional release of items that traverse unrestricted areas but remain within possession and control of the licensee. The NRC staff’s evaluation of each of these elements is described below.

In Section 5.8.6.2, “Surface Contamination Control for Uranium,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its program to perform monthly surveys of process areas and weekly surveys of designated clean areas. The licensee uses radiation detection instruments to detect alpha-emitting radionuclides associated with natural uranium. The NRC staff determined the licensee’s action levels for cleaning and resurveying contamination areas are consistent with the limits described in Regulatory Guide 8.30. The NRC staff determined this meets acceptance criterion 5.7.6.3(3).

In Section 5.8.6.3, “Personnel Contamination Control,” of the of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described the use of radiation detection instruments sensitive to alpha-emitting radionuclides to detect contamination on personnel before exiting the CPP and satellite facilities, and at the entrance to the CPP lunch room. Other personnel contamination control program elements include training on good housekeeping practices in process areas, use of personnel protective equipment, and showers. The NRC staff determined the licensee’s personnel contamination control procedures are consistent with the guidance in Regulatory Guide 8.30. The NRC staff determined this meets acceptance criteria 5.7.6.3(1) and 5.7.6.3(2).

In Section 5.8.6.4, “Surveys of Equipment and Materials Prior to Release to an Unrestricted Area,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its procedures for releasing potentially-contaminated equipment and materials for unrestricted use. The licensee committed to the release limits established in the Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials.” In Addendum 1, “Radiological Monitoring Equipment,” to Appendix I of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described the sensitivity of its radiation detection instruments for alpha-emitting and beta/gamma-emitting radionuclides.

The NRC staff evaluated the information contained in Addendum 1 of Appendix I. The licensee described use of the following detectors: a Ludlum Model 43-5 alpha detector; a Ludlum Model 43-65 alpha detector; and a Ludlum Model 43-89 alpha/beta detector. The licensee used the minimum detectable concentration equation by Strom and Stansbury (NRC, 1995b) to calculate the maximum background count rate that would enable detection of surface contamination below 500 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) using a static survey method. The NRC staff determined this MDC is acceptable because it meets the recommended MDC for surface contamination in Regulatory Guide 8.30, Table 3, “Summary of Survey Frequencies.” Furthermore, the method used by the licensee to demonstrate the minimum detectable concentrations was previously approved by NRC staff for another ISR licensee (NRC, 2015g).

In Section 5.8.6.4, “Surveys of Equipment and Materials Prior to Release to an Unrestricted Area,” the licensee also stated, “The RSO, HPT, or properly trained employees perform surveys for removable contamination as well as surveys for alpha and beta contamination of items removed from the restricted areas with the exception of small, hand-carried items.” However, the NRC staff determined that the licensee did not describe the qualifications and training requirements for “properly training employees” that perform surveys to release items for unrestricted use. Furthermore, NRC staff Regulatory Position C.2.6 of Regulatory Guide 8.31 states, “The RSO and radiation safety office staff are responsible for performing all routine and special radiation surveys as required by license conditions and by 10 CFR Part 20.” Because the licensee has not justified a departure from Regulatory Position C.2.6, the NRC staff will include a license condition requiring that surveys for release of items for unrestricted use shall by performed by either an RSO or health physics technician. This license condition is described in SER Section 6.2.3.2.1.

In Section 5.8.6.5, “Protective Equipment and Procedures,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described how protective gear and clothing, such as coveralls, boots, shoe covers, gloves, and respirators, are used to control contamination. The NRC staff determined the licensee’s procedures for use of protective equipment are consistent with the guidance in Regulatory Guide 8.30. The NRC staff determined this meets acceptance criteria 5.7.6.3(1) and 5.7.6.3(2) and is therefore acceptable.

In Section 5.8.6.6, “Conditional Release Program,” of the Smith Ranch Renewal Technical Report, the licensee described its program for allowing certain potentially-contaminated items to be removed from restricted areas and remain under the licensee’s control until they are either returned to another restricted area or surveyed and released for unrestricted use. The program elements for the conditional release program for potentially-contaminated items and resin trailers are summarized in Tables 5.8-1 and 5.8-2 of the Smith Ranch Renewal Technical Report (Cameco, 2012b), respectively. The program includes action limits, tracking and tagging requirements, qualification and training requirements for employees performing conditional

release surveys, proficiency testing of employees, and annual employee requalification requirements. The NRC staff evaluated these elements and determined that these controls meet the guidance in Regulatory Position 2.7 of Regulatory Guide 8.30 that "The licensee should develop methods to prevent potentially contaminated equipment from leaving the restricted area without being monitored." The NRC staff evaluated the licensee's proposed action limit for items stated in Technical Report Table 5.8-1 of 50 counts per minute (cpm) by converting it to surface contamination levels in units of dpm/100 cm^2, and comparing this to the guidance in Regulatory Guide 8.30, Table 2. A typical alpha survey instrument identified in Addendum 1 to Appendix I of the Smith Ranch Renewal Technical Report is the Ludlum Model 2241 scaler-ratemeter and Model 43-65 alpha detector. From published Ludlum specifications, the NRC staff assumed a 2π detector efficiency of 34 percent and active area of the detector of 63 cm^2 (9.8 in^2). Using these assumptions, a net detector response of 50 cpm corresponds to a total surface contamination of:

$$Surface\ contamination = \frac{Net\ cpm}{(\epsilon_s)(\epsilon_s)(Area, cm^2)} = \frac{50\ cpm}{(0.34)(0.5)(63\ cm^2)} = 467\frac{dpm}{100\ cm^2}$$

The NRC staff determined that the licensee's proposed action level is acceptable because it is lower than the recommended surface contamination levels in Regulatory Guide 8.30, Table 2.

5.7.6.4 Evaluation Findings

The NRC staff has completed its review of the contamination control program at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.7.6.2 and the acceptance criteria outlined in SRP Section 5.7.6.3.

The licensee has established an acceptable contamination control program at the Smith Ranch Highland Uranium Project. Acceptable controls are in place to prevent contaminated employees or items from entering clean areas or from leaving the site. The standard operating procedures will include provisions for contamination control, such as maintaining changing areas and personal alpha radiation monitoring before leaving radiation areas. Acceptable action levels have been set in accordance with Regulatory Guide 8.30 (NRC 2002d), and plans for surveys are in place for skin and personal clothing contamination. The licensee has established that all items removed from the restricted area are surveyed by the radiation safety staff and meet release limits. All reporting and record keeping is done in conformance with protocols established in Regulatory Guide 8.7 (NRC 2005a). The licensee has demonstrated that the range, sensitivity, and calibration of monitoring equipment will protect the health and safety of employees during the full scope of facility operations. The licensee has demonstrated that contaminated surfaces will not be covered unless, before covering, a survey documents that the contamination level is below the limits specified in Regulatory Guide 8.30 (NRC 2002d). The licensee will determine the radioactivity on the interior surfaces of pipes, drain lines, or duct work by making measurements at appropriate access points that will have been shown to be representative of the interior contamination. The licensee has committed to establishing that contamination on equipment, or scrap will be within the limits in the Guidelines (NRC 1993a) before unrestricted release. To relinquish possession or control of equipment, or scrap with material in excess of the limits specified in the Guidelines, the licensee will provide detailed information on the contaminated material, provide a detailed health and safety analysis that shows that the release of the contaminated material will not result in an unreasonable risk to the health and safety of the public, and obtain NRC staff approval.

Based on the information provided in the application and the detailed review conducted of the contamination control program at the Smith Ranch Highland Uranium Project, and the license

condition described in SER Section 6.2.3.1.1, the NRC staff concludes that the contamination control program is acceptable and will be in compliance with 10 CFR 20.1101, which defines radiation protection program and as low as is reasonably achievable requirements; and 10 CFR 20.1501, which provides survey and monitoring requirements.

5.7.7 Airborne Effluent and Environmental Monitoring Program

5.7.7.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the proposed airborne effluent and environmental monitoring program for the Smith Ranch Highland Uranium Project meets the requirements of 10 CFR 20.1003, 10 CFR 20.1301, 10 CFR 20.1302, 10 CFR 20.1101(d), 10 CFR 20.1501 10 CFR 40.65, and Criteria 7 and 8 of Appendix A to 10 CFR Part 40.

5.7.7.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Sections 4.1.3(5), 5.7.7.3, and 7.3.1 of the SRP (NRC 2003a), except that the NRC staff determined that SRP Section 7.3.1.1.3 is not applicable because there are no public exposures from water pathways at the Smith Ranch Highland Uranium Project. Regulatory Guide 4.14 (NRC 1980a) provides guidance on how compliance with the applicable regulations can be demonstrated.

5.7.7.3 Staff Review and Analysis

In Section 5.10, “Environmental Monitoring Programs During Operations,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its programs for air environmental monitoring (Section 5.10.1); surface water monitoring (Section 5.10.2); groundwater monitoring (Section 5.10.3); wastewater and land application monitoring (Section 5.10.4); and reporting procedures (Section 5.10.5). The licensee described how it will monitor air effluents in Section 7.3.3.5.1, “Compliance with 10 CFR 20.1302(1),” of the Smith Ranch Renewal Technical Report (Cameco 2012b).

5.7.7.3.1 Air Effluent Monitoring

In Section 7.3.3.5.1, “Compliance with 10 CFR 20.1302(1),” [sic] of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its program for air effluent monitoring. The licensee stated that because it uses a vacuum dryer to prepare its yellowcake, only radon and radon progeny are principal radionuclides in air effluents from the facility. The licensee stated it would monitor particulate matter radionuclides in effluents at the CPP and CPF for one year to verify that these effluent quantities are low, then request NRC approval to discontinue these measurements. For the reasons stated by the licensee, the NRC staff finds the one-year monitoring program of particulate matter radionuclides acceptable.

The licensee stated it would estimate quantities of radon in air effluents by monitoring waste tank vents; CPP and CPF building exhaust; header houses; and spills. In Smith Ranch Renewal Technical Report Section 7.3.3.5.1, “Compliance with 10 CFR 20.1301(1)” [sic], the licensee explained that it would inventory its significant radon release points and then use Lucas cells to measure radon concentrations at each vent at a frequency of once per quarter, beginning in the first quarter after the license is renewed. The licensee did not explain how it

would determine which air effluent sources it would monitor and requested a license condition requiring that it further develop and implement an effluent monitoring program. Therefore, the NRC staff will include a condition in the renewed license which requires the licensee to estimate air effluent quantities of radon-222 and its short-lived progeny and report quantities in the semi-annual effluent report:

10.1.19 *At the end of the first full calendar quarter that occurs one year after issuance of the renewed license, and at the end of every calendar quarter thereafter, the licensee shall determine air effluent quantities of radon-222 and its short-lived progeny (i.e., curies per quarter) at facilities at which groundwater was processed during the previous quarter. Quarterly air effluent quantities shall be reported in semi-annual effluent monitoring reports. The licensee shall estimate air effluent quantities from sources for which monitoring is not practicable (i.e., unmonitored effluents). Unmonitored sources of air effluent quantities shall not exceed 30 percent of total air effluent quantities in any year. The licensee shall document its bases for which air effluent sources are monitored and unmonitored, and this document shall be available for inspection. In its semi-annual effluent reports, the licensee shall assume air effluent quantities of radon-222 short-lived progeny are equal to air effluent quantities of radon-222, unless the licensee has separately measured radon-222 short-lived progeny or documented an alternative approach acceptable to NRC for determining effluent quantities of radon-222 short-lived progeny. The licensee shall compare semiannual effluent quantities of radon-222 from each central processing plant and satellite building to an air effluent quantity limit of 100 curies per year (Ci/yr), and from each wellfield (including header houses) to an air effluent quantity limit of 1,000 Ci/yr. If any effluent quantity of radon-222 exceeds its applicable air effluent quantity limit, the licensee shall include that exceedance specifically in the semi-annual effluent report.*

The NRC staff's regulatory bases for each requirement in the license condition described above is as follows:

1. The overall requirement is based on 10 CFR 40.65, "Effluent monitoring reporting requirements," wherein each licensee must, among other things, "specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents." The requirement applies to all modes of facility operation (i.e., yellowcake production, groundwater restoration, decommissioning, etc.)

2. Allowing the licensee one year to implement the requirement is reasonable to allow the licensee to: inventory its air effluent sources; perform tests and measurements; and to finalize its effluent monitoring program. This delay in program implementation is reasonable because the NRC staff's independent conservative analysis of public dose at the SRHUP, described in SER Section 5.7.7.3.3, is below the public dose limit in 10 CFR 20.1301. The NRC staff's calculation of public dose is conservative because it assumes all central processing facilities, satellites and wellfields are operating simultaneously, which is unlikely.

3. With regard to which radionuclides must be included in the licensee's air effluent quantity estimates, the NRC staff's safety evaluation supports the requirement that the licensee need only estimate effluent quantities of radon-222 and its short-lived progeny. This is because radon-222 and its short-lived progeny account for more than 99 percent of the public dose.

4. The requirement that unmonitored air effluent quantities shall not exceed 30 percent of the total air effluent quantities is based on Regulatory Position 3.3 of Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities” (NRC, 1993c).

5. It is conservative to require the licensee to assume air effluent quantities of radon-222 short-lived progeny are equal to effluent quantities of radon-222. Other methods acceptable to the NRC to estimate concentrations of radon-222 progeny, and thereby estimate effluent quantities of radon-222 progeny, are described in a draft Interim Staff Guidance document (NRC, 2014d).

6. The requirement for the licensee to compare the air effluent quantities of radon-222 to a limit is based on the 10 CFR 40.65 requirement that licensees compare effluent quantities to the “licensee’s design objectives previously reviewed as part of the licensing action.” In its renewal application, the licensee did not develop design objectives for radon-222 in air effluents. Therefore, the NRC staff included in the license condition described above effluent quantity limits that are similar to estimates developed by NRC staff in its independent public dose calculation for the central processing plant and satellite building (100 Ci/yr), and for each wellfield, including header houses (1,000 Ci/yr). These effluent quantities are safe because, at these levels, the NRC staff is assured that the public dose limit in 10 CFR 20.1301 would not be exceeded for any nearby member of the public. The purpose of this requirement is to ensure the licensee investigates and explains why a specified limit was exceeded, which is similar to the requirement in 10 CFR 40.65.

5.7.7.3.2 Environmental Monitoring

In Section 5.10.1, “Air Particulate Monitoring,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its program for environmental monitoring of ambient air. The licensee described its operational program for environmental monitoring of ambient air at the Smith Ranch-Highland and North Butte licensed areas.

Smith Ranch-Highland

The Smith Ranch-Highland site currently has three operational environmental monitoring stations. Location AS-1 (Dave’s Water Well), located in the southwest portion of the Smith Ranch site, is the background location. The licensee explained it planned to use its new on-site meteorological data collected near the CPP to corroborate air sampler locations and to re-locate the AS-1 background station. The new location of AS-1 is shown on Figure 5.7 of the Smith Ranch Renewal Technical Report (Cameco, 2012b), and is upwind of all Smith RanchHighland mine units and facilities near the southwest boundary of the site. The licensee also explained it is not collecting samples from AS-4 (Highland Controlled Area) and AS-5 (Fowler Ranch), because the CPF is not operating. AS-6 (Reynolds Ranch Satellite) will become operational once the satellite facility is constructed. As a result, the current operational samplers are AS-1, as the background station, and downwind stations AS-2 (CPP Controlled Area Boundary) and AS-3 (Vollman Ranch).

As recommended in Regulatory Guide 4.14, Revision 1 (NRC, 1980a), the licensee uses operational air monitoring stations AS-1 (background), AS-2 (CPP controlled area boundary), and AS-3 (Vollman Ranch) to collect monthly particulate matter samples that are composited quarterly and analyzed for natural uranium, thorium-230, radium-226, and lead-210. The

licensee also deploys track-etch detectors for measure radon-222 concentrations and optically stimulated luminisence (OSL) detectors that measure total gamma radiation exposure. The NRC staff observes that the licensee's monthly frequency of particulate matter samples is less frequent than the weekly filter change recommended in Regulatory Guide 4.14 for operational particulate air samples. However, the NRC staff agrees that in environments where filter dust loading does not impair the licensee's ability to collect representative samples, a monthly sample is acceptable provided it is continuous. The NRC staff observes that the licensee maintains only three operational environmental monitoring stations, whereas Regulatory Guide 4.14 indicates the program should have no less than five: three at or near the site boundaries in different sectors that have the highest predicted concentrations of airborne particulates; one at the nearest residence or occupiable structure; and one background location. On the basis of the NRC staff's independent evaluation described in SER Section 5.7.7.3.3, the NRC staff determined that monitoring at downwind locations AS-2 and AS-3 ensures that the licensee continues to monitor occupied locations with the highest predicted concentrations.

In Section 5.10.1.1, "Air Particulate Monitoring," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described 11 years of historical results of environmental monitoring. These results are provided in Table 5-10, "Radionuclide Air Monitoring Data 2000-2010 Dave Water Well (AS-1)," Table 5-11, "Radionuclide Air Monitoring Data 2000-2010 Smith Ranch Controlled Area Fence Line (AS-2)," and Table 5-12, "Radionuclide Air Monitoring Data 2000-2010 Vollman Ranch (AS-3)," of the Smith Ranch Renewal Technical Report. The licensee provided background-subtracted radon-222 concentrations at the AS-2 and AS-3 locations in Technical Report Table 5-13, "Net Rn-222 Concentrations at Monitoring Locations AS-2 and AS-3."

The NRC staff evaluated the data in Tables 5-10 through 5-13 of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The NRC staff focused on radon-222 data because it is the principal radionuclide in air effluents at the Smith Ranch Highland Uranium Project and other ISRs. The NRC staff observed several errors. First, the NRC staff observed that radon-222 concentrations depicted in the figure included in Technical Report Table 5-12, "Radionuclides Air Monitoring Data 2000-2010 Vollman Ranch (AS-3)" are not the data presented in the table. The data depicted in the figure are the gamma radiation dose rate data provided in the row below the radon-222 data shown in Technical Report Table 5-12. Second, the net (i.e., background subtracted) radon-222 concentrations provided in Technical Report Table 5-11 (for location AS-2) and Technical Report Table 5-12 (for location AS-3) are not the same as the net radon-222 concentrations shown in Technical Report Table 5-13 for the same locations. Third, the NRC staff compared the radon-222 data provided in Technical Report Tables 5-10 and Table 5-13 to results provided previously in semiannual reports and determined the results did not match. Fourth, the NRC staff observed that the licensee compared the annual average radon-222 concentrations at locations AS-2 and AS-3 to the 10 CFR 20, Appendix B, Table 2, Column 1 effluent concentration for radon-222 with daughters removed (i.e., 1E-8 µCi/mL). This is incorrect for two reasons: (1) radon-222 at these locations has daughters present; and (2) a comparison to Appendix B, Table 2, effluent concentrations in accordance with 10 CFR 20.1302(b)(2)(i) must be made at the boundary of the unrestricted area, and sample location AS-3 (Vollman Ranch) is located well outside any restricted or controlled area.

As a result of the licensee's errors described above, the NRC staff disregarded Tables 5-10 through 5-13 in the Smith Ranch Renewal Technical Report (Cameco, 2012b) and independently evaluated radon-222 concentration data from semiannual effluent reports provided by the licensee for the period 2000 through 2017 (see SER Appendix A for a list of references for these reports) (NRC 2018c). The NRC staff's summary is provided in Table

20~~Table 20~~. Using the paired observation procedure in Section 15.3 of NUREG-1475, "Applying Statistics," (NRC 2011b) the NRC staff compared paired samples for the AS-1 background location and two downwind locations AS-2 (controlled area boundary) and AS-3 (Vollman Ranch) from calendar year 2000 to 2017 and determined that there was no statistical difference between either of the two downwind locations and background.

Table 20. Average Radon-222 Concentrations at Smith Ranch Highland Environmental Sampling Stations

Year	Radon-222 Concentration, pCi/L		
	AS-1 Dave's Water Well	AS-2 Controlled Area Boundary	AS-3 Vollman Ranch
2000	0.925	1.300	1.150
2001	0.975	1.075	0.925
2002	1.100	1.600	1.000
2003	0.975	1.150	0.950
2004	2.975	1.475	1.375
2005	1.050	1.300	1.350
2006	1.000	1.450	1.150
2007	1.200	2.000	1.500
2008	1.050	1.650	1.800
2009	1.400	2.600	1.050
2010	0.750	1.250	1.750
2011	1.950	0.800	0.550
2012	2.200	1.450	1.350
2013	3.250	1.000	1.700
2014	1.050	0.900	0.900
2015	0.900	1.300	1.000
2016	0.800	1.200	1.300
2017	0.405	0.420	0.365
Average*	**1.33 ± 0.35**	**1.33 ± 0.22**	**1.18 ± 0.18**

* Arithmetic mean ± 1.96 times the standard error of the mean

The NRC staff also evaluated the licensee's statement in Section 5.10.1.1, "Air Particulate Monitoring," of the Smith Ranch Renewal Technical Report (Cameco, 2012b) that direct gamma exposures are below the limits in 10 CFR 20.1302(b)(2)(ii). The limits cited by the licensee are a dose from external sources of less than 0.02 mSv (0.002 rem) in an hour and 0.5 mSv (0.05 rem) in a year to an individual continuously present in an unrestricted area. The NRC staff observes that this limit is applicable only if the licensee chooses to demonstrate compliance with the public dose limits in 10 CFR 20.1301 using the method in 10 CFR 20.1302(b)(2). If the licensee were to choose the method in 10 CFR 20.1302(b)(2), the dose limits apply in the unrestricted area (e.g., Smith Ranch environmental monitoring station AS-2) assuming an individual was continuously present, and not necessarily at the nearest residence (e.g., Smith Ranch environmental monitoring station AS-3). However, as noted below in SER Section 5.7.7.3.3, the licensee has opted to demonstrate public dose limits are met using the method in 10 CFR 20.1302(b)(1). Though the licensee did not provide a historical summary of direct gamma measurements at the environmental monitoring stations at Smith Ranch or the North

Butte remote satellite, the NRC staff obtained the data from the licensee's semiannual effluent and environmental monitoring reports. The NRC staff estimated the 2013 through 2017 five-year average net gamma exposure rate at the CPP fenceline (Station AS-2) is about 0.33 mSv/year (33 mrem/year). Likewise, the 2013 through 2017 five-year average net gamma exposure rate at the Christensen Road at the North Butte remote satellite fenceline is about 0.14 mSv/year (14 mrem/year). The nature of ISR operations ensure that there are no intermittent sources of gamma radiation that would cause an exceedance of the 0.02 mSv (0.002 rem) in an hour external dose rate limit, if the annual dose rate limit is met. On the basis of the NRC staff's analysis above, the NRC staff agrees that external doses in the unrestricted areas near the licensee's processing facilities are below the limits in 10 CFR 20.1302(b)(2)(ii).

North Butte and Gas Hills Remote Satellites

In Section 5.10.1.1, "Air Particulate Monitoring," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee stated that air particulate monitoring stations at North Butte and Gas Hills remote satellites will be installed in 2012. The licensee stated it used the factors described in Regulatory Position 1.1.1 of Regulatory 4.14 (NRC, 1980a) to identify the locations of these air particulate monitoring stations. The licensee depicted the locations of environmental monitoring stations for North Butte and Gas Hills remote satellites in Figure 5.8, "Environmental Sampling Location Map (North Butte)," and Figure 5.9, "Environmental Sampling Location Map (Gas Hills)," respectively. The NRC staff evaluated the locations of environmental monitoring stations by examining windroses and verifying that environmental monitoring stations are located on the boundaries and at nearby residences in both downwind and upwind (background) locations, as recommended in Regulatory Guide 4.14 (NRC, 1980a). The licensee provided the wind rose for the North Butte remote satellite in Figure 2.5-18, "North Butte Annual Wind Rose," of Appendix C of the Smith Ranch Renewal Environmental Report (Cameco, 2012b). The licensee provided the wind rose for the Gas Hills remote satellite in Figure 2.5-20, "Gas Hills Wind Rose," of Appendix D of the Smith Ranch Renewal Environmental Report.

Though the North Butte remote satellite was not in operation when the licensee submitted its license renewal application in February 2012, and no operational environmental monitoring data could therefore be provided at that time, the NRC staff examined semiannual reports for the 5-year period 2013 through 2017 to determine whether radon-222 concentrations were distinguishable from background. The NRC staff's summary of radon-222 concentrations at the background location (NB-9), the nearest resident (NB-8), and a downwind site boundary location (NB-13) is provided in SER Table 21~~Table 21~~. As described above for the Smith Ranch data, the NRC staff used the paired observation procedure in Section 15.3 of NUREG-1475, "Applying Statistics," (NRC 2011b) to compare paired samples from calendar year 2013 to 2017 for the NB-9 background location and the resident and downwind boundary location. The NRC staff's evaluation indicated Pfister Ranch (NB-8) had a statistically-significant higher radon concentration than the background location (NB-9); and there was no statistical difference between the downwind boundary location (NB-13) and background (NB-9). The NRC staff observed that, if the net radon concentration at Pfister Ranch is attributed to North Butte operations, the annual internal dose to a member of the public resulting from the net radon concentration at Pfister Ranch (NB-8) would be about 65 mrem, which is less than the 100 mrem per year public dose limit in 10 CFR 20.1301. The NRC staff calculated this public dose by assuming: a 0.5 equilibrium fraction; 100% occupancy; and a dose conversion factor of 500 mrem/year per pCi/L (NRC 2014d). To determine whether net radon concentration at Pfister Ranch should be attributed to North Butte operations, the NRC staff requested from the licensee pre-operational background radiological characterization measurements at the Pfister Ranch

environmental monitoring station (Cameco Resources, 2018g). The NRC staff evaluated the pre-operational data to determine whether Pfister Ranch radon concentrations in the pre-operational and operational periods are similar. The pre-operational period average radon concentration at Pfister Ranch (NB-8) was 1.05 pCi/L, which is higher than the 5-year average radon concentration for the operational period shown in SER Table 21. The NRC staff therefore determined that the North Butte environmental monitoring data are acceptable because a recent 5-year average of radon concentrations at Pfister Ranch (NB-8) was below the radon concentrations during the calendar year 2012 pre-operational period; and the net concentration of radon at Pfister Ranch (i.e., above background), even if it was attributable to North Butte operations, would result in a public dose below the 10 CFR 20.1301 public dose limit.

Table 21. Average Radon-222 Concentrations at North Butte Environmental Sampling Stations

Year	Radon-222 Concentration, pCi/L		
	NB-9 Background	NB-8 Pfister Ranch	NB-13 Anadarko Rd.
2013	0.75	0.75	0.65
2014	0.35	0.8	0.45
2015	0.95	1.3	1.05
2016	0.75	1.1	3.20
2017	0.23	0.36	0.27
Average*	**0.61 ± 0.27**	**0.86 ± 0.31**	**1.12 ± 1.05**

* Arithmetic mean ± 1.96 times the standard error of the mean

The NRC staff determined that the locations of radiological samples, sample frequencies, and sample parameters meet the acceptance criteria in SRP Section 5.7.7.3(2) through 5.7.7.3(6).

5.7.7.3.3 Public Dose Assessment

In Section 7.3, “Radiological Effects,” of the Smith Ranch Renewal Technical Report, the license stated that its prospective estimates of public dose from licensed operations use the source term methodology described in NUREG-1569, Appendix D, and the MILDOS-AREA computer model. The NRC staff evaluated these prospective dose estimates as follows: (1) for the Smith Ranch-Highland-Reynolds contiguous licensed areas, the NRC staff performed an independent dose assessment using MILDOS-AREA Version 4; (2) for the remote satellite locations North Butte and Gas Hills, the NRC staff evaluated the input parameters used by the licensee to verify that the input parameter values used by the licensee are reasonable.

While preparing its independent dose assessment for the Smith Ranch-Highland-Reynolds licensed area, the NRC staff noted several differences between its assessment and the licensee’s analysis described in Appendix L of the Smith Ranch Renewal Technical Report (Cameco, 2012b).

1. The licensee stated that the highest residential dose rate was 39.5 mrem/year at the Sunquest Ranch (also called Sundquist Ranch elsewhere in the renewal application, e.g., p. 3-5 of the Smith Ranch Renewal Environmental Report). However, the NRC staff observed that the location of Sunquest Ranch in Table 2 of Appendix L and in the enclosed MILDOS-AREA output files was assumed to be 1.1 km (0.7 mi) south of the CPP. However, the NRC

staff determined the correct location is about 4 km (2.5 mi) south of the CPP, as shown, for example, on Figure 3.1.4, "Ownership," of the Smith Ranch Renewal Environmental Report.

2. The licensee stated that the calculated dose rate at Vollman Ranch was 4.0 mrem/year. However, the NRC staff observed that the licensee's assumption regarding the location of Vollman Ranch in Table 2 of Appendix L and in the enclosed MILDOS-AREA output files was assumed by the licensee to be 6.4 km (4 mi) west of the CPP. However, the NRC staff determined the correct location is about 6.4 km (4 mi) east of the CPP. This error was significant for this receptor because Vollman Ranch is the location of downwind environmental sampling location AS-3, is the nearest resident to Smith Ranch, Highland, and Reynolds area facilities, and because 6.4 km (4 mi) west of the CPP is both offsite and upwind.

3. The licensee stated in Table 2 of Appendix L of the Smith Ranch Renewal Technical Report (Cameco, 2012b) that Duck Creek Ranch is located 8.1 km (5 mi) east and 3.2 km (2 mi) north of the proposed Reynolds Ranch satellite. In its MILDOS-AREA calculations contained in Appendices B8 through B12 of Appendix L, the licensee assumed Duck Creek Ranch is located 0.6 km (0.4 mi) east and 3.7 km (2.3 mi) south of the Reynolds Ranch satellite. Both of these stated locations are contrary to information provided by the licensee in Section 3.1.6.1, "Local Land Use," of the Smith Ranch Renewal Environmental Report, which states the Duck Creek Ranch is located in Township T37N, R74W, Section 2, SWNW, or about 1 km (0.6 mi) west and 8.3 km (5.2 mi) north of the proposed Reynolds Ranch satellite, or about 12 km (7.5 mi) north and slightly west of where the licensee assumed the ranch to exist in its calculation. The NRC staff used independent sources to verify that a ranch exists 1 km (0.6 mi) west and 8.3 km (5.2 mi) north of the proposed Reynolds Ranch satellite (or about 17.5 km (11 mi) north and 2.5 km (1.5 mi) west of the CPP) and used this location in its assessment.

4. In its MILDOS-AREA model calculation, the licensee assumed, for purposes of modeling air effluents, that satellite SR-1 was co-located with the CPP because SR-1 purge water is piped to the CPP. In its assessment, the NRC staff assumed that because SR-1 purge water is stored in ventilated waste tanks at SR-1, from which radon gas is a likely air effluent, the actual location of SR-1 should be used in the MILDOS-AREA model (i.e., about 2,800 m [9,200 ft] west and 800 m [2,600 ft] north of the CPP).

5. The licensee's analysis was completed prior to submitting the original license renewal application in 2012, when the only available meteorological data was collected at the Glenrock Coal Company site located 13 km (8 mi) west of the Smith Ranch site. In its independent evaluation, the NRC staff used on-site Smith Ranch meteorological data reported in a March 2018 revision to Appendix B of the Smith Ranch Renewal Environmental Report (Cameco, 2012b).

6. In its analysis, the licensee performed two calculations to arrive at the highest potential public doses to nearby receptors. In the first calculation, presented in Appendix B6 of Appendix L, "Radiation Doses from Cameco's Smith Ranch and Reynolds Ranch Expansion Area In-Situ Uranium Leaching Operations," the licensee assumed all mine unit leaks (at a rate of 1 percent per day) and purge (bleed) occur at six locations: the Central Processing Plant at a purge (bleed) rate of 840 lpm (222 gpm); each of four satellites at the Smith Ranch and Highland sites, each at a purge (bleed) rate of 840 lpm (222 gpm); and the Reynolds Ranch satellite at a purge (bleed) rate of 6,662 lpm (1,760 gpm). In the second calculation, presented in Appendix B7 of Appendix L, the licensee assumed all leaks and

purge (bleed) from all mine units, satellites and the Central Processing Plant at the Smith Ranch, Highland, and Reynolds site occur at a single location -- the Central Processing Plant. The licensee then multiplied the dose for each receptor calculated in the first calculation by 0.25, and multiplied the doses calculated in the second calculation by 0.75, and then added the two sub-products to arrive at a dose for each receptor. For example, the maximum dose reported by the licensee for Sunquest (or Sundquist) Ranch was calculated as [(0.25 x 13.4 mrem) + (0.75 x 48.2 mrem)] = 39.5 mrem. On p. 19 of Appendix L, the licensee explained that it has historically used this approach in MILDOS-AREA dose assessments.

In its independent assessment, the NRC staff used an approach similar to that described in Appendix D of NUREG-1569 (NRC 2003a). The notable differences between the licensee's approach and the NRC staff's approach are:

- The NRC staff modeled purge (bleed) as point sources located at the CPP and at each of the five satellite facilities, but modeled leaks in each mine unit as circular area sources equal in size to the ore body (rather than point sources), the centroid of which were located in each of the 28 Smith Ranch-Highland-Reynolds mine units;

- Because the NRC staff calculated effluent quantities resulting from leaks and purge (bleed) for each satellite and mine unit, there was no need to use the 0.25/0.75 apportionment procedure used by the licensee;

- The NRC staff assumed purge flow rates of 1 percent of the average monthly flow rate limit contained in license conditions 10.1.1 and 10.4.1 of the current license (i.e., purge flow rates of 757 lpm [200 gpm] for Smith-Ranch-Highland and 170 lpm [45 gpm] for Reynolds Ranch). The NRC staff apportioned the total purge effluent quantity at Smith Ranch-Highland to the CPP and each of the four Smith Ranch-Highland satellites according to the estimated water volume in circulation at each facility and its associated mine units.

The NRC staff independently calculated a maximum potential dose rate of 14 mrem/year at Vollman Ranch, 8 mrem/year at Sunquest (or Sundquist) Ranch, and 6 mrem/year at Duck Ranch (NRC 2018c). The NRC staff therefore concludes that Vollman Ranch is the location of the individual likely to receive the highest dose, not Sunquest Ranch, as determined by the licensee. The doses calculated by both the licensee and the NRC staff are below the public dose limit of 1 mSv (0.1 rem) in 10 CFR 20.1301 and are, therefore, acceptable. These results also confirm that the Vollman Ranch environmental air station (AS-3) is correctly located at the nearest resident downwind of the facility, in accordance with Regulatory Guide 4.14, Revision 1 (NRC 1980a). The NRC staff's evaluation confirms that inhalation of radon-222 and its progeny is the dominant pathway (i.e., more than 99% of the 14 mrem/year total effective dose equivalent), and that pathways involving vegetation are not important. Regulatory Guide 4.14, Table 2, "Operational Radiological Monitoring Program for Uranium Mills," footnote (o) states, "Vegetation or forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway (an exposure pathway should be considered important if the predicted dose to an individual would exceed 5% of the applicable radiation protection standard)." However, the licensee stated in Smith Ranch Renewal Technical Report Section 5.10.1.2, "Soil and Vegetation Sampling at Air Particulate Monitoring Stations," that it would perform soil sampling at the location within the Smith Ranch license area estimated to be the point of maximum concentration. The licensee

stated soil sampling will include 3 samples taken annually to demonstrate continued absence of detectable radionuclides in soil.

The NRC staff also evaluated the licensee's public dose calculations for the North Butte and Gas Hills remote satellite facilities, which the licensee provided in Appendix K and M of the Smith Ranch Renewal Technical Report, respectively. For these areas, the NRC staff evaluated the licensee's calculation by evaluating key assumptions and input parameters used in the calculation. The NRC staff evaluated whether the licensee: (1) used a source term methodology and reasonable estimates of parameter values, consistent with the method described in NUREG-1569, Appendix D; (2) used on-site meteorological data representative of long-term conditions; and (3) identified nearby man camps, other human activities, and residences where individuals would be likely to receive the highest dose. The licensee calculated the dose at the nearest resident and man camp at the North Butte remote satellite is less than 1 mrem per year and 7.1 mrem per year, respectively. The licensee calculated the dose to the nearest resident and other members of the public (i.e., delivery people, tour groups, and campers) at the Gas Hills remote satellite (JE Ranch) is less than 1 mrem per year.

The NRC did not observe errors in the licensee's calculation for the North Butte facility. However, the NRC staff observed several errors in the licensee's calculation for the Gas Hills remote satellite, as follows:

- In MILDOS-AREA output files included in Appendix M of the Smith Ranch Renewal Technical Report, the NRC staff observed that the licensee, when it estimated public dose from bleed in Mine Units 3 and 4 after the ninth year of operation (see MILDOS-AREA output files "PP1-10.MIL" and "PP11-18.MIL"), assumed the alternate satellite facility was co-located with the Carol Shop satellite facility, rather than at a separate location 3.9 km (2.4 mi) west and 3.2 km (2 mi) south of the Carol Shop satellite facility.

- The licensee assumed bleed in Mine Unit 4 would result in effluent quantities of 2,570 Ci/year of radon-222, which is over ten times too high for the input parameters stated by the licensee in Table 4, "Important Input Parameters," and Table 5, "Resource Area-Specific Parameters," of Appendix M of the Smith Ranch Renewal Technical Report (see MILDOS-AREA output files "RP1-10.MIL" and "RP11-20.MIL").

- The licensee assumed there was no radon-222 effluent from Mine Unit 3 resulting from mine unit venting during restoration in the first ten years of operation (see MILDOS-AREA output file "RV1-10.MIL").

As a result of these errors, the NRC staff performed a confirmatory MILDOS-AREA calculation for the peak year (i.e., year 12), which verified that public doses at the site boundary, assuming 100 percent occupancy, were no greater than 11 mrem/year, which is below the public dose limit (NRC 2018c).

In Section 7.3.3.5.1, "Compliance with 10 CFR 20.1302(1)," the licensee explained that for its annual demonstration of compliance with public dose limits, it would use approaches consistent with 10 CFR 20.1302(b)(1) to show compliance with the annual public dose limits in 10 CFR 20.1301. The requirement in 10 CFR 20.1302(b)(1) allows a licensee to demonstrate by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit in 10 CFR 20.1301. The licensee's proposed two different methods to meet 10 CFR

20.1302(b)(1). The first approach involves using Equation 1 from the draft Interim Staff Guidance (NRC 2014d). Because this approach is based on published draft guidance on meeting pubic dose limits in radon exposure scenarios, this approach is acceptable to the NRC staff. The second approach proposed by the licensee involves measuring facility effluent quantities, as required by 10 CFR 40.65, and using the MILDOS-AREA computer code to calculate total effective dose equivalent. In a safety evaluation for the Nichols Ranch ISR Project, the NRC staff explained why this approach is not acceptable (NRC 2014f). In its 2014 safety evaluation, the NRC staff stated,

> The specific guidance in NUREG-0859 (NRC, 1982) to Uranium Recovery Licensing Branch staff relevant to this review regarding the assessment of radioactivity concentrations to which individuals may be exposed is "...the primary means of compliance must be by measurements made at the point of an actual individual receptor..." and that "...actual compliance determination during operation will be based on environmental monitoring data.

Furthermore, as described above, the NRC staff identified several errors in the licensee's MILDOS-AREA calculation in support of license renewal application, which does not provide adequate assurance that the licensee's proposed use of MILDOS-AREA for annual demonstrations of compliance with 10 CFR 20.1301 would yield acceptable results.

The NRC staff observes that the measurements at environmental monitoring station AS-3 located at Vollman Ranch, the location of the individual likely to receive the highest dose, can support compliance with 10 CFR 20.1301 public dose limits. For example, as shown in SER Table 20~~Table 20~~, the 2015 net (background subtracted) radon-222 concentration is 0.1 pCi/L. Using Equation 1 of the draft Interim Staff Guidance (NRC 2014d), and assuming a generally-acceptable indoor equilibrium factor of 0.5, and occupancy factor of 1, the NRC staff estimated the dose to be 25 mrem/year from radon-222 inhalation. As described in the draft Interim Staff Guidance, the licensee may justify site-specific equilibrium factors and occupancy times in its annual assessment.

The NRC staff determined that the licensee used an appropriate method, namely use of the MILDOS-AREA computer model, in its prospective assessment of future public doses over the term of the renewed license from internal and external exposure to radionuclides in air effluent in accordance with acceptance criteria in SRP Sections 7.3.1.2.3(3) through 7.3.1.2.3(5), 7.3.1.3.3, and 7.3.1.4.3. As described above, the licensee's annual assessment of compliance with public dose limits in 10 CFR 20.1301 will be based on radionuclide and radiation measurements at nearby occupied structures.

5.7.7.4 Evaluation Findings

NRC has completed its review of the airborne effluent and environmental monitoring programs at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.7.7.2 and the acceptance criteria outlined in SRP Section 5.7.7.3.

The licensee has established acceptable airborne effluent and environmental monitoring programs at the Smith Ranch Highland Uranium Project. The programs are consistent with guidance in Regulatory Guide 4.14 (NRC, 1980a). The licensee will sample radon, air particulates, surface soils, subsurface soils, direct radiation, and sediment. Locations of

monitoring stations are consistent with Regulatory Guide 4.14 (NRC, 1980a). Instrumentation is appropriate.

Based on the information provided in the application and the detailed review conducted of the airborne effluent and environmental monitoring programs at the Smith Ranch Highland Uranium Project, the NRC staff concludes that the airborne effluent and environmental monitoring programs are acceptable and are in compliance with 10 CFR 20.1302, which requires effluent monitoring to determine dose to individual members of the public; 10 CFR 20.1501, which specifies survey and monitoring requirements; 10 CFR Part 20, Subpart L, which establishes record keeping requirements; and10 CFR 40.65, which specifies effluent and environmental monitoring requirements.

5.7.8 Surface Water and Groundwater Monitoring Program

5.7.8.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the surface water and groundwater monitoring program for the Smith Ranch Highland Uranium Project meets the requirements of 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 5B(5), and 10 CFR Part 40, Appendix A, Criterion 5D.

5.7.8.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 5.7.8.3 of the SRP (NRC, 2003a). In addition, Regulatory Guide 4.14 (NRC 1980a) provides guidance on how compliance with the applicable regulations can be demonstrated.

5.7.8.3 Staff Review and Analysis

In Section 5.10, “Environmental Monitoring Programs During Operations,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its programs in Section 5.10.2, “Surface Water Monitoring,” Section 5.10.3, “Environmental Groundwater Monitoring Programs,” Section 5.10.4, “Wastewater and Land Application Monitoring Program,” and Section 5.10.5, “Reporting Procedures.”

In this section, the staff reviews the surface water and groundwater monitoring programs to be implemented at the Smith Ranch Highland Uranium Project during mine unit operations. SER Section 2.5 addresses pre-operational background monitoring for surface water and groundwater characterization, and SER Section 6.1 addresses restoration monitoring.

5.7.8.3.1 Surface Water Monitoring

Smith Ranch Highland

The licensee provided the surface water monitoring program for the Smith Ranch Highland license area in Section 5.10.2.1, “Smith Ranch,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated it sampled eleven surface water sampling sites, SW-1 through SW-11, within the Smith Ranch Highland license. All of these sites were identified as stock ponds located near mine units. The licensee also stated it has six surface water sampling locations in the Reynolds Ranch license area. These sites included one spring, Spring 1, and

five stock ponds. The location of all of these surface water sampling sites was shown in Figure 5.7 of the Technical Report.

The licensee stated that samples from surface water locations have been and will continue be monitored quarterly when water is present. The licensee reported the parameters that are analyzed for the operational surface water monitoring program are natural uranium and Ra-226. These parameters represent a reduced list of parameters from those recommended in Table 2 in Regulatory Guide 4.14, as approved by the NRC in the prior license renewal (NRC 2001a). The licensee is required to provide the quarterly surface water monitoring results in the semi-annual environmental and effluent monitoring reports by license condition 12.2 of License SUA-1548.

The licensee reviewed the surface water monitoring results since the last license renewal. The licensee stated that the concentrations of natural uranium and radium have remained near background. Specifically, the licensee reported the concentration of natural uranium has varied from below detection limits to a maximum of 2.2E-7 µCi/l. The licensee stated this maximum is below unrestricted release effluent concentration limit of 3.0E-7 µCi/l or natural uranium in Table 2 of Appendix B in 10 CFR Part 20. The licensee also reported the concentration of Ra-226 has varied from below detection limits to a maximum of 1.1E-8 µCi/l. This maximum is below unrestricted release effluent concentration limit of 6.0E-8 µCi/l for Ra-226 in Table 2 of Appendix B in 10CFR Part 20.

The NRC staff review found no performance issues since the last license renewal and no new safety issues were identified with the surface water monitoring program. The staff review finds that the operational surface water monitoring programs at the Smith Ranch Highland license area are satisfactory and meet the recommendations in Regulatory Guide 4.14 (NRC, 1980a) and the acceptance criteria of SRP Section 5.7.8.3.

North Butte

The licensee provided the surface water monitoring program for the North Butte license area in Section 5.10.2.2, “North Butte Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee provided the location of eighteen impoundments, NB1-NB18, and twelve drainage sampling locations for North Butte license area in Table 5.15-1 of the Technical Report. The location of all of these surface water sampling sites was shown in Figure 5.8-1 of the Technical Report. The licensee stated it would monitor all surface water sites for natural uranium, Ra-226, and Pb-210 in the Technical Report. The licensee is required to provide the quarterly surface water monitoring results in the semi-annual environmental and effluent monitoring reports by license condition 12.2 of License SUA-1548.

When monitoring began in the first quarter of 2013, the semi-annual report (Cameco 2013c) shows the licensee monitored for the parameters of dissolved and suspended uranium, Th-230, Ra-226, Po-210, and Pb-210 as recommended in Table 2 in Regulatory Guide 4.14 (NRC, 1980a). However, beginning in the first half of 2014, the licensee reported it will analyze the surface water sites for only natural uranium and Ra-226 (Cameco 2014b). These parameters are in agreement with those originally approved by the NRC (NRC 1990c).

The licensee stated that samples from surface water locations have been and will continue be monitored quarterly when water is present. However, as shown in the semi-annual monitoring reports, the licensee has consistently sampled a subset of the sites shown in Table 5.15-1, including two impoundments, NB12 and NB16, and eight surface water sites, NBSWS1,

NBSWS2, NBSU1, NBSU2, NBSU4, NBSD1, NBSD2 and NBSD3 since operations began at North Butte in 2013.

The NRC staff reviewed the North Butte surface water monitoring results in the semi-annual reports from first quarter of 2013 through the fourth quarter of 2014 (Cameco, 2013c, Cameco, 2014a, Cameco, 2014b, Cameco, 2015a). The NRC staff review finds all of the sites were dry except for one impoundment, NB-16, in the second quarter and fourth quarter of 2013. The sampling results were non-detect for all constituents except natural uranium and suspended Po-210. Both of these constituents were well below the unrestricted release values in Table 2 of Appendix B in 10 CFR Part 20. In the first and third quarters of 2014, samples were obtained from four drainage locations and two impoundments. For these quarters, the licensee measured only natural uranium and Ra-226 in these sampling events. The uranium concentrations remained well below (<2.0%) the concentration of natural uranium unrestricted release effluent concentration limit of 3.0E-7 µCi/l in Table 2 of Appendix B in 10 CFR Part 20. The Ra 226 concentrations also remained well below (<6%) the unrestricted release effluent concentration limit of 6.0E-8 µCi/l in Table 2 of Appendix B in 10CFR Part 20.

The NRC staff finds no safety issue related to the current commitment to measure natural uranium, Ra-226 and Pb-210 quarterly at surface water sampling sites at North Butte. The NRC staff review finds that the operational surface water monitoring program at the North Butte license area are satisfactory and meet the recommendations in Regulatory Guide 4.14 (NRC 1980a) and the acceptance criteria of the SRP (NRC 2003a).

Gas Hills

The licensee provided the surface water monitoring program for the Gas Hills license area in Section 5.10.2.3, “Gas Hills Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee provided the location of four locations, including Cameron Spring, a small stock pond near MU1, and upstream and downstream sampling sites on West Canyon Creek. The location of all of these surface water sampling sites was shown in Figure 5.9 of the Technical Report. The licensee is required to provide the quarterly surface water monitoring results in the semi-annual environmental and effluent monitoring reports by license condition 12.2 of License SUA-1548.

The licensee stated that surface water from surface water sampling locations will be collected quarterly when water is present. The licensee stated that natural uranium and Ra-226 will be measured in these samples in the Technical Report. The NRC staff observes the recommended constituents for the operational surface water monitoring program are dissolved and suspended uranium, Th-230, Ra-226, Po-210, and Pb-210 as identified in Table 2 in Regulatory Guide 4.14 (NRC 1980a). However, NRC staff has no safety concern with the licensee request to measure only natural uranium and Ra-226. The licensee stated that the surface water monitoring results will be submitted within the semi-annual environmental and effluent monitoring reports.

The staff finds that the proposed operational surface water monitoring programs for the Gas Hills license area are satisfactory and meet the recommendations in Regulatory Guide 4.14 (NRC 1980a) and the acceptance criteria of the SRP (NRC 2003a).

Ruth

The licensee stated the surface water monitoring program for the Ruth license area has not been developed in Section 5.10.2.4, "Ruth Remote Satellite," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). NRC staff will therefore continue to retain the current license condition 10.2.1 in License SUA-1548 that requires the licensee to provide a plan of operations for the Ruth Site for NRC review and approval before operations begin.

5.7.8.3.2 Groundwater Monitoring

The licensee described the groundwater monitoring programs to be conducted at the Smith Ranch Highland Uranium Project in Section 5.10.3, "Environmental Groundwater Monitoring Programs," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The program includes: (1) baseline water quality monitoring for the mine unit ore zone; (2) operational monitoring of excursion wells in the overlying aquifer, underlying aquifer and the perimeter ring in the ore zone aquifer; (3) mine unit hydrologic testing document; (4) private well monitoring; and (5) evaporation and surge pond monitoring. The NRC staff reviewed each part of the groundwater monitoring program in the following sections except (5), which is addressed in Section 4.3 of this SER.

Baseline Water Quality in Mine Unit Ore Zone and Excursion Monitoring Wells

The licensee provided its mine unit ore zone and excursion monitoring well baseline sampling program for the Smith Ranch Highland Uranium Project in Section 3.4.4, "Baseline Water Quality Determination," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee committed to sampling select recovery and injection wells within the ore zone aquifer. The licensee also committed to conduct baseline sampling of all excursion monitoring wells in the overlying aquifer, underlying aquifer and perimeter ring in the ore zone aquifer.

As described in SER Section 3.1.3.4.3, the licensee stated the ore zone baseline monitoring wells will be installed on a density of one well per 1.2 ha (3 ac). The overlying and underlying aquifer excursion monitoring wells will also have density of one well per 1.2 ha (3 ac). In the prior license renewal, the licensee stated the excursion monitoring wells in the ore zone aquifer perimeter ring will be located not more than 152.4 m (500 ft) from the edge of the well patterns and 152.4 m (500 ft) apart (PRI, 1999).

The licensee stated that four samples will be collected at least two weeks apart from the all of designated wells within the ore zone aquifer, overlying aquifer, underlying aquifer and ore zone aquifer perimeter ring to establish baseline water quality in a mine unit. The first and second samples will be sampled for all constituents listed in Table 3-4 of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The third and fourth sampling events may be analyzed for a reduced list of parameters. The parameters that may be deleted from the third and fourth sampling events are those that are below the minimum analytical detection limits during the first and second sampling events. The licensee will use the same well sampling procedures it has successfully employed for the current mine unit operations. The NRC staff finds this sampling is consistent with what is required by current License Condition 10.1.9 of License SUA-1548; therefore, this license condition will be retained as Condition 10.1.8 of the renewed license.

The licensee described the statistical assessment of the baseline water quality data in Section 3.4.5, "Statistical Assessment of Baeline Water Quality Data," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated the baseline water quality will be averaged to establish the background groundwater protection standards required in 10 CFR Part 40 Appendix A Criterion 5(B)(5)(a) for the ore zone aquifer and all of the excursion

monitoring wells. The mean and standard deviation for all ore zone and excursion monitoring wells will be established using appropriate statistical techniques, including outlier analysis. The licensee stated if the baseline water quality samples show subzones of different water quality in the ore zone aquifer, perimeter ring and trend wells, the data will not be averaged together but calculated for the separate subzones. The licensee stated the Restoration Target Values (RTVs) for constituents in each mine unit ore zone aquifer will be set equal to the mean of the baseline sampling values plus two standard deviations. The NRC staff notes these RTVs will therefore be equivalent to the background groundwater protection standard for restoration as described in SER Section 6.1.3.

The NRC staff finds the licensee's proposed density of baseline water quality for ore zone and excursion monitoring wells, sampling methods, and list of constituents to be measured, and statistical methods are acceptable to establish the background groundwater protection standards in Criterion 5(B)(5)(a). The NRC staff also finds that the licensee's proposed density of baseline water quality wells, sampling methods, and list of constituents to be measured are consistent with that approved in last license renewal (NRC, 2001a). The NRC staff has not identified any new safety-related concerns pertaining to proposed density of baseline water quality wells, sampling methods, and list of constituents to be measured based in the staff's evaluation of the performance of the Smith Ranch Highland Uranium Project since the last license renewal safety evaluation (NRC 2001a) as described in SER Appendix A.

Excursion Detection Monitoring Program

The licensee described the excursion detection monitoring program for the Smith Ranch Highland Uranium Project in Section 5.10.3.1, "Operational Groundwater Monitoring," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated that wells to be used for the excursion monitoring program will be located in the overlying aquifer and underlying aquifer and in the perimeter ring surrounding the ore zone aquifer. The location of these wells and their baseline sampling was reviewed in the prior section.

The licensee stated the indicator parameters of chloride, conductivity, and alkalinity for the excursion monitoring program in Section 3.4.6, "Upper Control Limit Determination," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated it will set upper control limits (UCLs) for the excursion parameters of conductivity and total alkalinity at the mean value plus five standard deviations. The UCL for chloride will be determined by adding 15 mg/l to the baseline mean if that value is greater than the baseline mean plus five standard deviations.

The licensee stated the excursion detection monitoring program and verification program has and will continue to consist of sampling all excursion monitoring wells in the program twice a month at least 10 days apart for the designated excursion parameters. The licensee stated that if the levels of two of the three indicator parameters exceed their respective UCLs at a well, an excursion is deemed to have occurred. The licensee will then perform additional sampling to verify the excursion. The licensee stated the verification monitoring consists of a second resampling within 24 hours of receiving the results. If the second sample supports the first, the well will be placed on excursion. If the first and second sample are in conflict, a third sample will be taken and used to verify the excursion. The licensee stated that upon verification, the well is placed on excursion status and the NRC staff is notified within 24 hours. The NRC staff finds this commitment is in agreement with License Conditions 11.5 (existing, 11.3 in the renewed license) and 12.1 of License SUA-1548.

The licensee stated that once a well is placed on excursion status, the well will be sampled at least once every seven days until the excursion status for the well is terminated. The licensee stated the well will be tested for all three indicators and uranium while on excursion status in the Technical Report. The licensee will then implement corrective action until the excursion is terminated. An excursion is considered terminated when the concentrations of at least two excursion indicators remain below the established UCLs for three consecutive samples. If an excursion status is not corrected within 30 days, the licensee stated it is required to conduct sampling for a complete set of parameters per WDEQ requirements. In addition, per License Condition 12.1, the licensee will provide the NRC staff with a detailed written report, which documents the corrective actions taken, to the NRC project manager within 30 days.

The licensee provided a review of historical excursions at the Smith Ranch Highland Uranium project since the last license renewal in Section 3.10.2.1, "Wellfield Excursions," of Smith Ranch Renewal Technical Report (Cameco, 2012b). In this review, the licensee provided a detailed description of all excursions and root causes in all operating mine units form November 15, 1999 through March 31, 2011 at the Smith Ranch Highland Uranium Project. A summary is provided below:

- Mine Unit 1 – No excursions
- Mine Unit 2 – No excursions
- Mine Unit 3 – No excursions
- Mine Unit 4 and 4A – One excursion
- Mine Unit 9 – No excursions
- Mine Unit 15 and 15A – No excursions
- Mine Unit B – One excursion
- Mine Unit C – Repeated excursions in three wells; root cause in two wells attributed to completion of the wells in underground mine workings
- Mine Unit D – Repeated excursions in three wells; root cause in all of the wells are from migration of contaminated fluids from nearby underground mine workings
- Mine Unit E – No excursions
- Mine Unit F – One excursion, later attributed to casing leak and not fluids form ore zone aquifer
- Mine Unit H – One excursion; root cause attributed to injection imbalance
- Mine Unit I – Excursions in three wells; root cause attributed to injection imbalance
- Mine Unit J – Excursions in three wells; root cause attributed to low well yield impacting indicator concentrations
- Mine Unit K – no excursions

The licensee reported that the low number of excursions since the last license renewal demonstrates it has minimized and corrected excursions at the Smith Ranch Highland mine units. Specifically, the licensee stated it has sampled excursion monitoring wells approximately 240,000 times and confirmed only twelve wells to be on extrusion status. In addition, only five mine units have had excursions since the last license renewal. The licensee stated that with the exception of excursions caused by the production fluid contamination in underground mine working in MUs C and D, the licensee was able to control the excursions by corrective actions such as rebalancing of injection and production wells. The licensee stated that the restoration of MUC and MUD show trends of decreasing concentration and one of the wells which was completed in these working has gone off excursion status. The licensee predicted the complete restoration of these mine units will eliminate potential contamination from the underground mine workings in the future.

The NRC staff conducted an independent review of historical excursions at the Smith Ranch Highland Uranium project since the last license renewal in Section A.4 of SER Appendix A. The NRC staff provided a table listing the date, well name, mine unit and 30 day report for all excursions since 2001. The NRC staff reported there were 37 excursions from June 2001 to February 2016, with four wells reporting more than one excursion event. The NRC staff concluded this is a small number of excursions when compared to the more than 1,500 excursion monitoring wells at the facility. The NRC staff finds that most excursions have been corrected quickly by mine unit balancing. The NRC staff also finds the licensee has taken actions to correct excursions from the underground mine workings in MUs C and D which have been successful.

The NRC staff finds the licensee's excursion monitoring program is consistent with License Conditions 11.5 (existing, 11.3 in the renewed license) and 12.1 of License SUA-1548 as it addresses the same commitments to excursion monitoring, verification and corrective actions; therefore, these license conditions will remain without revision. The NRC staff has not found any performance issues based on the licensee's review and staff's review of historical excursions in SER Appendix A. NRC staff has also not identified any new safety concerns pertaining to the excursion monitoring program. Therefore, the NRC staff finds that the licensee's excursion monitoring program is acceptable because the program has and will continue to ensure that the production fluids are confined to the mine unit, thus meeting the requirements in 10 CFR 40.41(c) for a licensee to confine the possession and use of source and byproduct material to the locations and purposes authorized by a license. The excursion monitoring program is also acceptable to meet the groundwater detection program standards in Criterion 5(D).

Mine Unit Hydrologic Testing Document

The licensee stated it will conduct extensive hydrogeologic and baseline water quality testing of each mine unit before operation and provide this information to NRC in a mine unit hydrologic data testing document. The licensee described the information to be included in the mine unit hydrologic testing document in Section 3.4.3, "Hydrologic Testing Document," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). At a minimum the package will include: (1) description of mine units; (2) mine unit patterns and monitoring well location maps; (3) revised isopach maps; (4) revised geologic cross-sections; (5) hydrologic test results including mine unit production zone aquifer pumping test results ; (6) demonstration that the excursion monitoring wells are properly located; (7) baseline water quality data including proposed UCLs and restoration target values (RTVs); (9) discussion of the impact of faults and mining disturbances located in or near mine units and proposed mitigation methods; (10) and any other pertinent information. The licensee stated it will approve the information in the mine unit hydrologic testing document using its SERP process, reviewed in SER Section 5.1.3, before it begins ISR operations in a mine unit.

The NRC staff finds the information in the mine unit hydrologic testing document acceptable with one exception. As described in SER Section 2.4.3.2.1, the NRC staff found that some private wells may be completed within the ore zone aquifer near a Smith Ranch Highland Uranium Project mine unit. The NRC staff finds that these private wells are not hydrologically isolated from the ore zone aquifer. The NRC staff finds the presence of any private well in the ore zone aquifer is a safety issue as its use could interfere with hydraulic control of production fluids and impact the safety of receptors. In addition, the NRC staff finds the licensee did not explicitly commit to plug and abandon these private wells before operations. This finding

represents a new safety issue. Therefore, the NRC staff will add a new License Condition 10.1.13 to License SUA-1548 that will require any private wells completed in a mine unit production zone aquifer and determined to be within 152.4 m (500 ft) of the mine unit perimeter monitoring ring once defined in the mine unit hydrologic testing document to be plugged and abandoned.

With License Condition 10.1.13, the NRC staff finds that the proposed information to be included in the mine unit hydrologic testing document is satisfactory as it meets acceptance criteria in the SRP (NRC 2003a).

Private Well Monitoring

Smith Ranch Highland

The licensee provided the details of the private well groundwater monitoring program for the Smith Ranch Highland license area in Section 5.10.3.2, “Smith Ranch Satellite,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated it samples all operating livestock and domestic wells within 1 km (0.6 mi) of operating mine units as approved in the prior license renewal (PRI 1999). The licensee provided the name, location, WSEO permit number and use of the 25 private wells in the groundwater monitoring program in Table 5-16 of the Technical Report. The location of the wells was provided in Figure 5.7 of the Technical Report. The licensee is required to provide the quarterly groundwater monitoring results in the semi-annual environmental and effluent monitoring reports by 10 CFR40.65 and License Condition 12.2 of License SUA-1548.

The licensee stated that samples from the private wells have been and will continue be monitored quarterly when water is present. The licensee reported the parameters that are analyzed for the operational groundwater water monitoring program are natural uranium and Ra-226. These parameters represent a reduced list of parameters from those recommended in Table 2 in Regulatory Guide 4.14, which were approved by the NRC (NRC 2001a).

The licensee analyzed the results of the private well groundwater monitoring since the last license renewal in Section 5.10.3.2, “Smith Ranch Satellite,” of the Technical Report. The licensee stated that only one private well, GW-5, has exceeded the unrestricted release effluent concentration limit of 3.0E-7 µCi/l of natural uranium in Table 2 of Appendix B in 10 CFR Part 20. The exceedances at GW-5 occurred in three measurements which were reported in Table 5-17 of the Technical Report. The licensee analyzed the exceedance in GW-5 and concluded it was naturally occurring as GW-5 is completed in a shallow uranium ore zone. The licensee reported that none of the private well samples has exceeded the unrestricted release effluent concentration limit of 6.0E-8 µCi/l for Ra-226 in Table 2 of Appendix B in 10CFR Part 20. The licensee stated the monitoring results show that the Smith Ranch Highland mine unit operation have not affected any aquifers at the depth of the private wells, which are completed at 45.7 to 213 m (150 to 700 ft) bgs.

The NRC staff review found no performance issues with the private well groundwater monitoring program since the last Smith Ranch Renewal as reviewed in SER Appendix A. In addition, NRC staff found no new safety issues with the private well groundwater monitoring program. The staff review finds that the operational groundwater monitoring programs at the Smith Ranch Highland license area are satisfactory and meet the recommendations in Regulatory Guide 4.14 (NRC 1980a) and the acceptance criteria in the SRP (NRC 2003a).

North Butte

The licensee provided the private well groundwater monitoring program for the North Butte license area in Section 5.10.3.3, “North Butte Remote Satellite,”of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee reported there are ten stock wells within 2 km (1.2 mi) of the mine units. The licensee provided the name, WSEO permit number, location, and flow rate of each of these wells in Technical Report Table 5-18. The licensee stated it would monitor all wells within 2 km (1.2 mi) of an operating mine unit for natural uranium, Ra-226, and Pb-210 in the Technical Report. These constituents represent a reduced list from those recommended in Table 2 in Regulatory Guide 4.14 (NRC, 1980a). The licensee is required to provide the quarterly groundwater monitoring results in the semi-annual environmental and effluent monitoring reports by 10 CFR 40.65 and license condition 12.2 of License SUA-1548.

The licensee began monitoring private wells in the first quarter of 2013 when operations began in Mine Unit 1. At this time, the licensee monitored private wells within 2 km (1.2 mi) of Mine Unit 1 for the parameters of dissolved and suspended uranium, Th-230, Ra-226, Po-210, and Pb-210 as recommended in Table 2 in Regulatory Guide 4.14 (NRC, 1980a). However, beginning in the first half of 2014, the licensee reported it would monitor only the natural uranium, and Ra-226 in private wells within 1 km (0.6 mi) of an operating mine unit (Cameco 2014b). The NRC staff determined that the licensee had no requirement to measure any constituents in any private wells in the last license renewal approved by the NRC (NRC 1990c).

The NRC staff reviewed the North Butte private groundwater monitoring results in the semi-annual reports from first and second half of 2013 (Cameco 2013c, and Cameco, 2014a) before the licensee stopped monitoring any private wells in the third quarter of 2014 (Cameco, 2014b). During 2013, the licensee quarterly monitored two wells, the Beck Well and the Brown Well. The sampling results were non-detect for all constituents except for natural uranium, Ra-226 in both wells and Po-210 and Pb-210 in the Beck Well. All of these constituents were well below the unrestricted release effluent limits in Table 2 of Appendix B in 10 CFR Part 20, except for one measurement of suspended Pb-210 in the 4th quarter of 2013 at the Beck Well. This measurement was 1.0E-8 µCi/l which was the same as the unrestricted release effluent limit for Pb-210 in Table 2 of Appendix B in 10 CFR Part 20. Beginning in the first half of 2014, the licensee discontinued monitoring of the Beck Well and Brown well as they were not within 1 km (0.6 mi) of an operating mine unit (Cameco, 2014b).

The NRC staff finds no safety issue related to the current commitment to measure natural uranium, Ra-226 and Pb-210 quarterly in all private wells within 2 km (1.2 mi) of an operating mine unit. To ensure this commitment is maintained, the NRC staff will a new condition in license SUA-1548 to require quarterly sampling of all private wells within 2 km (1.2 mi) of an operational mine unit for the North Butte, Gas Hills and Ruth Satellite license areas:

10.4.3 *The licensee shall quarterly sample all private wells within 2 km of an operating mine unit at the North Butte license area as described in Section 5.10.3.3 of the Technical Report.*

With this new license condition, the NRC staff review finds that the operational groundwater monitoring program at the North Butte license area is satisfactory and meets the recommendations in Regulatory Guide 4.14 (NRC 1980a) and the acceptance criteria of the SRP (NRC 2003a).

Gas Hills

The licensee stated it has not yet developed the private well groundwater monitoring program for the Gas Hills license area in Section 5.10.3.4, “Gas Hills Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee reported there are five livestock wells or springs within the license area or within 2 km (1.2 mi) of the license boundary in the Technical Report. The licensee provided the name, WSEO permit number, location, and flow rate of each of these wells in Technical Report Table 5-18.

In the prior review for the Gas Hills license area, the licensee committed to monitor private wells quarterly for the constituents of natural uranium and Ra -226 (NRC, 2004a). As NRC staff has identified no new safety issue, this commitment remains acceptable for this license renewal. The licensee, however, has made no commitment to monitor all private wells within 2 km (1.2 mi) of an operating mine units as recommended in Regulatory Guide 4.14 (NRC 1980a). NRC will include a new condition in liceuse SUA-1548 to require quarterly sampling of all private wells within 2 km of an operational mine unit within the Gas Hills license area:

10.3.6 *The licensee shall quarterly sample all private wells within 2 km of an operating mine unit at the Gas Hills license area as described in Section 5.10.3.4 of the Technical Report.*

The licensee will continue to be required to provide the private well groundwater monitoring results within the semi-annual environmental and effluent monitoring reports under current License Condition 12.2 in SUA-1548.

With this license condition, the NRC staff finds that the proposed operational groundwater monitoring programs for the Gas Hills license area are satisfactory and meet the recommendations in Regulatory Guide 4.14 (NRC 1980a) and the acceptance criteria of the SRP (NRC 2003a).

Ruth

The licensee stated the groundwater monitoring program for the Ruth license area has not been developed in Section 5.10.3.5, “Ruth Remote Satellite,” of the Smith Ranch Renewal Technical Report (Cameco 2012b). NRC staff will therefore continue to retain the current License Condition 10.2.1 in License SUA-1548 that requires the licensee to provide a plan of operations for the Ruth Site for NRC review and approval before operations begin. In addition, NRC will include a new license condition to include quarterly sampling of all private wells within 2 km (1.2 mi) of an operational mine unit within the Ruth license area:

10.2.4 *The licensee shall quarterly sample all private wells within 2 km of an operating mine unit at the Ruth license area as described in Section 5.10.3.5 of the Technical Report.*

Evaporation and Surge Pond Monitoring

The NRC staff evaluated the evaporation and surge pond design and monitoring program in SER Section 4.2.3.4.

5.7.8.4 Evaluation Findings

The NRC staff evaluated the licensee's characterization surface water and groundwater monitoring programs at the Smith Ranch Highland Uranium Project in accordance with the review procedures in SRP Section 5.7.8.2 and the acceptance criteria in the SRP (NRC 2003a).

The NRC staff finds the licensee has adequately described the Smith Ranch Highland and North Butte groundwater and surface water monitoring programs by providing the surface water monitoring to be conducted and the baseline, excursion, and private well groundwater monitoring to be conducted at the Smith Ranch Highland Uranium Project. The NRC staff finds that the mine unit baseline groundwater monitoring program, excursion monitoring and corrective action program, and content of the hydrologic testing document for the Smith Ranch Highland Uranium Project is acceptable and no performance or new safety issues were identified.

The NRC staff finds, however, the licensee provided a partial description of the private well groundwater monitoring programs for the Gas Hills and no description of the surface water or private well monitoring programs at the Ruth Satellite. The NRC staff also found one new safety issue in that the licensee's commitment to monitor all private wells within 2 km (1.2 mi) of a mine unit did not match its practice at North Butte and was not clearly addressed for the Gas Hills and Ruth Satellites. The NRC staff will therefore add a new license conditions 10.4.3, 10.3.6, and 10.2.4, which requires the monitoring of all private wells within 2 km (1.2 mi) of a mine unit in the North Butte, Gas Hills and Ruth Satellite license areas. The NRC staff will also continue to retain the current License Condition 10.2.1 in License SUA-1548 that requires the licensee to provide a plan of operations for the Ruth Site, which will include the surface water and private well groundwater monitoring programs, for NRC review and approval before operations begin.

The NRC staff will also add a new License Condition 10.1.13 to License SUA-1548, as described as described in SER Section 5.7.8.3.1, that will require any private wells completed in a mine unit ore zone aquifer and determined to be within 152 m (500 ft) of the mine unit perimeter monitoring ring as defined in the mine unit hydrologic test document to be plugged and abandoned.

Based on the information provided by the licensee, and the NRC staff's review conducted of the characterization of the groundwater and surface water monitoring program at the Smith Ranch Highland Uranium Project, the NRC staff concludes that with these licensee conditions, the surface water and groundwater monitoring programs are sufficient as they meet the acceptance criteria outlined in the SRP (NRC 2003a). In addition, the programs were also found to comply with the following regulations in 10 CFR 40.32(c), which requires the licensee's proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life and property; 10 CFR 40.41(c), which requires the licensee to confine source or byproduct material to the location and purposes authorized in the license; 10 CFR Part 40, Appendix A, Criterion 5B(5), which provides groundwater protection standards for contaminants; 10 CFR Part 40, Appendix A, Criterion 5D, which requires a groundwater corrective action program; and 10 CFR Part 40, Appendix A, Criterion 7, which requires a detection and compliance groundwater monitoring program. The licensee has defined acceptable groundwater and surface water sampling programs that are consistent with those used at existing ISR facilities, which have been shown to provide data that the operations at those facilities are protective of human health and safety and the environment.

5.7.9 Quality Assurance

In this section, the NRC staff evaluates the licensee's proposed quality assurance programs for all radiological, effluent, and environmental (including groundwater) monitoring programs.

5.7.9.1 Requirements

There are no regulatory requirements for quality assurance at ISR facilities.

5.7.9.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the NRC staff reviewed the Smith Ranch Renewal Technical Report (Cameco, 2012b) using the acceptance criterion (1) in SRP Section 5.7.9.3 that states a quality assurance program is acceptable if it is consistent with the guidance in Regulatory Guides 4.14, Section 3 and 6 (NRC 1980a) and Regulatory Guide 4.15 (NRC 1979).

5.7.9.3 Staff Review and Analysis

In Section 5.9.1, "Quality Assurance," of the Smith Ranch Renewal Technical Report (Cameco 2012b) the licensee presented its approach to quality assurance at Smith Ranch Highland Uranium Project. The licensee described its monitoring procedures, duplicative sampling, inter laboratory analysis, intra laboratory analysis, instrument calibration, records, and audits. The NRC staff previously reviewed the licensee's quality assurance program in 2001 and 2007 (NRC 2001a and NRC 2007a, respectively). The NRC staff concluded that the licensee's quality assurance program was consistent with the guidance in NRC Regulatory Guide 4.15, Rev 1 (NRC, 1979). In this license renewal request, the licensee did not identify any changes to its quality assurance program. During its review, the NRC staff did not identify any new information that would invalidate its previous findings. Additionally, the NRC staff's review of inspection results for license SUA-1548 did not identify violations related to the licensee's quality control program. Therefore, the NRC staff's previous conclusions related to quality assurance program being consistent with consistent with the guidance in Regulatory Guides 4.14, Section 3 and 6 (NRC 1980a) and Regulatory Guide 4.15 (NRC 1979) remain valid.

5.7.9.4 Evaluation Findings

NRC has completed its review of the quality assurance program at the Smith Ranch Highland Uranium Project. This review included an evaluation using the review procedures in SRP Section 5.7.9.2 and the acceptance criteria outlined in SRP Section 5.7.9.3.

The licensee has established an acceptable quality assurance program at Smith Ranch Highland Uranium Project. The licensee adequately described various aspects of its quality assurance program, including its monitoring procedures, duplicative sampling, inter laboratory analysis, intra laboratory analysis, instrument calibration, records, and audits. Based on the NRC staff's previous conclusion that the quality assurance program was acceptable, information provided by the licensee in this license renewal application and the review conducted of the quality assurance program at the Smith Ranch Highland Uranium Project, the NRC staff concludes that the quality assurance program is acceptable and is in compliance with 10 CFR 20.1101, which provides requirements for radiation protection programs; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and 10 CFR Part 20, Subpart M, which defines reporting and notification requirements.

6.0 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

6.1 Plans and Schedules for Groundwater Quality Restoration

6.1.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the proposed plans and schedules for groundwater quality restoration for the Smith Ranch Highland Uranium Project meet the requirements of 10 CFR 40.32(c), 10 CFR Part 40.42, and Criterion 5B(5) of Appendix A to 10 CFR Part 40.

6.1.2 Regulatory Acceptance Criteria

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

6.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by the licensee in the Smith Ranch Highland Renewal Technical Report (Cameco, 2012b). The staff also visited the site on several occasions during the course of this review to confirm information presented in the application.

This section discusses plans for the groundwater quality restoration at the Smith Ranch Highland Uranium Project. The plans include proposed groundwater restoration water quality goals and standards, groundwater restoration methods, groundwater restoration monitoring, historical groundwater restoration performance, and the proposed restoration schedule.

6.1.3.1 Groundwater Quality Restoration Goals and Standards

The licensee described the groundwater quality restoration goals and standards in Section 6.1.1, “Aquifer Exemption and Restoration Goals,” and 6.1.2, “Groundwater Restoration Criteria and Restoration Target Values,” of the Smith Ranch Highland Renewal Technical Report (Cameco, 2012b). The licensee stated that the primary restoration goal is to the return the groundwater quality in the aquifers affected by ISR to the standards in Criterion 5B (5) of Appendix A to 10 CFR Part 40. The licensee stated these standards are the background constituent concentration or the maximum values for groundwater protection in the table in 10CFR Part 40 Appendix A, whichever level is higher. The licensee stated that if after employing best practicable technology (BPT), the restoration efforts do not achieve these standards, an alternate concentration limit (ACL) may be proposed by a licensee for NRC review and approval in accordance with Criterion 5B (6) of Appendix A to 10 CFR Part 40.

The licensee stated that the restoration target value (RTV), or restoration goal, for the groundwater quality for each hazardous constituent in an ore zone aquifer in a mine unit is based on the on the baseline water quality measured in wells in the planned production zone. The methods used to collect, measure and establish the baseline water quality of these constituents in the ore zone, overlying and underlying aquifers was reviewed by NRC staff in SER Section 5.7.8.3.2. The licensee stated that the RTV for each constituent will be set to the mean value plus two standard deviations. The NRC staff affirms the licensee will be required to

establish and attempt to meet this restoration goal for all hazardous constituents, not only in the ore zone aquifer, but also in any aquifer which has been impacted by ISR operations and requires restoration (e.g., surrounding, overlying and underlying aquifers). If this RTV cannot be met using BPT, the licensee will then need to propose an ACL for that constituent for NRC review and approval.

The NRC staff finds that the licensee's definition of the restoration goal for each constituent is acceptable and the licensee's proposed groundwater restoration standards are in agreement with the regulations in 10 CFR Part 40 Appendix Criterion 5B(5). The NRC clarified that these water quality standards apply to the restoration of groundwater affected by ISR in Regulatory Information Summary (RIS) 2009-05. However, to ensure that the licensee meets these restoration groundwater quality standards, NRC staff is slightly modifying condition existing condition 10.1.9 (10.1.8 in the renewed license) to read as follows:

10.1.8 Prior to uranium recovery operations, baseline groundwater quality data and restoration criteria shall be established for each uranium recovery unit as described in Chapter 5 in the approved license application. The number and location of Perimeter Monitor Wells, Production Zone Monitor Wells, and Upper and Lower Aquifer Monitor Wells shall be installed as described in section 3.5.1.2 (Monitor Well Spacing and Placement) of the License Application. Baseline water quality samples shall be obtained at these wells in accordance with Section 3.4.4.1 (Data Collection) of the License Application for each uranium recovery unit.

a. Groundwater restoration goals shall be established on a parameter-by-parameter basis.~~, and the primary goal of restoration shall be to return the groundwater quality, on a uranium recovery unit average, to baseline conditions. Should baseline conditions not be achieved after application of the Best Practicable Technology (BPT) available, the licensee shall commit to a secondary goal of returning the groundwater to a quality consistent with pre-uranium recovery use, or uses, for which the water was suitable prior to ISL uranium recovery activities.~~ *Hazardous constituents in the groundwater shall be restored to the numerical groundwater protection standards required by 10 CFR Part 40, Appendix A, Criterion 5B(5). In submitting any license amendment application requesting review and approval of proposed alternate concentration limits (ACLs) pursuant to Criterion 5B(6), the licensee must show that it has first made practicable efforts to restore the specified groundwater constituents to the background or maximum contaminant levels (whichever is greater).*

b. Prior to commencing ground-water restoration in each wellfield, the licensee shall, through the SERP process, add wellfields to the wellfield restoration plan in Chapter 6 of the application. The licensee shall be required to demonstrate baseline conditions are not achievable in order to apply any alternate standard of performance. Upon restoration completion of each wellfield, the licensee shall submit a wellfield completion report for NRC review and approval.

6.1.3.2 Groundwater Restoration Methods

The licensee presented the groundwater restoration methods it has and will use in Section 6.1.3, "Groundwater Restoration Methodology," of the Smith Ranch Renewal Technical Report (Cameco, 2012b). The licensee stated that its BPT for groundwater restoration will consist three phases including groundwater treatment and reinjection, reductant addition and chemical

treatment for pH. The groundwater treatment and injection phase will use groundwater sweep and RO to reduce Total Dissolved Solids (TDS). The reductant addition phase may use biological or chemical reductant treatment to reduce redox sensitive constituents like uranium, selenium and arsenic. The chemical treatment phase will use chemical additives to adjust the pH to remove other metal constituents.

The licensee described how it will conduct and optimize each of these restoration phases in Sections 6.1.4.3, “Treater Water Injection,” and 6.1.4.4, “Biological/Chemical Reductant,” of the Technical Report. Specifically, the licensee described how each phase would be conducted in the mine unit to optimize restoration of the production zone aquifer while minimizing interaction with aquifers in adjacent mine units. The licensee reported its experience had shown that the groundwater treatment and injection phase should be conducted and completed sequentially in well patterns, starting with the well patterns with the highest TDS. The licensee stated its restoration planning will include setting the injection and extraction locations and rate at the well patterns at each header house to optimize the groundwater treatment. The licensee stated its experience has shown that more time is required to restore groundwater quality in the first set of well patterns in a mine unit. In addition, the licensee has found that groundwater treatment and injection works best when treated water is directed at a small number of well patterns before advancing to the next pattern. In addition, the licensee stated that it has found that it is beneficial to reduce oxygen in the reinjected fluids during this phase. The licensee stated it has successfully used and will continue to use either a vacuum degasser or a catalytic hydrogen gas bed to remove the oxygen.

The licensee stated that if it is unable to achieve the desired reduction in constituents using only groundwater treatment by RO, it may add treatment by biological or chemical reductants. The licensee stated this treatment may be needed in individual mine units or on a pattern by pattern basis in a mine unit. The licensee stated its experience has shown that chemical reductants such as hydrogen sulfide or sodium sulfide are effective for the immobilization of redox sensitive constituents such as selenium, arsenic and uranium. The licensee stated that biological reductants have been effective in laboratory testing but have presented challenges in field application at mine units. Specifically, the licensee reported it has attempted the addition of different types of substrates (e.g. cheese whey, methanol) to enhance the growth of native bacteria in the ore zone aquifer to create a reducing environment to remove redox sensitive constituents. These biological amendments have demonstrated efficacy for selenium removal but have been less successful with respect to uranium. In addition, the licensee reported that field testing of biological reductant addition in Mine Unit C led to problems with plugging of well screens which caused inadequate injection and recovery in the treated well patterns and failed wells. These failures constitute possible safety issues in that they may impact the performance of the equipment and wells in a mine unit. The licensee has not implemented the methodology used for the field test across an entire mine unit.

The licensee stated it continues to conduct research on the use of biological reductants to find solutions to these safety issues. In the Section 6.1.4.4, “Biological/Chemical Reductant,” of the Technical Report, the licensee committed that prior to conducting a biological reductant addition it will submit a proposal to the NRC and WY LQD for review which will include: (1) the goal of the biological amendment addition; (2) the type of biological amendment to be used and its effect on the native bacterial population; (3) an evaluation of the ability to deliver the biological amendment into the formation; (4) target concentration for the biological amendment in the formation; (5) a monitoring plan to evaluate progress toward interim goals and enable flexibility to adjust operations; (6) procedures to address biofouling and undesirable precipitation which can impact equipment and well performance.

In addition to the explanation of the restoration methods it would employ, the licensee also described the approach it will use to address restoration of stacked ore horizons in the same formation in Section 6.1.4.8, “Restoration of Stacked Ore Horizons,” of the Technical Report. As reviewed by the NRC staff in SER Section 3.1.3.4.3, the licensee may use recompleted wells or twinned wells in ore zone aquifer to recover from ore zones which are vertically separated within the same formation. To recover uranium the licensee stated it would complete and produce the well from the lower ore zone first. Then it would temporarily seal off the well screen in the lower ore zone and recomplete the well with a new screen in the upper ore zone. Then production would be conducted in the upper ore zone. The licensee stated that to conduct restoration, it would then remove the temporary seal in the lower ore zone. The restoration methods would then be employed in each well through both completions, treating the two zones as a single unit. The pore volume would be calculated using an average well screen length which included both completed zones.

The licensee stated based on its over twenty years of experience with restoration of mine units at Smith Ranch Highland facility, it will be able to complete restoration by applying these restoration methods for at least one pore volume (PV) of groundwater sweep and eight PVs of groundwater treatment and reinjection. The licensee defines a PV as the surface area of the mine unit ore zone aquifer, multiplied by the average well screen interval and a flare factor. The flare factor represents the amount of dispersion of production fluids around the perimeter of the ore zone as a percentage of the PV. The licensee stated it calculates the flare factor for each individual mine unit based on its specific hydrogeological characteristics. The licensee reported the flare factors for the Smith Ranch Highland and North Butte mine units currently in operation in the most recent financial assura ce estimate range from 1.06 -2.88 (Cameco 2017b and 2018a).

The NRC finds the groundwater restoration methods used and proposed by the licensee are based on the licensee’s lengthy experience with restoration. NRC staff has found the groundwater sweep and groundwater treatment and injection have been successfully used for the restoration of Smith Ranch Highland mine units. The NRC staff finds the licensee has demonstrated techniques it will use to optimize the restoration of mine units based on its experience. For biological reductant addition, the licensee has committed to provide a plan for NRC review to address the safety issues which may occur with its application. With this commitment, NRC staff finds no new safety issues in the continued use of the proposed restoration methods or the use of biological reductant treatment methods.

6.1.3.3 Restoration Groundwater Monitoring

The licensee presented the groundwater restoration monitoring program in Section 6.1.5, “Groundwater Restoration Monitoring,” of the Smith Ranch Highland Renewal Technical Report (Cameco, 2012b). The licensee described how it will conduct groundwater restoration monitoring during active restoration in Section 6.1.5.1, “Operational Monitoring,” and groundwater stability monitoring once active restoration has met the restoration goals in Section 6.1.5.2, “Restoration Stability Sampling,” of the Technical Report.

During active groundwater restoration, the licensee reported that the original baseline monitoring wells in the ore zone aquifer with be sampled and analyzed for the full suite of parameters listed in Table 6.2 of the Technical Report. The licensee stated the first sampling for all of these parameters will occur at the “end of injection” to provide the starting point. The well will then be sampled every two months, at least 45 days apart, for conductivity, chloride and

uranium to track the progress of the active restoration. The licensee stated that it may also measure other parameters, such as selenium, to evaluate the need for chemical or biological reductant addition.

In Section 6.1.5.2, "Restoration Stability Sampling," of the Technical Report, the licensee stated that once restoration goals are met, active restoration will be considered completed. The licensee stated it will then notify WY LQD and NRC that it will begin restoration stability monitoring. The licensee stated it will also provide documentation of how the restoration was conducted, and data to support the decision to begin stability monitoring.

The licensee stated the stability monitoring will be conducted for at least one year to demonstrate that the restoration groundwater standard has been met and can be maintained. The licensee report that the groundwater stability monitoring program will consist of an initial sampling of all ore zone aquifer wells at the beginning of the stability period and then quarterly for the full suite of constituents listed in Table 6-2 of the Technical Report. The licensee committed to conduct the stability sampling until enough data is collected to obtain a robust statistical sample of the constituent of concerns, up to three years. The licensee stated it will use appropriate groundwater statistical and modeling methods to analyze the groundwater quality to assess statistical trends.

The licensee stated it will monitor the excursion monitoring wells in the perimeter ring, overlying and underlying aquifers once every two months for the excursion indicator parameters of chloride, alkalinity or bicarbonate, and conductivity during active restoration and stability monitoring until the restoration report is reviewed and approved by NRC.

NRC finds the licensee has provided its restoration groundwater monitoring program which is acceptable for active restoration. The NRC staff finds the excursion monitoring program during restoration and restoration stability is acceptable. The NRC staff found no performance issues with these programs or new safety issues. The NRC also finds that the licensee has committed to conduct restoration stability monitoring including quarterly monitoring of all constituents of concern at the specified ore zone aquifer wells and assess trends to determine stability. The NRC staff, however, finds the licensee has not committed to conduct stability monitoring until at least the most recent four consecutive quarters of data indicate that constituent concentrations do not demonstrate any statistically significant increasing trend which would exceed the groundwater quality standard for each constituent. The NRC staff finds at least four quarters of data are necessary to conduct a trend analysis. Therefore, NRC staff is imposing a new license condition specifying the requirements for the licensee to demonstrate stability for at least four consecutive quarters for all constituents of concern after active restoration is completed:

10.1.16 *The licensee shall conduct four rounds of sampling of all WDEQ-LQD Guideline 8, Assay Suite A constituents during stabilization monitoring, with each well sample being at least three months apart. The licensee shall continue the stability monitoring until the data show the most recent four consecutive samples indicate no statistically significant increasing trend for individual constituents which would lead to an exceedance above the approved restoration target values.*

6.1.3.4 Historical Groundwater Restoration

The licensee presented the groundwater restoration history at the Smith Ranch Facility and Highland Facility in Sections 6.1.6, "Smith Ranch Restoration History," and 6.1.7, "Highland Restoration History," respectively, of the Smith Ranch Highland Renewal Technical Report

(Cameco, 2012b). The licensee described the mine units which are currently in restoration and those which have been approved for restoration in Sections 6.1.6.1, “Mine Unit 1,” 6.1.6.2, “Mine Unit 4/4a,” and Sections 6.1.7.2, “Mine Unit B,” through 6.1.7.5, “Mine Unit E.” The licensee also provided a description of the improvements it has made to enhance its restoration performance in these and future mine units in Section 6.1.8, “Groundwater Restoration Improvements,” of the Technical Report.

The licensee reported that MU1 and MUs 4/4A are in restoration at the Smith Ranch facility. MU1 began operations 1997 and started restoration in in 2006. The groundwater treatment phase included RO and chemical reductant addition. The licensee provided the groundwater restoration report for MU 1 to NRC in 2018 (Cameco 2018b). This report is currently under review by NRC staff.

The licensee reported that MUs 4/4A are in restoration at the Smith Ranch facility. MU4/4A began operatios 1999 and started restoration in in 2010. The mine unit was undergoing groundwater treatment by RO until 2011, when the licensee temporarily suspended restoration to address issues with the RO. Groundwater modeling of the mine units has been conducted and the licensee stated it was installing replacement wells portions of the mine unit.

The licensee reported that the Highland MU A operated from 1988 to 1991. MUA underwent restoration form 1991-1998 and stability monitoring from 1999-2000. The restoration included groundwater sweep and treatment by RO and chemical reductant addition. The licensee stated the restoration of MUA was conditionally approved by WY LQD in 2003 with a requirement for the licensee to conduct long term groundwater monitoring (LTM). This groundwater monitoring was required to demonstrate that natural attenuation of constituents by adsorption and dispersion would protect groundwater quality down gradient of the mine unit. The NRC also reviewed and approved the restoration of MUA (NRC, 2004c) contingent on this LTM.

The licensee reported that the WYLQD and NRC approved the MUA LTM plan which was implemented in beginning in June 2004 (NRC 2004c). The licensee reported that the LTM plan includes two wells in the mine unit (MP-4, I-21), one well in flare at the edge of the well pattern (LTM-4), and two perimeter ring excursion monitoring wells (M-3, M-4) downgradient. The licensee stated that the wells in the mine unit display uranium concentrations over those predicted by the LTM plan; however, the concentration of Ra-226, Fe, Mn and Se are similar to the concentrations at the perimeter ring wells (M3, M4). In addition, the concentration of uranium at LTM-4 is below the baseline concentration of 0.05 mg/l. The NRC staff has independently reviewed the sampling results from all of the LTM plan wells from 2005-2013 and concurs with the licensee’s conclusion that the downgradient wells have remained at background constituent concentrations as predicted.

The licensee reported that the Highland MU B operated from 1988 to 1991. MUB underwent restoration from 1991-2004 and stability monitoring for six months in 2004. The restoration included groundwater sweep and treatment by RO and chemical reductant addition. The WY LQD required additional stability monitoring for arsenic for six months in three wells. In addition, the WY LQD expressed concerns about a perimeter excursion monitoring well, BM-42, that remained on excursion during stability monitoring. The licensee submitted the restoration report to NRC in in June 2009. The NRC staff did not approve the restoration because the licensee had not addressed the continuing excursion at BM-42, pumping had been conducted during stability monitoring, and the concentration of several constituents did not meet background concentrations. The licensee submitted an ACL approval request for MUB to NRC in May 2013 (Cameco 2013b). NRC staff conducted an acceptance review of the ACL application, and

provided comments to the licensee that would need to be addressed before the NRC staff could proceed with its review. The NRC staff provided the comments during a public meeting in in December 2013 (NRC 2014a). Additionally, the NRC staff and Cameco held an additional public meeting to discuss the MUB ACL application in 2015 (NRC 2015f).

The licensee reported that the Highland MU C operated from 1989 to 1999. MUC underwent restoration from 1999 using IX and RO and remains in restoration. In 2009, the licensee conducted a bioremediation test known as the Mine Unit C Bioremediation Project. In this test, the licensee injected a biological reductant starting April 2009. The licensee reported the addition of the reductant reduced the concentration of selenium substantially and it remained low. However, uranium concentration remained high, so the project ended in January 2010. In addition, numerous problems were encountered during the project, including well plugging and inadequate delivery of the reductant to the ore zone aquifer. The licensee stated it continues to conduct conventional restoration without biological reductants in MUC.

The licensee also reported that MUs D and D extension have been in active restoration since 2011. MU D has been undergoing infrastructure upgrades including well installation. MU E was also reported to be in preparation for restoration, which upgrades including refurbishment of header house and the installation of numerous replacement wells. Some areas of MUE were reported to be undergoing groundwater sweep and RO treatment.

NRC finds the licensee has described the history of restoration and restoration approval at the mine units at the Smith Ranch Highland facility. The NRC staff finds that although there have been performance issues which have led to delays in timeliness of restoration, the licensee has addressed them or continues to work to find solutions. The NRC staff finds that most of the issues with historical restoration delays are not safety related and there are no new safety issues, except for biological reductant addition which was addressed by the NRC staff in SER Section 6.1.3.2.

6.1.3.5 Groundwater Restoration Improvement

The licensee provided a description of the improvements it has made to enhance its restoration performance in current and proposed mine units in Section 6.1.8, “Groundwater Restoration Improvements,” of the Smith Ranch Highland Renewal Technical Report (Cameco, 2012b).

The licensee stated it has developed and implemented several procedures to improve and expedite restoration since the last license renewal. These procedures include: (1) review of mine unit infrastructure prior to restoration, including an assessment of the need for additional wells and repair or replacement of existing wells; (2) inspection and refurbishment of mine unit header houses, bell holes and pipelines prior to restoration; (3) expansion of RO treatment capacity from 3,407 to 8,139 lpm (900 to 2,150 gpm); (4) expansion of liquid waste disposal capacity for groundwater sweep and RO reject water including the drilling of three addition DDWs and anti-scaling and other treatment of existing DDWs to improvement injection performance; (5) construction of the radium and selenium treatment plant at Satellite 2 to reduce selenium and radium to levels to enable continued use of PSR2 and land application; (6) continued research to assess biological reductant addition to reduce constituent levels; (7) continued research to evaluate methods to reduce water consumption during restoration to lower liquid waste volumes.

NRC staff review of these procedures finds the licensee has worked and continues to work to improve the timeliness and success of groundwater restoration at the mine units at the Smith Ranch Highland Uranium Project.

6.1.3.6 Restoration Schedule

The licensee provided the restoration schedule for the mine units for the Smith Ranch Highland Uranium Project including the North Butte and Gas Hills satellites in Section 6.1.3, "Groundwater Restoration Schedule," of the Smith Ranch Highland Renewal Technical Report (Cameco, 2012b). The restoration schedules for Smith Ranch Highland and Reynolds Ranch are shown in Technical Report Tables 3-12, 3-13, and 3-14, respectively. The restoration schedules for the North Butte and Gas Hills Satellites are shown in Figures 3-15 and 3-11, respectively of the Technical Report. The licensee did not provide a restoration schedule for the Ruth Satellite; however, NRC staff will require it to be provided in the operations plan to be submitted under License Condition 10.2.1.

The licensee stated that the restoration schedules are based on a water balance which was calculate on the assumption of one PV of groundwater sweep and eight pore volumes of groundwater treatment, the practical extraction rate range for each mine unit, and the waste disposal capacity at each facility. The licensee stated the practical extraction rate is the rate which creates cone of depression which does not interfere with or cause incursions from adjacent mine units. The licensee reported that the water balances for the North Butte and Gas Hills satellites are preliminary. The licensee stated that more definite schedules would be developed for these satellites after further hydrologic testing is conducted to define the ore zones to be targeted in each mine unit, the final size of each mine unit, and the pore volumes for restoration of each mine unit.

The NRC staff review of the production and restoration schedules for all of the Smith Ranch Highland mine units shown in Technical Report Tables 3-12, 3-13, and 3-14 found that the licensee used realistic production, bleed, and practical extraction rates for the remaining mine units in production or restoration and proposed mine units. NRC staff reviewed the assumption of nine total restoration PVs in SER Section 6.1.3.2 and found it to be acceptable. The NRC staff found the liquid waste disposal rates and capacity at the Smith Ranch Highland facility were acceptable as discussed in SER Section 3.1.3.6.1. Therefore, NRC staff finds the restoration schedules are supported and realistic at the Smith Ranch Highland facility. The NRC staff understands that the restoration schedules are dynamic and that the licensee may alter them depending on market conditions.

The NRC staff review of the preliminary production and restoration schedule for the North Butte Satellite mine units shown in Technical Report Table 3-15 found that the licensee used realistic production, bleed, and practical extraction rates for the remaining mine units in production or restoration and proposed mine units given the limited information available. NRC staff reviewed the assumption of nine total restoration PVs in SER Section 6.1.3.2 and found it to be acceptable for North Butte given the similar hydrogeological setting to Smith Ranch Highland facility. The NRC staff found the liquid waste disposal rates and capacity at the Smith Ranch Highland facility were acceptable as discussed in SER Section 3.1.3.6.2. Therefore, NRC staff finds the preliminary restoration schedule is supported and realistic at the North Butte Satellite facility.

The NRC staff review of the preliminary production and restoration schedule for the Gas Hills Satellite mine units shown in Technical Report Table 3-11 found that the licensee used realistic

production, bleed, and practical extraction rates for the remaining mine units in production or restoration and proposed mine units given the limited information available. NRC staff reviewed the assumption of nine total restoration PVs in SER Section 6.1.3.2, but could not verify it was acceptable because the licensee must conduct further hydrologic testing of each Gas Hills mine unit to determine the location of ore zones and assess the complex hydrogeological setting. The NRC staff will review and verify the mine unit hydrologic testing document per License Condition 10.3.2. The NRC staff found the preliminary liquid waste disposal rates and capacity at the Gas Hills were acceptable as discussed in SER Section 3.1.3.6.3. Given that the Gas Hills restoration schedule is preliminary and the licensee will provide the hydrologic testing document for NRC review and verification, NRC staff has no safety based objection to the preliminary restoration schedules at the Gas Hills Satellite facility.

The NRC staff observes that the licensee is required to meet the requirements in 10 CFR 40.42, which states the licensee must complete decommissioning 24 months after the cessation of principal activities or submit an alternate schedule for decommissioning for NRC review and approval. The NRC staff considers injection of lixiviant to be a principal activity for ISR facilities. In this license renewal request and in accordance with 10 CFR 40.42(i) , the licensee asked that the schedules provided in the Technical Report be approved as an alternate restoration schedules for the Smith Ranch Highland Uranium Project; however, based on the last financial assurance update (Cameco 2017b and 2018a estimates), the restoration schedule has been updated once already during the NRC staff's review of this application. Therefore, the NRC staff will review and approve the restoration schedule as part of its annual financial assurance update.

6.1.4 Evaluation Findings

Based on the information provided by the licensee and the NRC staff detailed review of plans and schedules for groundwater quality restoration at the Smith Ranch Highland Uranium Project, NRC staff concludes that the licensee's groundwater restoration water quality goals and standards, groundwater restoration methods, groundwater restoration monitoring, historical groundwater restoration performance, and the proposed restoration schedules are in compliance with 10 CFR 40.32(c), requiring the licensee's proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property.

However**,** to ensure the licensee meets the restoration standards for groundwater quality which are covered listed in Criterion 5B(5) of Appendix A in 10 CFR Part 40 and performs acceptable restoration stability monitoring, two License Conditions 10.1.8 and 10.1.16 will be imposed as described in SER Sections 6.1.3.1 and 6.1.3.3.

6.2 Decommissioning

6.2.1 Regulatory Requirements

In this section, the NRC staff determines whether the licensee has demonstrated that the proposed plans for decommissioning the Smith Ranch Highland Uranium Project will meet the requirements of 10 CFR 40.42 and 10 CFR Part 40, Appendix A, Criterion 6(6).

6.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40.42 and 10 CFR Part 40, Appendix A, Criterion 6(6)

using the applicable acceptance criteria presented in NUREG-1569, Sections 6.2.3, 6.3.3, and 6.4.3 of (NRC 2003a).

6.2.3 Staff Review and Analysis

In this section, the NRC staff evaluates the licensee's plans for decommissioning the proposed Smith Ranch Highland Uranium Project. The requirements for decommissioning an ISR facility are contained in 10 CFR 40.42, "Expiration and termination of licenses and decommissioning of sites and separate buildings or outdoor areas." The applicable standards for residual byproduct material concentrations in soil are contained in 10 CFR Part 40, Appendix A, Criterion 6(6).

6.2.3.1 Timely Submittal of Decommissioning Plans

In Section 6.2, "Decontamination and Decommissioning," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee stated it would submit a detailed Decommissioning Plan for NRC review and approval at least 12 months prior to the planned commencement of final decommissioning of the entire licensed area or an individual area with the licensed area. The licensed stated that the Decommissioning Plan(s) would include a description of planned decommissioning activities; structures and equipment to be decommissioned; methods planned to ensure protection of workers and the environment from radiation hazards; the planned final radiation survey (benchmark analysis); and an updated, detailed cost estimate. The NRC staff determined that these commitments meet the requirements for a Decommissioning Plan, as stated in 10 CFR 40.42(d), regarding timeliness of the Decommissioning Plan, and 10 CFR 40.42(g)(4), regarding information contained in a Decommissioning Plan and is therefore acceptable.

6.2.3.2 Description of Decommissioning Activities Prior to Surface Reclamation

In the following subsections, the NRC staff evaluates the licensee's descriptions of plans for decommissioning of structures and equipment, land areas, and transportation of decommissioning waste to a byproduct material disposal facility.

6.2.3.2.1 Decommissioning of Structures and Equipment

In Section 6.3, "Procedures for Removing and Disposing of Structures and Equipment," sub-Section 6.3.1, "Preliminary Radiological Surveys and Contamination Control," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee committed to the same type of radiation surveys described in Section 5.8.6, "Contamination Control Program" of the Smith Ranch Renewal Technical Report for contaminated surfaces of structures, equipment, or scrap. In Section 5.6.8.4, "Surveys of Equipment and Materials Prior to Release to an Unrestricted Area," the licensee stated that its release limits are set as specified in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials" (NRC 1987a). Contrary to this commitment, in Section 6.3.2.1, "Building Materials, Equipment and Piping to be Released for Unrestricted Use," the licensee stated it would use release limits for contaminated materials that are identical to those in NRC guidance in Regulatory Guide 8.30, Table 2 (NRC, 2002d). However, the NRC has consistently required that release of surface-contaminated equipment, materials, and packages, for unrestricted use shall be based on the requirements in the 1993 Guidelines (NRC 1993a), which includes, among other things, separate limits for alpha-emitting and beta/gamma-emitting radionuclides, and a separate beta dose rate standard. Therefore, the NRC staff will add a license condition which clarifies the correct criteria to be used for

surveys to release equipment, materials, and packages for unrestricted use, during both facility operations and decommissioning. As described in SER Section 5.7.6.3, this license condition also addresses the qualification of individuals that perform radiation surveys in support of release of contaminated equipment, materials, or packages for unrestricted use.

9.13 *Release of contaminated equipment, materials, or packages for unrestricted use shall be in accordance with the NRC guidance in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Materials," dated April 1993 (ML003745526). Radiation surveys for release of items for unrestricted use shall be performed by a qualified radiation safety officer or qualified health physics technician.*

6.2.3.2.2 Decommissioning of Land Areas

In Section 6.4, "Procedures for Conducting Post-Reclamation and Decommissioning Radiological Surveys" of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its cleanup criteria for soils, which is based on 10 CFR 40, Appendix A, Criterion 6(6), including the requirement for a benchmark dose analysis to determine the cleanup criteria for byproduct material other than radium. The licensee specifically committed to using site-specific parameters and NRC guidance in NUREG-1569, Appendix E, "Guidance to the U.S. Nuclear Regulatory Commission Staff on the Radium Benchmark Dose Approach," to perform benchmark modeling.

With the inclusion of the license condition described in SER Section 6.2.3.2.1, the NRC staff determined that the licensee's description of decommissioning activities meets the acceptance criteria in NUREG-1569, Sections 6.2.3(1), 6.3.3(1) to 6.3.3(4), 6.3.4(1), 6.3.4(3), and 6.3.4(4), regarding cleanup criteria for soils and buildings, including use of a radium benchmark analysis to determine for cleanup criteria for byproduct material other than radium in soils.

6.2.3.2.3 Disposal of Byproduct Material

In Section 6.3.3, "Waste Transportation and Disposal," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described its current requirement in License Condition 9.6 to maintain an agreement for disposal of 11e.(2) byproduct material, and to notify NRC in writing, should this agreement expire or a new agreement be established. The licensee also explained that this material will be transported in accordance with NRC transportation regulations in 10 CFR 71. The NRC staff determined that this commitment meets the acceptance criteria in NUREG-1569, acceptance criterion 6.2.3(6).

6.2.3.3 Surface Reclamation

Because there are no applicable NRC regulations for surface reclamation, the NRC staff did not evaluate in detail the information described below contained in Section 6.2.3, "Surface Disturbance," and Section 6.2.4, "Surface Reclamation," of the Smith Ranch Renewal Technical Report.

6.2.4 Evaluation Findings

The NRC staff has completed its review of the licensee's decommissioning program description at the Smith Ranch Highland Uranium Project. This review included an evaluation of the methods that will be used using the review procedures in SRP Sections 6.2 through 6.4.

The licensee has acceptable plans for pre-reclamation (characterization) radiation surveys that will use instrumentation and techniques similar to the pre-operational survey used to establish baseline site conditions. The licensee has committed to consider results from operational monitoring and other information relative to areas of expected contamination in its decommissioning plans. Future decommissioning plans that meet 10 CFR 40.42(g) will address appropriate procedures for the pre-reclamation survey and the means used to identify areas for cleanup using the acquired data and any required changes to the radiation safety program identified as a result of the decommissioning work will be implemented before commencing the work.

Based on the information provided in Sections 6.2, 6.3, and 6.4 of the Smith Ranch Renewal Technical Report and the proposed license condition 9.13 described above, the licensee has established an acceptable program for the measurement and control of residual contamination on structures and equipment. In future decommissioning plans, the licensee will propose acceptable plans for measurements of radioactivity on the interior surfaces of pipes, drain lines, and ductwork by making appropriate measurements at all traps and other access points where contamination is likely to be representative of system-wide contamination. All premises, equipment, or scrap likely to be contaminated but that cannot be measured, will be assumed by the licensee to be contaminated in excess of limits and will be treated accordingly. For all premises, equipment, or scrap contaminated in excess of specified limits, the licensee will provide detailed, specific information describing the premises, equipment, or scrap in terms of extent and degree of radiological contamination. The licensee will provide a detailed health and safety analysis that reflects that the contamination and any use of the premises, equipment, or scrap will not result in an unacceptable risk to the health and safety of the public or the environment. The licensee plans to conduct a comprehensive radiation survey to establish that any contamination is within limits specified before the release of the premises, equipment, or scrap. The licensee will have a contract with a licensed waste disposal site operator to dispose 11e.(2) byproduct material.

The licensee has developed acceptable methodologies for verification of cleanup (final status survey plan) that demonstrate that the radium concentration in the upper 15 cm [5.9 in.] of soil will not exceed 5 pCi/g and in subsequent 15 cm [5.9 in.] layers will not exceed 15 pCi/g. Also, the cleanup of other residual radionuclides in soil will meet the criteria developed with the radium benchmark dose approach (Appendix E), including a demonstration of ALARA.

Based on the information provided in the Smith Ranch Renewal Technical Report and the proposed license condition 9.13 described above, the NRC staff concludes that future Decommissioning Plans will comply with 10 CFR 40.32(c), which requires licensee proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property; 10 CFR 40.42(g)(4), which provides requirements for final decommissioning plans; 10 CFR 40.41(c), which requires the licensee to confine source or byproduct material to the locations and purposes authorized in the license; 10 CFR Part 40, Appendix A, Criterion 2, which requires that the licensee provide objective evidence of an agreement for disposal of 11e.(2) byproduct materials either in a licensed 11e.(2) byproduct materials disposal site to demonstrate non-proliferation of waste disposal sites; and 10 CFR Part 40, Appendix A, Criterion 6(6), which identifies cleanup criteria requirements.

The final decommissioning plans will meet the criteria of 10 CFR 40.42(g)(4) and 40.42(g)(5). The final decommissioning plans will sufficiently demonstrate that the proposed decommissioning activities will result in compliance with 10 CFR 40.42(j)(2) requirements to

conduct a radiation survey. The final decommissioning plans will comply with the 10 CFR 40.42(k)(1) and 40.42(k)(2) requirements that source material be properly disposed of and reasonable effort be made to eliminate residual radioactive contamination.

6.3 Financial Assurance

6.3.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the proposed financial assurance for SRHUP meets the requirements of Criterion 9 of Appendix A to 10 CFR Part 40.

6.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the NRC staff reviewed the Smith Ranch Renewal Technical Report (Cameco, 2012b) for compliance with the applicable regulations of 10 CFR Part 40 using the acceptance criteria presented in Section 6.5.3 of the SRP (NRC, 2003a).

6.3.3 Staff Review and Analysis

The licensee presented its financial assurance commitments in Section 6.5, “Financial Surety,” of the Smith Ranch Renewal Technical Report (Cameco 2012b). The licensee did not include an updated financial assurance estimate; however, it has submitted annual updates as required by condition 9.5 of license SUA-1548. The licensee did describe its current financial assurance arrangements for license SUA-1548; the licensee maintains a series of letters of credit. These letters of credit cover the cost of groundwater restoration, decommissioning, disposal of buildings, and surface reclamation activities. As the licensee did not submit an updated financial assurance estimate, the remainder of this section focuses on compliance with the regulations in 10 CFR Part 40, Appendix A, Criterion 9 and condition 9.5 of license SUA-1548.

Condition 9.5 of license SUA-1548 contains specific requirements related to financial assurance arrangements for the licensee (NRC, 2016a). This condition is consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 9 and calls for: (i) the licensee to provide annual updates of the financial assurance amount on an annual basis, (ii) the licensee to extend the period of the instrument if the NRC does not approve a revision prior to the expiration date of the instrument; (iii) the financial assurance estimate includes a minimum 15 percent contingency; and (iv) the licensee submit a revision for any changes not included in the annual update at least 90 days prior to any planned construction or operational change.

During the past renewal period, the licensee submitted annual updates documenting changes in the financial assurance amount as required by condition 9.5 of license SUA-1548. The updates to the financial assurance estimate have included a basis for unit costs, effort required to complete tasks, and a minimum 15 percent contingency. Amendment 24 to license SUA-1548 documents the NRC staff’s last modification to the financial assurance amount (NRC, 2016a). As a result of the NRC staff’s review, the licensee maintains financial assurance of no less than the following amounts for the different portions of license SUA-1548. Note that the remote satellites that comprise license SUA-1548 (Ruth remote satellite, Gas Hills remote satellite, and North Butte remote satellite) all operate under separate WDEQ permits. Therefore, the licensee currently maintains separate letters of credit for the various portions of license SUA-1548 to maintain consistency with the requirements of the WDEQ permit.

Table 22. Current Fincancial Assurance Amounts

Facility	Amount
Smith Ranch (including Highland and Reynolds)	$212,675,100
Ruth	$364,900
North Butte	$27,738,300
Gas Hills	$2,834,243
Total	$243,612,543

By letter dated March 14, 2018, the NRC staff documented its review of the 2017-2018 financial assurance estimates (NRC, 2018a). In its review, the NRC staff verified that the financial assurance estimate updates for Smith Ranch, Ruth, North Butte, and Gas Hills reasonably include funds sufficient to cover the estimated current costs of groundwater restoration and decommissioning efforts at the facilities. During its review, the NRC staff observed that the financial assurance estimates included the following items:

- Groundwater restoration for mine units where lixiviant has been injected is estimated to require one pore volume of groundwater sweep, seven pore volumes of reverse osmosis treatment, and one pore volume of reverse osmosis treatment with a chemical reductant;
- Groundwater restoration, plugging and abandonment costs, and surface reclamation costs for all mine units where lixiviant has been injected;
- The costs to plug and abandon deep disposal wells;
- A groundwater restoration schedule for Smith Ranch and North Butte that reflects the water balances for those facilities;
- Reclamation of existing surface and storage ponds;
- The costs to decommission and remove existing buildings;
- Costs to reclaim access roads;
- Costs for off-site disposal of solid byproduct material at an appropriately licensed NRC or Agreement State facility.
-

At the completion of its verification review (NRC 2018a), the NRC staff determined that the updated financial assurance amount meets the requirements of 10 CFR Part 40, Appendix A, Criterion 9 and LC 9.5 (NRC, 2016a) and is therefore acceptable. The NRC staff chose to defer updating the minimum financial assurance amounts in condition 9.5 of license SUA-1548 until a future licensing action. At this time, the NRC staff us updating the financial assurance amounts in condition 9.5 of license SUA-1548 as follows:

Table 23. New Financial Assurance Assurance Amounts

Facility	Amount
Smith Ranch (including Highland and Reynolds)	$219,685,500
Ruth	$418,900
North Butte	$22,526,000
Gas Hills	$2,465,799
Total	$245,095,600

In Section 6.5, "Financial Surety," of the Smith Ranch Renewal Technical Report (Cameco 2012b), the licensee has committed to: (i) continue annual updates to the financial assurance estimate; (ii) maintain an instrument consistent with the standard license condition related to financial assurance; (iii) have the financial assurance instrument automatically renew; and (iv) submitting an updated financial assurance estimate at least ninety days prior to any planned expansion or operational change. The NRC staff observes that the licensee has not proposed any changes to its financial assurance arrangements or any changes to condition 9.5 in license SUA-1548. The NRC staff finds the commitments in Section 6.5, "Financial Surety," of the Smith Ranch Renewal Technical Report coupled with condition 9.5 of license SUA-1548 to be consistent with the acceptance criteria in Section 6.5.3 of the SRP (NRC, 2003a).

6.3.4 Evaluation Findings

The NRC staff evaluated the licensee's financial assurance commitments and method of cost estimation for the Smith Ranch project following the review procedures in SRP section 6.5.2 and the acceptance criteria in SRP section 6.5.3. Based on the information provided in the Smith Ranch Renewal Technical Report (Cameco 2012b) and the NRC staff's most recent review of the financial assurance updates (NRC, 2018a), the NRC staff concludes that the financial assurance estimate updates reasonably includes funds sufficient to cover the estimated current costs of groundwater restoration and decommissioning efforts at the facilities. The NRC staff determined that the updated financial assurance amount meets the requirements of 10 CFR Part 40, Appendix A, Criterion 9 and LC 9.5 and is therefore acceptable.

Condition 9.5 contains the financial assurance requirements for license SUA-1548. This condition is consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 9. To reflect the updated financial assurance amounts that were verified in the NRC staff's last financial assurance estimate review, the new version of condition 9.5 is below. The NRC staff has also proposed minor editorial changes to clarify the condition. The minor editorial changes include clarifying that a revised estimate shall be submitted following NRC approval of a decommissioning plan, removal of the sentence about identifying a date for the Reynolds Ranch update as the licensee has decided to incorporate the estimate for Reynolds Ranch into the Smith Ranch Highland Estimate, and including a citation date for NUREG-1569.

9.5 The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR Part 40, Appendix A, Criterion 9, adequate to cover the estimated reclamation and closure costs, if accomplished by a third party, for all existing operations and any planned expansions or operational changes for the

upcoming year. Reclamation includes all cited activities and groundwater restoration, as well as off-site disposal of all 11e.(2) byproduct material.

Within three months of NRC approval of a ~~revised closure (~~decommissioning~~)~~ plan and its cost estimate, the licensee shall submit, for NRC review and approval, a proposed revision to the financial surety arrangement if estimated costs exceed the amount covered in the existing financial surety. The revised surety instrument shall then be in effect within 30 days of written NRC approval of the surety documents.

Proposed annual updates to the surety amount, consistent with 10 CFR Part 40, Appendix A, Criterion 9, shall be provided to NRC 90 days prior to the anniversary date (e.g., renewal date of the surety instrument/vehicle) of September 30 of each year for Smith Ranch-Highland Uranium Project, March 26 for Ruth, April 30 for North Butte, November 7 for the Gas Hills Project. ~~The surety update renewal date for Reynolds Ranch will be determined following consultation with PRI and the State of Wyoming.~~ If NRC has not approved a proposed revision 30 days prior to the expiration date of the existing surety arrangement, the licensee shall extend the existing arrangement, prior to expiration, for one year. Along with each proposed revision or annual update of the surety, the licensee shall submit supporting documentation showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15 percent contingency, changes in engineering plans, activities performed, and any other conditions affecting estimated costs for site closure.

At least 90 days prior to beginning construction associated with any planned expansion or operational change which was not included in the annual surety update, the licensee shall provide, for NRC approval, an updated surety to cover the expansion or change. The licensee shall also provide NRC with copies of surety-related correspondence submitted to the State of Wyoming, a copy of the State's surety review, and the final approved surety arrangement. The licensee also must ensure that the surety, where authorized to be held by the State, identifies the NRC-related portion of the surety and covers the above-ground decommissioning and decontamination, the cost of offsite disposal of 11e.(2) byproduct material, soil and water sample analyses, and groundwater restoration associated with the site. The basis for the cost estimate is the NRC-approved site closure plan or the NRC-approved revisions to the plan. Reclamation or decommissioning plan cost estimates, and annual updates, should follow the outline in Appendix E to NUREG-1569 (~~NRC, 2003~~ *June 2003*), entitled "Recommended Outline for Site-Specific *In Situ* Leach Facility Reclamation and Stabilization Cost Estimates.

~~Power Resources, Inc. shall maintain approved surety instrument(s) in the total amount of no less than $243,612,543.00 for all facilities under this license. The minimum amount for each area of the license is identified in the following paragraphs.~~

~~Power Resources, Inc., shall continuously maintain an approved surety instrument(s) for the Smith Ranch Highland Project, in favor of the State of Wyoming, in the amount of no less than $212,675,100.00 for the purpose of complying with 10 CFR Part 40, Appendix A, Criterion 9, until a replacement is authorized by both the State of Wyoming and the NRC.~~

~~The licensee shall continuously maintain an NRC-approved surety instrument(s) for the current non-operational Ruth facility in the amount of no less than $364,900.00, in favor of the State of Wyoming, until a replacement is authorized by both the State of Wyoming and the NRC.~~

~~The licensee shall continuously maintain an NRC-approved surety instrument(s) for the North Butte facility in the amount of no less than $27,738,300.00 in favor of the State of Wyoming, until a replacement is authorized by both the State of Wyoming and the NRC.~~

~~The licensee shall continuously maintain an NRC-approved surety instrument(s) for the current non-operational Gas Hills Project facility in the amount of no less than $2,834,243.00 in favor of the State of Wyoming, until a replacement is authorized by both the State of Wyoming and the NRC.~~

Power Resources, Inc. shall maintain approved surety instrument(s) for all facilities under this license, in favor of the State of Wyoming, in the total amount of no less than $245,095,600 for the purpose of complying with 10 CFR Part 40, Appendix A, Criterion 9, until a replacement is authorized by both the State of Wyoming and the NRC. The minimum amount for each area of the license is identified below.

Minimum Surety Amounts

Facility	***Amount***
Smith Ranch (including Highland and Reynolds)	*$219,685,500*
Ruth	*$418,900*
North Butte	*$22,526,000*
Gas Hills	*$2,465,799*
Total	*$245,095,600*

At least six months prior to the expected commencement of construction of a commercial facility at the Ruth, and Gas Hills Project sites, the licensee shall submit for NRC and State approval, an itemized cost estimate for implementation of the NRC-approved decommissioning/restoration plan for the commercial facility. Site construction activities shall not commence until the NRC and State approve the surety amount and accept the surety arrangement. This surety shall be written in favor of the State of Wyoming or the NRC and shall be continuously maintained until a replacement is authorized by both the State of Wyoming and the NRC.

7.0 ACCIDENTS

7.1 Regulatory Requirements

In this SER section, the NRC staff determines if the licensee has addressed potential accidents at the Smith Ranch Highland Uranium Project and demonstrated that the facility will meet the requirements of 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect public health and minimize danger to life or property.

7.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 7.5.3 of the SRP (NRC 2003a).

7.3 Staff Review and Analysis

The NRC staff reviewed and analyzed the licensee's description of potential accidents at the Smith Ranch Highland Uranium Project, the design features and measures proposed by the licensee to prevent accidents, and response plans and training proposed to respond to and mitigate accidents. Unless specifically stated otherwise, the information reviewed for this section were provided by the licensee in Section 7.5, "Potential Effects of Accidents," of the Smith Ranch Renewal Technical Report (Cameco 2012b).

In Section 7.5, "Potential Effects of Accidents," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee provided information on the potential accidents that could occur at the facility and procedures and training lessen the likelihood of an accident and mitigate the consequences, should an accident occur. The NRC staff notes that the hazard assessments in NUREG/CR-6733, "A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees," (Mackin et al. 2001), indicate that radiological consequences from accidents can be mitigated through use of effective emergency procedures and proper training of personnel implementing the procedures. The following SER sub-sections address specific information on accidents analyzed by the licensee.

In Section 5.2.1, "Safety, Health, Environment and Quality Management System," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee explained that its Safety, Health, Environment and Quality Management System (SHEQMS) includes emergency procedures in Volume 8. In Section 5.2.1.1, "Emergency Management Protocols, Procedures and Programs," of the Smith Ranch Renewal Technical Report, the licensee described its procedures for non-routine and emergency operations. In Section 5.10.5.4, "Non-Routine Report," of the Smith Ranch Renewal Technical Report, the licensee committed to following the reporting requirements of 10 CFR 20, Subpart M, "Reports," which includes the specific requirements in 10 CFR 20.2202, "Notification of incidents," and 10 CFR 20.2203, "Reports of exposures, radiation levels, and concentrations of radioactive material exceeded the constraints or limits." The NRC staff determined that the licensee's commitments to response procedures, training, and notification, together with the specific prevention and mitigation measures described in the following SER sub-sections, are adequate to protect public health and minimize danger to life or property.

7.3.1 Process-Related Failures

In Section 7.5.1, "Potential Accidents Involving Radioactivity," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described potential accidents involving failures of liquid-filled tanks, pipes, mine unit equipment, and ponds. The licensee described accident prevention features, such as tanks manufactured of materials suitable for their service and mine unit pipelines constructed of high-density polyethylene (HDPE) with butt-welded joints. The licensee also described accident mitigation design features, including containment berms, curbs, and floor sumps, that would contain potential leaks and spills, should they occur. The licensee also described individual well pressure monitors that are remotely observed in the satellite control rooms and the use of roving mine unit inspections to detect small leaks. With regard to ponds, the licensee stated it uses lined holding ponds which are routinely monitored for leaks using a leak detection system.

In NUREG/CR-6733 (Mackin et al., 2001), the NRC considered a bounding scenario for spills, in which it assessed an accident involving a yellowcake thickener. A failure of the thickener was assumed to result in a spill up to 24,200 kg (53,300 lbs) U_3O_8 in 278 m^3 (73,000 gallons) of liquid on the floor of the Central Processing Plant. In that generic assessment, the authors concluded, "Based on these conservative calculations, it can be concluded that the dose from a spill to the public is expected to be below 10 CFR Part 20 limits. Doses to unprotected workers could exceed the 5×10^{-2} Sv (5 rem) limit specified in 10 CFR Part 20." As a result, the authors recommended licensees should have procedures for timely spill cleanup, protective equipment for workers involved in cleanup, and worker training programs (Mackin et al., 2001). Because this previous assessment included sensitivity analyses, in which a range of parameter values such as the volume of the spill, atmospheric stability class, and wind speed were evaluated, the NRC staff has reasonable assurance that the consequences described above bound the risk of potential spills at the Smith Ranch Highland Uranium Project.

The NRC staff also evaluated information provided by the licensee in Technical Report Table 3-15, "Summary of Spills and Releases" between November 23, 1999 and July 22, 2011, and Technical Report Table 3-16, "Summary of East and West Storage Pond Leak Events – November 15, 1999 through September 30, 2011," and determined that no spills at the Smith Ranch Highland Uranium Project during these timeframes exceeded both the volume and concentration of the bounding accident described above.

During this evaluation, the NRC staff observed that the licensee did not address the potential for sealed drums filled with yellowcake to pressurize in the license renewal application. Drum pressurization occurs when dried yellowcake decomposes and produces oxygen and other non-condensable gasses in drums that have not been adequately cooled and vented prior to being sealed. The NRC addressed this hazard in Information Notice 99-03, Revision 1, "Exothermic Reactions Involving Dried Uranium Oxide Powder (Yellowcake)," on March 4, 2014 (NRC 2014b). In Information Notice 99-03, Revision 1, the NRC concluded that a cooling and venting period of at least 12 hours to prevent oxygen gas build-up in sealed yellowcake drums appears necessary at facilities using hydrogen peroxide precipitation and drying temperatures below 800°C (1472 °F). The NRC also concluded that licensees are implementing visual inspections of drums for signs of pressurization prior to shipment. The NRC revised IN 99-03 following events in 2006 and 2012 in which drum lids blew off the drums following receipt of drums at uranium conversion facilities, resulting in ejections of yellowcake and uranium intake by plant workers. The NRC staff reviewed a copy of the licensee's procedures for venting yellowcake drums during an inspection in 2015 (NRC, 2015a). The NRC staff did not identify any issues with the licensee's procedures. However, because the licensee did not address this hazard in

its renewal application, the NRC staff will include a license condition in the renewed license requiring the minimum cooling and venting period and inspections described above.

10.1.12 *The licensee shall allow each drum filled with dried yellowcake to vent and cool at least 12 hours before the drum is sealed, and shall inspect each drum for pressurization prior to shipment.*

On the basis of the information described above, the NRC staff determined that the licensee considered credible accidents involving process equipment, including mitigation of consequences of these accidents, and has adequately considered operating experience of similar facilities, in accordance with acceptance criteria in Section 7.5.3 of NUREG-1569 (NRC 2003a).

7.3.2 Lixiviant Excursion

In Section 7.5.1.5, "Potential Lixiviant Excursion," of the Smith Ranch Renewal Technical Report, the licensee described its procedures to both prevent and mitigate excursions. The NRC staff's evaluation of these procedures is described in SER Section 5.7.8.3.2.

7.3.3 Transportation Accidents

In Section 7.5.2, "Potential Transportation Accidents," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described the approximate numbers and types of hazardous material shipments at the Smith Ranch Highland Uranium Project, the NRC and Department of Transportation regulatory requirements for hazardous material in transport, and the licensee's procedures to comply with these regulations. The following sections describe the licensee's consideration of accidents involving the different hazardous materials in transport to and from the licensed operations.

In Section 7.5.2.1, "Potential Accidents Involving Resin or Yellowcake Slurry Shipments," and Section 7.5.2.2, "Potential Accidents Involving Yellowcake Shipments," of the Smith Ranch Renewal Technical Report, the licensee described potential accidents involving resin, yellowcake slurry, and dried yellowcake. The licensee described transportation routes between remote satellites and the central processing facilities and transportation accident prevention and mitigation procedures, including its transportation plans to comply with NRC/DOT transportation regulations. The licensee stated that the worst case accident scenario involving resin transportation would involve spill of the entire contents of a 15,120-liter (4,000-gallon) tanker trailer. The licensee stated the effects of an accident involving yellowcake slurry would not be different from dried yellowcake, with the exception that the contained water in the slurry would prevent windblown contamination of nearby soils and vegetation. In Section 7.5.2.2, "Potential Accidents Involving Yellowcake Shipments," of the Smith Ranch Renewal Technical Report, the licensee referenced the probability of an accident involving dried yellowcake presented in NUREG-0706, "Final Generic Environmental Impact Statement on Uranium Milling." In Section 7.5.2.4, "Potential Accidents Involving Shipments of 11e.(2) Byproduct Material," the licensee stated these infrequent shipments have minimal impact in the event of an accident, and impacts would be mitigated by the emergency response plan for transportation accidents.

In Section 4.5, "Transportation Hazard Risk Analysis," of NRC's prior baseline hazard analysis (Mackin et al., 2001), the NRC staff evaluated accidents associated with resin slurry and yellowcake. With regard to resin slurry transportation accidents, the NRC, citing the Crownpoint Uranium Solution Mining Project Final Environmental Impact Statement (NRC 1997),

determined that the probability of an accident involving a resin tank truck at the Crownpoint ISR site was about 0.009 in any year, and that the radiological consequences would be lower than for yellowcake spills because airborne releases from wet material are minimal if the spill is cleaned up quickly (Mackin et al., 2001). The NRC's prior probability estimate was based on 100 truck shipments per year, over a distance of 67 km (42 miles), at an two-lane road accident rate of 1.4×10^{-6} accidents per kilometer (2.2×10^{-6} accidents per mile) (NRC 1997).

With regard to yellowcake transportation accidents, NRC previously considered a generic uranium mill (NRC 1980b) and the proposed ISR facility at Crown Point (NRC 1997). The generic analysis considered annual yellowcake production rates of up to 590,000 kg (1.3 million lb) and transportation distances of up to 2,200 km (1,400 mi). The 50-yr dose commitments in a well-populated area with up to 61 persons/km^2 were up to 200 person-rem for a case in which 45 percent of the yellowcake is spilled, and 14 person-rem for a case in which 3 percent of the yellowcake is spilled. Based on these doses, the authors estimated cancer deaths of 0.0008 to 0.01 per year as a result of yellowcake transport accidents associated with one ISR facility. The authors also summarized the specific NRC and DOT requirements for transporting LSA-I material. The NRC concluded that transporters should have spill response plans, and actual accidents should continue to be evaluated to inform safety and equipment regulations (Mackin et al., 2001). The NRC staff's review of the licensee's regulatory performance history is discussed in Appendix A to this SER. The NRC staff's review includes a discussion of several transportation related issues related to shipments of barium sulfate sludge.

On the basis of the information described above, the NRC staff determined that the licensee considered credible transportation accidents involving licensed material, including mitigation of consequences of these accidents, and has adequately considered operating experience of similar facilities, in accordance with acceptance criteria in Section 7.5.3 of NUREG-1569 (NRC 2003a).

7.3.4 Natural Disasters

In Section 7.5.3, "Potential Natural Disaster Risk," and 7.5.4, "Potential Range Fire Risk," of the Smith Ranch Renewal Technical Report (Cameco 2012b), the licensee described its commitment to best practices in the design of chemical storage facilities against high wind and seismic hazards. The licensee also described regional high wind and seismicity statistics, and provided an overview of its emergency response procedures. The licensee also explained its procedures in the event of a range (grass) fire in the vicinity of structures containing NRC-licensed material. If a grass fire threatens structures, the Incident Commander will inform employees by radio and telephone intercom, proceed to the fire area, assess the situation, and determine the appropriate response by licensee-trained personnel.

In Section 4.6, "Tornado Hazard and Consequence Analysis," of NRC's prior baseline hazard analysis (Mackin et al., 2001), the NRC concluded that tornado risk is very low at uranium ISR facilities and that no design or operational changes are required to mitigate the risk of tornado strikes on ISR facilities. Similarly, the NRC concluded that no special measures are required to protect uranium ISR facilities from seismic hazards.

On the basis of the information described above, the NRC staff determined that the licensee considered credible accidents caused by natural phenoma, including mitigation of consequences of these accidents, and has adequately considered operating experience of

similar facilities, in accordance with acceptance criteria in Section 7.5.3 of NUREG-1569 (NRC 2003a).

7.3.5 Chemical Accidents

In its license renewal application, the licensee considered accidents caused by on-site storage and use of process chemicals and accidents resulting from on-site coal bed methane production. The following SER sections address each kind of chemical hazard.

7.3.5.1 Process Chemicals

In multiple subsections of 7.5.5, "Potential Chemical Risk," of the Smith Ranch Renewal Technical Report (Cameco, 2012b) (e.g., Section 7.5.5.1, "Oxygen", Section 7.5.5.2, "Carbon Dioxide,"), the licensee described potential accidents involving process chemicals used at the Smith Ranch Highland Uranium Project. These process chemicals include sodium carbonate, sodium chloride, sodium sulfide, sodium hydroxide, hydrogen peroxide, sulfuric acid, oxygen, and carbon dioxide. The licensee stated none of the chemicals are listed by the U.S. Occupational Safety and Health Administration as toxic and reactive highly hazardous chemicals. In each case the licensee committed to appropriate industry standards for storage and use of chemicals (e.g., Compressed Gas Association (CGA) Standard G-4.4, "Oxygen Pipeline and Piping Systems," for oxygen).

The NRC previously evaluated the use of hazardous chemicals in use at ISR facilities, including all of the chemicals identified by the licensee for use at the Smith Ranch Highland Uranium Project (Mackin et al., 2001). For each of the hazardous chemicals considered, the prior study concluded that ISR licensees should comply with codes and accredited standards appropriate for these chemicals. On the basis of the information described above, the NRC staff determined that the licensee considered credible process chemical accidents, including mitigation of consequences of these accidents, and has adequately considered operating experience of similar facilities, in accordance with acceptance criteria in Section 7.5.3 of NUREG-1569 (NRC 2003a).

7.3.5.2 Coal Bed Methane

In Section 7.5.6, "Potential Accident Risks Associated with Coal Bed Methane Development," of the Smith Ranch Renewal Technical Report (Cameco, 2012b), the licensee described the potential for methane migration and seepage through naturally-occurring seeps and non-CBM wells that penetrate the coal seam. The licensee stated that current CBM industry standards for cementing and casing wells that isolate and protect uranium ore zones from gas or fluid migration are sufficient to reduce the risk of methane intrusion into uranium ore zones. The licensee also considered the potential for heavy equipment to breach buried natural gas pipelines carrying coal bed methane. The licensee explained prevention and mitigation features such as pipeline markers, pipeline pressure monitoring, and pipeline shutoff valves. The NRC staff finds this approach acceptable because it is consistent with the NRC staff's previous findings in Section 7.3.11, "Communication through Coal Bed Methane and Oil/Gas Wells," of the NRC staff's July 2011 "Safety Evaluation Report for the Nichols Ranch In Situ Recovery Project in Johnson and Campbell Counties, Wyoming, Materials License No. SUA-1597" (NRC 2011e).

7.4 Evaluation Findings

NRC has completed its review of the applicant's description of the effects of accidents for the Smith Ranch Highland Uranium Project. This review included an evaluation of the methods that will be used to evaluate the effects of accidents using the review procedures in SRP Section 7.5.2 and the acceptance criteria outlined in SRP Section 7.5.3.

The licensee has acceptably described all likely significant effects of accidents from facility operations. The licensee has provided an acceptable analysis of probable accidents and their consequences, if necessary, consistent with facility design, site features, and planned operations. If appropriate, the licensee has confirmed that facility design, site features, and planned operations are consistent with previous NRC accident analyses. The licensee has identified likely environmental impacts from such accidents and has included mitigation measures. Any accident analyses have considered past operating experience from similar facilities. Adequate response and remediation procedures have been identified or referenced, and the facility personnel will be qualified to implement them. The applicant's response program for radiological accidents will comply with the notification requirements of 10 CFR 20.2202 and 20.2203.

Based on the information provided in the application and the detailed review conducted of the effects of accidents for the Smith Ranch Highland Uranium Project, the NRC staff concludes that the effects of accidents are acceptable and are in compliance with 10 CFR 40.32(c), which requires that the applicant's proposed equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property; and 10 CFR 20.2202 and 20.2203, which define response program requirements for radiological accidents.

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Appendix A. Historical Aspects of Site Performance: Smith Ranch Highland ISR Project License Renewal

The guidance in NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications," Appendix A, "Guidance for Reviewing Historical Aspects of Site Performance for License Renewals and Amendments," (NRC 2003a), describes specific areas relating to the licensee's compliance history or record of site operations and changes that the NRC staff should review as part of licensing actions. Appendix A states,

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

The NRC staff has reviewed historical aspects of site operations, as described below. During its evaluation of Cameco's performance at Smith Ranch, the NRC staff followed the guidance in Appendix A of NUREG-1569. Briefly, the NRC staff's evaluation included a review of items such as: NRC inspection reports (including any violations), Cameco's license amendment requests, changes to Cameco's operating practices or procedures (documented in Safety and Environmental Review Panel [SERP] evaluations); semi-annual effluent and environmental monitoring reports, reports of spills or excursions, or any root cause analyses. The review documented the operational history of activities conducted under license SUA-1548 and to determine if any unreviewed safety-related concerns exist. The NRC staff's review of Cameco's performance under License SUA-1548 is documented in the following sections.

A.1 U.S. NRC Inspection Reports

Since the last renewal was issued for license SUA-1548 on May 8, 2001, the NRC staff has inspected the Smith Ranch Highland facility following the inspection frequencies identified in Inspection Manual Chapter 2801, Uranium Mill and 11e.(2) Byproduct Material Disposal Site and Facility Inspection Program. A summary of the inspection dates and ADAMS Accession Numbers for the inspection reports is provided in Table A-1.

Table A.1. NRC Inspections July 2001 through November 2017

Inspection Date	Reference	Portion of Facility
July 10 to 11, 2001	NRC, 2001b	Smith Ranch
April 29 to 30, 2002	NRC, 2002b	Smith Ranch
September 9 to 11, 2002	NRC, 2002e	Smith Ranch
July 22 to 24, 2003	NRC, 2003c	SR-HUP
August 23 to 25, 2004	NRC, 2004d	SR-HUP
August 22 to 25, 2005	NRC 2005b	SR-HUP
July 11 to 13, 2006	NRC, 2006c	SR-HUP
April 2 to 5, 2007	NRC, 2007c	SR-HUP
September 20 to 21, 2007	NRC, 2007d	SR-HUP
March 24 to 27, 2008	NRC, 2008b	SR-HUP

September 23 to 25, 2008	NRC, 2008i	SR-HUP
March 17 to 19, 2009	NRC, 2009a	SR-HUP
September 15 to 17, 2009	NRC, 2009b	SR-HUP
February 22 to 25, 2010	NRC, 2010a	SR-HUP
August 24 to 26, 2010	NRC, 2010b	SR-HUP
February 14 to 17, 2011	NRC, 2011c	SR-HUP
August 29 to September 1, 2011	NRC, 2011g	SR-HUP
February 27 to March 1, 2012	NRC, 2012a	SR-HUP
August 7 to August 9, 2012	NRC, 2012d	SR-HUP
April 1 to April 4 and May 29 to May 30, 2013	NRC, 2013d	SR-HUP, NB
September 9 to September 12, 2013	NRC, 2013e	SR-HUP, NB
May 20 to May 22, 2014	NRC, 2014g	SR-HUP
April 14 to April 16, 2015	NRC, 2015a	SR-HUP
June 21 to June 24, 2016	NRC, 2016e	SR-HUP, NB
November 15 to 17, 2016	NRC, 2017b	SR-HUP
May 8 to May 11, 2017	NRC, 2017c	SR-HUP
November 13 to November 16, 2017	NRC, 2017f	SR-HUP, NB
June 25 to June 28, 2018	NRC, 2018b	SR-HUP, NB

The NRC staff has not identified any unreviewed safety-related concerns during inspections of activities authorized under license SUA-1548. The NRC staff has issued a number of violations; further discussion is presented in section A.3.

A.2 Amendments to License SUA-1548 and changes to operating practices or procedures

This section reviews amendments to License SUA-1548 as well as any changes to operating practices or procedures. NRC has issued 24 license amendments since the last renewal issuance of Source Materials License SUA-1548 in May 2001. The table below shows the amendment number, the date it was issued, a brief reason for the amendment, and the NRC's Agencywide Documents Access and Management Systems (ADAMS) accession number for the document containing the NRC staff's review. Most of these amendments are related to annual updates in the financial assurance provisions required by License Condition 9.5. The NRC staff's evaluation of financial assurance related to the Smith Ranch Highland Uranium Project renewal request is addressed in Sections 1 and 6.5 of this SER. With respect to the amendments identified in Table A-2, the NRC staff has not identified any unreviewed safety related concerns.

Table A-2. Amendments to SUA-1548, September 2001 through February 2016

No.	Date Issued	Reason for Amendment	ADAMS Accession No.
1	9/27/2001	Financial assurance update – Smith Ranch	ML012700363
2	3/5/2002	Administrative changes to application related to flare factor and Mine Unit 1 restoration plan	ML020650374

3	7/11/2002	Change of control from Rio Algom to Power Resources, Inc.	ML021920473
4	9/3/2002	Administrative changes to license	ML022470391
5	8/18/2003	Consolidation of Smith Ranch, Highland, Ruth, and North Butte into license SUA-1548	ML032320650, ML032320650 (P)
6	1/29/2004	Gas Hills Remote Satellite expansion	ML040350012, ML040350016, ML040350022
7	3/22/2004	Financial assurance update – Ruth, North Butte	ML040830695, ML040840127
8	7/22/2004	Financial assurance update – Smith Ranch, Highland	ML042110016, ML042110020
9	12/3/2004	Reduction of licensee inspection frequencies at Ruth and North Butte	ML043420490, ML043420491
10	8/10/2005	Financial assurance update – Gas Hills	ML052290108
11	1/31/2007	Reynolds Ranch Satellite Expansion	ML062710051
12	1/10/2008	Construction and operation of SR-2 satellite facility	ML073511462
13	8/18/2008	Administrative changes to chapter 9 of application	ML082050064
14	3/12/2009	Financial assurance update	ML083150141
15	9/15/2009	Third Party Resin processing	ML092250421
16	3/11/2010	Financial assurance update – Gas Hills, Ruth, North Butte	ML093200172
17	2/2/2012	Financial assurance update – Smith Ranch, Highland, North Butte, Gas Hills, Ruth	ML112510155
18	3/27/2013	Financial assurance update – North Butte	ML13071A447
19	4/15/2014	Financial assurance update – Smith Ranch, Highland, and Gas Hills	ML14016A069
20	5/29/2014	Financial assurance update – North Butte	ML14115A229
21	3/26/2015	Financial assurance update – Smith Ranch, Highland	ML15028A303
22	5/11/2015	Financial assurance update – Gas Hills	ML15068A367
23	8/31/2015	Financial assurance update – North Butte	ML15209A584
24	2/29/2016	Financial assurance update – Smith Ranch, Highland, Gas Hills, Ruth	ML15348A074

From 2001 through 2017, the licensee made 113 changes to the licensing basis approved by its Safety & Environmental Review Panel (SERP). The individual SERP process determinations are listed in Table A-3 with the ADAMS accession number for the licensee's semi-annual reports containing a summary of each change. During routine inspections, the inspectors review licensee-initiated changes made through the SERP process to evaluate if program changes, tests, or experiments require an NRC license amendment prior to implementation. The NRC inspectors concluded that the licensee had implemented the SERP process in accordance with license condition 9.4 of Source Materials License SUA-1548.

Table A-3. Summary of Licensee-Approved Changes, Tests, or Experiments

Year	Number of Changes	SERP Nos.	ADAMS Accession No.
2001	0	No SERP reviews completed	N/A
2002	10	Work Order 576, Work Order 476, Work Order 513, Work Order 606, Work Order 665, Work Order 598, Work Order 702, Work Order 594, Work Order 551, Work Order 557	ML031110410
2003	6	SERP 721, SERP 46, SERP 1, SERP 2, SERP 3, SERP 4	ML040650721
2004	6	SERP 2004-1, SERP 2004-2, SERP 2004-3, SERP 2004-4, SERP 2004-5, SERP 2004-6	ML050470256
2005	6	SERP 2005-1, SERP 2005-2, SERP 2005-3, SERP 2005-3A, SERP 2005-4, SERP 2005-5	ML060610149
2006	4	SERP 2006-1, SERP 2006-2, SERP 2006-3, SERP 2006-4	ML070520428
2007	3	SERP 2007-1, SERP 2007-2, SERP 2007-3	ML080650349
2008	2	SERP 2008-1, SERP 2008-2	ML090630766
2009	5	SERP 2009-1, SERP 2009-2, SERP 2009-3, 071609-1, 090409-1	ML092600297, ML100700412
2010	5	SERP 02/10-1, SERP 02/10-2, SERP 5/10-1, SERP 7/10-1, SERP 10/10-1	ML11222A040
2011	9	SERP 03/11-1, SERP 03/11-2, SERP 08/11-1, SERP 09/11-1, SERP 09/11-2, SERP 09/11-2(s), SERP 10/11-2, SERP 10/11-6, SERP 12/11-3	ML12087A157
2012	9	SERP 08/11-1, SERP 10/11-5, SERP 02/12-1. SERP 02/12-4, SERP 03/12-1, SERP 04/12-1, SERP 05/12-2, SERP 08/12-2, SERP 10/12-1	ML13073A836
2013	12	SERP 04/12-4, SERP 10/12-2, SERP 1/13-1, SERP 1/13-3, SERP 4/13-1, SERP 4/13-2, SERP 6-13/1, SERP 6/13-3, SERP 7/13-1, SERP 9/13-1, SERP 10/13-1, SERP 11/13-1	ML14066A398
2014	17	SERP 1/14-1, SERP 2/14-2, SERP 2/14-3, SERP 3/14-4, SERP 3/14-6, SERP 4/14-7, SERP 5/14-9, SERP 6/14-10, SERP 6/14-11, SERP 7/14-13, SERP 8/14-14, SERP 8/14-15, SERP 8/14-16, SERP 9/14-18, SERP 9/14-19, SERP 11/14-20, SERP 12/14-21	ML15069A259
2015	8	SERP 01/15-1, SERP 02/15-2, SERP 5/15-5, SERP 8/15-7, SERP 8/15-8, SERP 8/15-9, SERP 8/15-10, SERP 11/15-11,	ML16063A305
2016	4	SERP 02/16-01, SERP 3/16-03, SERP 3/16-04, SERP 10/16-11	ML17128A305
2017	7	SERP 1/17-01, SERP 3/17-04, SERP 7/17-07, SERP 7/17-08, SERP 8/17-10, SERP 9/17-12, SERP 10/17-14	ML18075A039
2018			

The NRC staff's review of the amendment and SERP history did not identify any unreviewed safety-related concerns.

A.3 License violations

Since the last renewal was issued for license SUA-1548 on May 8, 2001, the NRC staff has inspected the Smith Ranch Highland facility following the inspection frequencies identified in Inspection Manual Chapter 2801, Uranium Mill and 11e.(2) Byproduct Material Disposal Site and Facility Inspection Program. Cameco has been cited for several violations of the applicable regulations in 10 CFR Part 40, Appendix A and specific conditions in Source Materials License SUA-1548. A summary of the inspection dates and violations cited is presented in Table A-4. Note that inspections where no violations were cited are not included in the table.

Table A-4. Violations of NRC Requirements, July 2006 through November 2016

Inspection Date	Reference	Portion of Facility	Inspection Results
July 11 to 13, 2006	NRC, 2006c	SR-HUP	Violation, failure to develop radiation work permit for non-routine work activity
April 2 to 5, 2007	NRC, 2007c	SR-HUP	Violation, failure to post radiation area
September 23 to 25, 2008	NRC, 2008i	SR-HUP	Three violations - exceedence of public dose limit in unrestricted areas, failure to store byproduct materials in a restricted area, failure to maintain surveillance and control of licensed material at a satellite
September 15 to 17, 2009	NRC, 2009b	SR-HUP	Violation, timeliness in decommissioning
February 22 to 25, 2010	NRC, 2010a	SR-HUP	Violation, failure to post radiation area
August 24 to 26, 2010	NRC, 2010b	SR-HUP	Violation related to U.S. Department of Transportation regulations
August 29 to September 1, 2011	NRC, 2011g	SR-HUP	Three violations - failure to store byproduct materials in a restricted area, failure to report spill/excursions to NRC, failure to alarm in event of a spill
August 7 to August 9, 2012	NRC, 2012d	SR-HUP	One violation related to DOT regulations
April 1 to April 4 and May 29 to May 30, 2013	NRC. 2013d	SR-HUP, NB	One violation related to conduct of work under a radiation work permit
April 14 to April 16, 2015	NRC, 2015a	SR-HUP	One violation related to DOT regulations

June 21 to June 24, 2016	NRC, 2016e	SR-HUP, NB	One violation related to calculation of committed effective dose equivalent
November 15 to 17, 2016	NRC, 2017b	SR-HUP	Nine apparent violations related to transportation program
June 25 to 28, 2018	NRC, 2018b	SR-HUP	One apparent violation related to posting a radiation area and one apparent violation related to controlling access to radioactive material

The NRC staff reviewed the inspection findings and observes that most of the violations cited have been severity level IV. Cameco has adequately addressed all of the severity level IV violations cited by the NRC staff. Cameco addressed the severity level IV violations through the inspection process.

The NRC staff has issued one confirmatory action letter to Cameco (NRC, 2016c). The confirmatory action letter resulted from the staff's June 21 to 24, 2016 inspection of Smith Ranch. The NRC staff identified several issues related to shipments of barium sulfate sludge from Smith Ranch to Energy Fuels Resources, Inc. (EFRI) White Mesa Mill in Blanding, Utah. Under the Confirmatory Action Letter, Cameco is not allowed to ship barium sulfate sludge to EFRI White Mesa until several actions are completed. The NRC staff's November 2016 inspection of Smith Ranch focused on the transportation program and completion of the actions identified in the Confirmatory Action Letter. The NRC inspectors identified that Cameco had not completed all of the actions identified in the Confirmatory Action Letter and that Cameco had not resumed shipments of barium sulfate sludge to EFRI White Mesa. The NRC inspection report for the November 2016 inspection identified nine potential violations that resulted in a severity level III violation. The severity level III violation related to the implementation of Cameco's transportation program at Smith Ranch. The NRC staff closed the confirmatory action letter on August 25, 2017 (NRC 2017d).

In addition to the inspection reports, the NRC also completed one investigation report related to activities performed under License SUA-1548. The investigation report was focused on aspects of Cameco's radiation protection program at the North Butte remote satellite. Specifically, the investigation report evaluated Cameco's exit survey procedures, record keeping, hazard awareness training, and release survey procedures (NRC, 2016b). The investigation report resulted in issuance of a confirmatory order to Cameco (NRC, 2016d).

The NRC staff's review of the inspection history did not identify any unreviewed safety-related concerns.

A.4 Excursions, incident investigations, or root cause analyses

This section documents the NRC staff's review of Cameco's operational history with respect to excursions of lixiviant and unplanned releases within the areas of license SUA-1548. Since 2001, the NRC staff has identified 38 excursions at Smith Ranch Highland (including the North Butte remote satellite) during the renewal period. The excursion history is provided in Table A-5.

Table A-5. Excursions from November 2001 through May 2018.

Date on Excursion Status	Mine Unit	Well	ADAMS Accession No.
11/05/2001	D	DM-9	ML020160110
03/21/2002	D	DM-10	ML020980287
07/01/2002	F	FM-5	ML021910345
11/07/2002	B	M-42	ML023230276
09/03/2004	4	M428	ML042730390
11/15/2006	J	JMO-009	ML12163A067
11/15/2006	J	JMO-013	ML12163A067
05/01/2007	I	IM-11	ML071730433
07/03/2007	C	CM-32	ML11152A093
02/22/2008	C	CM-33	ML080730269, ML12163A067
11/12/2008	I	IM-8	ML11272A224
11/18/2008	C	CM-15	ML083450656
02/11/2009	I	IM-10	ML090570740
03/27/2009	I	IM-14	ML091040295
04/14/2009	I	IM-8	ML091270126
05/20/2009	I	IM-8	ML091540748
07/07/2009	F	FM-8	ML092230237, ML092710575
07/30/2009	I	IM-8	ML092250302
11/19/2009	D	DM-3	ML12250A676, ML14073A642
01/12/2010	H	HM-20	ML100341073, ML11272A224, ML12163A067
06/07/2010	C	CM-38	ML101730553, ML102371056
09/09/2010	C	CM-15	ML102730215

03/08/2011	J	JM-005	ML110810562, ML11272A224
06/03/2011	D	DM-10	ML12101A232, ML12319A084
09/06/2011	K	KM-031	ML11307A395
01/12/2012	J	JM-007	ML12026A247, ML12250A676
07/30/2012	F	FM-9	ML13109A015
08/03/2012	J	JM-007	ML12250A676
08/17/2012	K	KM-031	ML12285A369
02/15/2013	K	KM-031	ML13109A015
03/12/2013	C	CM-032	ML13072A132, ML13093A373, ML13141A422
03/12/2013	K	KMO-007	ML13072A132, ML13093A374, ML14203A059
08/08/2013	C	CM-032	ML13225A121, ML13234A226, ML13352A191
12/11/2013	D	DM-004	ML13361A110, ML14255A380
08/26/2014	D	DM-003A	ML16141A323
12/04/2015	D	DM-004A	ML15351A492, ML16050A392
09/20/2016	NB1	NBM-031	ML16279A081, ML16319A080
11/17/2017	NB2	NB2M-059	ML17325B142, ML17345A154
11/17/2017	NB2	NB2M-060	ML17325B142, ML17345A154
5/3/2018	NB1	NBM-030	ML18134A135, ML18137A207

Based on the most recently approved financial assurance cost estimate for Smith Ranch Highland (NRC, 2017x – ML17192A348), the NRC staff observes that there are currently more than 1500 excursion monitoring wells at the facility. The number of monitoring wells that have been on excursion status during the renewal period is relatively small. The NRC staff observes that almost all of the excursions detected at Smith Ranch Highland have been on the Highland side of the facility. As discussed in Chapter 1 of this SER, the earliest ISR activities were conducted at the Highland portion of the facility. The NRC staff observes that well construction materials and techniques have evolved over time. Cameco has also refined its understanding of the hydrogeologic conditions at Smith Ranch Highland over time. The NRC staff observes

that several excursions were detected in areas with underground mine workings that were related to past conventional mining activities at Smith Ranch Highland.

The licensee has had 89 unplanned release reports in accordance with its WDEQ permit. In accordance with condition 12.1 of license SUA-1548, copies of these reports are provided to NRC. A summary is provided in Table A~~Table A~~-6.

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Table A-6. Unplanned releases and spills, June 2001 through October 2017

Event Date	Volume in Liters (gallons)	Substance Spilled	Location	ADAMS Accession No.
6/18/01	4,164 (1,100)	disposal fluid	Deep Disposal Well #1	ML011800058
10/14/01	13,628 (3,600)	injection fluid	Southwest Quarter of the Southeast Quarter of Section 26,Township 36 North, Range 74 West	ML021360097
10/22/01	236,210 (62,400)	injection fluid	Header House 3-2, Mine Unit 3	ML013180281
12/5/01	13,628 (3,600)	injection fluid	Injection Well Mine Unit 3	ML020240339
1/4/02	6,814 (1,800)	production fluid	Production Well, Mine Unit 3	ML020440033
4/24/02	68,137 (18,000)	injection fluid	Header House, Mine Unit 4	ML021340151
4/25/02	13,249 (3,500)	injection fluid	Header House, Mine Unit 4	ML021340151
1/11/03	5,224 (1,380)	production fluid	Production Well, Mine Unit 3	ML030240361
2/9/03	1,893 (500)	production fluid	Production Well, Mine Unit 3	ML030580466
9/6/03	78,736 (20,800)	injection fluid	Header House, Mine Unit 4	ML032690931
9/29/03	18,927 (5,000)	restoration fluid	Monitor Well , Mine Unit C	ML032801430
10/15/03	18,927 (5,000) 15,141 (4,000) recovered	production fluid	Production Well, Mine Unit 2	ML032930417
10/20/03	10,599 (2,800)	injection fluid	Injection Well, Mine Unit C	ML033140046
12/20/03	2,271 (600)	injection fluid	Header House, Mine Unit F	ML040020057
2/8/04	1,893 to 3,786 (500 to 1,000)	injection fluid	Injection Well, Mine Unit D	ML040650097
2/12/04	1,514 to 2,271 (400 to 600)	injection fluid	Injection Well, Mine Unit 4	ML040580463
5/3/04	3,028 to 3,786 (800 to 1,000)	production fluid	Production Well, Mine Unit 4	ML041410250

7/22/04	10220 to 18,927 (2,700 to 5,000), 757 (200) recovered	production fluid	Production Well, Mine Unit 4	ML042250175
9/6/04	3,786 (1,000)	injection fluid	Mine Unit 2, Header House 2	ML15147A434
9/12/04	6,057 (1,600)	production fluid	Mine Unit F Near Header House F-42	ML042750177
9/29/04	7,570 (2,000) 4,542 (1,200) recovered	injection fluid	Mine Unit I, Satellite No. 2	ML042920181
10/9/04	18,927 (5,000) 9,085 (2,400) recovered	restoration fluid	Mine Unit C	ML042880409
1/10/05	1,136 (300)	injection fluid	Injection/Production Well, Mine Unit F	ML050270211
2/26/05	11,356 (3,000)	production fluid	Header House, Mine Unit F, Satellite No. 3	ML050750402
5/16/05	48,358 (20,700)	injection fluid	Injection Well – Mine Unit H	ML051570328
5/31/05	17,791 (4,700)	injection fluid	Mine Unit I	ML051730118
8/16/05	24,794 (6,550) 20,819 (5,500) recovered	production fluid	Mine Unit 15	ML052450347
8/30/05	3,785 (1,000)	production fluid	Production Well – Mine Unit F	ML053200361
9/2/05	17,034 (4,500)	production fluid	Production Well – Mine Unit 2	ML052720456
12/30/05	3,785 (1,000)	injection fluid	Injection Well – Mine Unit 3	ML060190405
1/9/06	23,621 (6,240)	injection fluid	Header House – Mine Unit 3, Satellite SR- 1	ML060270050
2/10/06	3,785 (1,000)	production fluid	Production Well – Mine Unit 2	ML060970449
10/21/06	26,653 (7,041) 11,734 (3,100) recovered	disposal fluid	Deep Disposal Well, CPP	ML070260691
11/22/06	7,949 (2,100)	disposal fluid	Mine Unit 3	ML070260693
12/5/06	37,854 (10,000) 34,069 (9,000) recovered	mix of monitor well, restoration, and mine unit water	Header House, Mine Unit 3	ML070260687
12/13/06	2,120 (560)	injection fluid	Injection Well, Mine Unit I	ML063630384
1/15/07	20,820 (5,500) 13,249 (3,500) recovered)	injection fluid	Mine Unit F	ML070260689
2/19/07	22,712 (6,000) 20,820 (5,500) recovered	production fluid	Mine Unit 15	ML070710130
5/21/07	2,650 (700)	injection fluid	Mine Unit 15 (Well I-19)	ML071780269

6/19/07	3,180 (840)	production fluid	Mine Unit K, Header House 5	ML071800206
6/22/07	757,404 (198,500) 13,249 (3,500) recovered	injection fluid	Mine Unit H	ML071790052, ML072000208
6/25/07	14,195 (3,750)	production fluid	Mine Unit H	ML072000212
6/28/07	3,407 (900)	injection fluid	Mine Unit 2, well 2-I 166	ML071970069
8/23/07	43,911 (11,600)	disposal fluid	trunk line to deep disposal well	ML072470517, ML072540010
7/18/08	59,268 (15,657) 48,340 (12,770) recovered	production fluid	Booster Station Near Mine Unit 4,	ML082120180
8/17/08	30,151 (7,965) 1,703 (450) recovered	injection fluid	Trunk Line to Header House K-6,	ML082410309
9/17/08	63,496 (16,774) 48,612 (12,842) recovered	injection fluid	Booster House 3, Mine Unit K	ML082760691
10/30/08	20,820 (5,500)	injection fluid	Mine Unit K Injection Trunk Line	ML083090069
12/26/08	3,115 (823) 2,839 (750) recovered	injection fluid	Mine Unit 9	ML090090526
12/29/08	4,331 (1,144)	injection fluid	Mine Unit 9, Well 9I-44	ML090090478
1/9/09	8,211 (2,169) 7,571 (2,000) recovered	production fluid	Mine Unit 15, well 15P-122	ML090280522
1/10/09	6,889 (1,820)	production fluid	Ion Exchange Tank, Valve/Piping on IX-21 in Satellite 2	ML090280521
2/9/09	55,267 (14,600) 14,385 (3,800) recovered	production fluid	Mine Unit 2	ML090570739
4/2/09	5,580 (1,474)	injection fluid	Mine Unit K, Header House K-7, Well KI-218	ML091100157
5/12/09	24,605 (6,500) 21,198 (5,600) recovered	production fluid	Header House J-3	ML091470393
5/26/09	19,116 (5,050)	production fluid	Mine Unit H, Well HI-43	ML091610440
6/10/09	719 (190)	injection fluid	Mine Unit 9, Well 9I-142	ML091820425
8/26/09	5,678 (1,500)	injection fluid	Mine Unit K	ML092520328
9/24/09	342,958 (90,600) 83,279 (22,000) recovered	clean water	Mine Unit E, Header House 1	ML093380230

11/19/09	2,120 (560)	injection fluid	Mine Unit 9, Well 9I-127A	ML093380232
1/29/10	848 (224)	injection fluid	Mine Unit J, JI-184	ML100491912
7/8/10	4,505 (1,190)	restoration fluid	Mine Unit 1, NE NW of section 36, T36N, R74W	ML11215A062
7/8/10	5,451 (1,440)	injection fluid	Mine Unit K, Well KI-006	ML102080110
9/10/10	3,634 (960)	injection fluid	Mine Unit 15, Header House 12	ML102730214
3/10/11	923,640 (244,000)	pump test water	Mine Unit K-North	ML11263A006
5/3/11	5,678 (1,500)	production fluid	Mine Unit 15a, Header House 15-20	ML11272A224
5/19/11	2,990 (790) 757 (200) recovered	production fluid	Mine Unit 9, Bellhole 1 Near SR-2	ML11165A194
7/22/11	201 (53)	injection fluid	Mine Unit 1, Well 1I-179	ML11215A063
12/6/11	6,734 (1,779)	injection fluid	Mine Unit 9, Header House 9-3	ML113470020
2/16/12	36,567 (9,660) 12,492 (3,300) recovered	RO permeate water	Mine Unit C, Restoration Injection Well CI-335	ML12061A005
3/7/12	2,930 (774)	injection fluid	Mine Unit J, Header House 7	ML12079A237
3/9/12	4,550 (1,202) 1,514 (400) recovered	injection fluid	Mine Unit F, Header House F-38, Injection Wells FI-1055 and FI-1056	ML12243A129
3/10/12	1,302 (344)	injection fluid	Mine Unit H, Bellhole 41-H	ML12079A238
10/16/12	189 (50)	injection fluid	Mine Unit 9, Well 9I-209	ML12311A032
10/20/12	379 (100)	production fluid	Mine Unit 3, Booster Station 3	ML12311A031
12/20/12	4,319 (1,141) 946 (250) recovered	production fluid	Mine Unit F,Header House F-2	ML13009A097
2/17/13	397 (105) 189 (50) recovered	injection fluid	Mine Unit F, Bellhole F-42	ML13063A067
5/3/13	321,760 (85,000) 60,567 (16,000) recovered	injection fluid	Mine Unit K South, Header House K-6	ML13141A450
7/31/13	3,967 (1,048) 1,893 (500) recovered	production fluid	Mine Unit F, SW 1/4 and NW 1/4 of Section 22, T36N, R73W	ML13275A039
10/29/13	454 (120)	mineral oil	Morton 1-20 Deep Disposal Well	ML13317B640
12/6/13	3,373 (891) 3,373 (891) recovered	disposal fluid	Vollman 33-27 Deep Disposal Well	ML13352A193

3/16/14	33,751 (8,916)	injection fluid	Mine Unit I, Well II-011	ML14084A307
6/11/14	1,654 (437)	injection fluid	North Butte Mine Unit 2, Header House 2, Well 2I-043	ML14174B097
8/19/14	34,349 (9,074)	injection fluid	Mine Unit K, Header House K-1	ML14245A481
9/8/14	708 (187)	injection fluid	North Butte Mine Unit 1, Well I-201	ML14267A073
10/30/14	57 (15)	injection fluid	Mine Unit 10, Header House 10-7, Well 10I-336	ML14316A436
1/16/15	13,325 (3,520)	injection fluid	Mine Unit 4/4a, Near Well M-403	ML15028A196
5/21/15	1,817 (480)	disposal fluid	Deep Disposal Well 1 Well House	ML15160A016
2/20/16	16,141 (4,264)	production fluid	Mine Unit C from Bellhole C-18 to area beyond Header House C-20	ML16055A217
10/19/2017	2,018 (533)	restoration fluid	Mine Unit 4, header house 4-3	ML17307A038

The NRC staff observes that none of these events met NRC reporting criteria in either 10 CFR 20, Subpart M or 10 CFR 40.60. The NRC staff observes that Cameco has corrected the causes of the unplanned releases and has documented the locations of the releases for further evaluation during decommissioning.

Since the last renewal of license SUA-1548, Cameco has reported 9 leaks in the storage ponds adjacent to the Smith Ranch CPP, as shown in Table A-7.

Table A-7. Pond leaks August 2001 through November 2011

Date of Leak	ADAMS Accession No.	Location
8/5/01	ML012540097	East and West evaporation pond
1/4/02	ML020570087	East and West evaporation pond
10/21/05	ML053390125	East evaporation pond
12/3/08	ML090140410	East evaporation pond
4/22/09	ML091270124	East evaporation pond
7/20/10	ML102090277	East evaporation pond

6/13/11	ML11222A039	East evaporation pond
8/15/2011	ML11285A038	East evaporation pond
11/4/2011	ML113120006	East evaporation pond

The NRC staff observes that Cameco's pond inspection program is capable of detecting pond leaks. The NRC staff also observes that Cameco has corrected the pond leaks. Cameco replaced the liner system for the east and west evaporation ponds in 2014.

During the renewal period, Cameco was under Administrative Order on Consent (AOC) Docket 3211-00 with the Wyoming Department of Environmental Quality. The AOC was originally dated August 9, 2000. The AOC related to an increased number of failed mechanical integrity tests (MIT) in Mine Units C, E, and F at Smith Ranch Highland. Cameco's field investigation identified potential contamination from MIT failures in the overlying aquifers between the ore zone and the surface. Cameco provided a series of progress reports on this issue to the NRC staff. By letter dated September 2, 2015, WDEQ determined that all of the conditions and requirements contained in the AOC had been addressed (WDEQ, 2015b). The NRC staff understands that Cameco is progressing with its corrective actions in Mine Units C, E, and F. The NRC staff continues to follow progress on this issue during inspections of the facility (reference inspection reports). The NRC staff observes that wells located in Mine Units C, E, and F were primarily constructed using glue and screw joints. This construction method was subsequently found to be problematic, as evidenced by the observed MIT failure rate in Table 1-6 of Cameco's Smith Ranch Renewal Technical Report (Cameco, 2012b). Within Mine Units C, E, and F, Cameco has installed replacement wells to address the issue. The NRC staff observes that the more recent mine units constructed at Smith Ranch Highland use spline joints. Cameco's observed MIT failure rate in subsequent mine units indicates the issue has been addressed.

The NRC staff's review of the semiannual report identified one issue with the purge storage reservoir 2 (PSR2). PSR2 is located near satellite 2 and is used to hold water prior to discharge via land application. PSR2 was approved for use by the staff in 1994 (NRC, 1994). PSR2 has a natural soil liner. In the semiannual monitoring reports, the NRC staff observed that the shallow monitoring wells around PSR2 were showing elevated levels of some constituents, which indicated that fluids may be migrating from PSR2. Cameco has developed a plan to address this issue (Cameco, 2015e). The NRC staff discusses the corrective action plan in SER Section 3.1.3.5.1.

The NRC staff's review of Cameco's excursion history, unplanned release history, or pond leak history did not identify any unreviewed safety-related concerns. The NRC staff considers the AOC to be an operational performance issue that warrants continued attention as it is corrected.

A.5 Radiation-related regulatory exceedences

This section documents the NRC staff's reviews of Cameco's semiannual effluent monitoring reports. These reports contain information such as the quantity of material released to the environment, worker doses, and the results of Cameco's soil, surface water, and groundwater monitoring activities around Smith Ranch. The reports provided since the last renewal of license SUA-1548 are shown in Table A-8.

Table A-8. Semiannual Effluent Reports, 2001 through 2017

Report Period	Reference	Report Period	Reference
1st Half 2001	Rio Algom 2001a	1st Half 2010	Cameco, 2010c
2nd Half 2001	Rio Algom 2002a	2nd Half 2010	Cameco, 2011a
1st Half 2002	PRI, 2002a	1st Half 2011	Cameco, 2011b
2nd Half 2002	PRI, 2003b	2nd Half 2011	Cameco, 2012c
1st Half 2003	PRI, 2003d	1st Half 2012	Cameco, 2012h
2nd Half 2003	PRI, 2004a	2nd Half 2012	Cameco, 2013a
1st Half 2004	PRI, 2004b	1st Half 2013	Cameco, 2013c
2nd Half 2004	PRI, 2005a	2nd Half 2013	Cameco, 2014a
1st Half 2005	PRI, 2005b	1st Half 2014	Cameco, 2014b
2nd Half 2005	PRI, 2006a	2nd Half 2014	Cameco, 2015a
1st Half 2006	PRI, 2006b	1st Half 2015	Cameco, 2015c
2nd Half 2006	PRI, 2007a	2nd Half 2015	Cameco, 2016b
1st Half 2007	PRI, 2007f	1st Half 2016	Cameco, 2016c
2nd Half 2007	Cameco, 2008a	2nd Half 2016	Cameco, 2017a
1st Half 2008	Cameco, 2008c	1st Half 2017	Cameco, 2017c
2nd Half 2008	Cameco, 2009a	2nd Half 2017	Cameco, 2018c
1st Half 2009	Cameco, 2009b		
2nd Half 2009	Cameco, 2010a		

During its review of Cameco's semiannual reports, the NRC staff identified an unreviewed safety-related concern. Specifically, the NRC staff has determined that Cameco's semiannual effluent monitoring reports are not consistent with the requirements of 10 CFR Part 20.1301. This section of the regulations relates to dose limits to members of the public. Specifically, Cameco does not properly consider radon progeny in its dose calculations. This is discussed in more detail in Section 5.7.7 of this SER.

There have been no occupational or public radiation-related regulatory exceedences reported in either semi-annual effluent reports submitted in accordance with 10 CFR 40.65 or the annual ALARA audits. The NRC staff did identify one unreviewed safety-related concern related to consideration of radon progeny in Cameco's public dose calculation. The NRC staff's review and analysis of Cameco's proposed method to address this issue can be found in section 5.7.7.3 of this SER. The NRC staff considers the issue at PSR2 to be an operational performance issue. The NRC staff will review Cameco's plan to address the issue.

A.6 Exceedences of non-radiation contaminant exposure or release limits

The NRC staff has not identified any instances of exceedences of a non-radiation contaminant or release limit.

A.7 Site characterization and land use

Section 2 of the Smith Ranch Renewal Technical Report contains site characterization information important to the evaluation of exposure pathways and doses, including site location

and layout; uses of adjacent lands and waters; population distributions; meteorology; the geologic and hydrologic setting; ecology; and background radiological characteristics. The NRC staff's review of this information is documented in Section 2 of this SER.

A.8 Summary

On the basis of this review, the NRC staff concludes that the Smith Ranch Highland Uranium Project (SHRUP) has been operated so as to protect health and safety and the environment. During its review, the NRC staff has identified one safety-related concern. The concern relates to how Cameco is accounting for radon in its public dose calculation for SRHUP. The NRC staff's review and analysis of how Cameco will comply with this regulation going forward can be found in Section 5.7.7 of this SER. In addition to the safety-related concern, the NRC staff has identified several performance issues related to the casing leak investigation, and PSR2.

Outside of the unreviewed safety-related concern, the NRC staff did not identify any other historical aspects of operations that would necessitate closer evaluation. Therefore, the NRC staff has determined that only those aspects of the Smith Ranch Renewal Technical Report (Cameco 2012b) that represent changes from previous descriptions reviewed and approved by the NRC staff should be reviewed in more detail. For aspects of Smith Ranch Highland that have not changed since the last renewal or amendment, the NRC staff will rely on its past review and approval.

Appendix B. Administrative Changes to License Conditions, Source Material License SUA-1548, Smith Ranch Highland Uranium Project

B.1 Introduction

The purpose of this Appendix is to describe the NRC staff's evaluation of administrative changes to certain license conditions in Source Material License SUA-1548 for the Smith Ranch Highland Uranium Project. The NRC staff will revise license conditions in Source Material License SUA-1548 after completing its safety evaluation of Cameco's February 1, 2012, license renewal request (Cameco, 2012b). The proposed license renewal application would allow uranium recovery operations to continue for an additional 10 years at all locations authorized by NRC License SUA-1548.

During the course of its review, the NRC staff has identified two groups of new or modified license conditions that are addressed in this SER. The first group includes license conditions, new or modified, which relate directly to the NRC staff's evaluation of the license renewal request. Some of these modifications were requested by the licensee (Cameco 2012), while others were identified during the NRC staff's review. The changes to license conditions in this first group, are described in the body of this SER.

During the course of the review of the license renewal application, both the NRC staff and the licensee identified several license conditions that have been fulfilled or overcome by events. Therefore, there is no need to include them in the renewed version of License SUA-1548. Documentation of the the NRC staff's rationale for removing these license conditions is provided in Section B.2 below. These are all administrative changes.

B.2 Evaluation of License Condition Changes

Note: In the revised license conditions in this Appendix, new text is printed in *underlined italics* and text being removed is struck out.

License Condition 1

License condition 1 contains the name of the licensee. The NRC staff is modifying this condition so that it is consistent with the licensee's NRC Form 313, dated January 27, 2012 that was submitted with this license renewal request.

1.0 Power Resources, Inc. *dba Cameco Resources*

License Condition 2

This license condition contains the licensee's mailing address. The licensee has closed its office in Cheyenne, Wyoming. Therefore, the condition has been changed to reflect the licensee's new mailing address.

2.0 Cameco Resources
P.O. Box 1210
Glenrock, WY 82637

License Condition 4

This condition contains the expiration date of the license. The licensee has requested a 10 year renewal. The expiration date will be changed to 10 years from issuance of the renewed license.

License condition 9.1

License condition 9.1 identifies the authorized places of use for license SUA-1548. To clarify and simplify this condition, the NRC staff pointed to specific figures from the license renewal application.

9.1 The authorized place of use shall be the licensee's Smith Ranch-Highland Uranium Project (SR-HUP), *as shown in the approved license application, Figure 1.2 (Smith Ranch-Highland-Reynolds areas) (ML12163A065), Figure 1.10 (North Butte Remote Satellite) (ML12163A073), Figures 1.11 and 1.12 (Gas Hills Remote Satellite) (ML12163A075 and ML12163A076), and Figure 1.13 (Ruth Remote Satellite) (ML12163A077).*~~which is the primary processing facility located in Converse County, Wyoming; Highland In-situ Leach (ISL) Satellite facility located in Converse County, Wyoming; Ruth ISL Satellite facility located in Johnson County, Wyoming; North Butte ISL Satellite facility located in Campbell County, Wyoming; Gas Hills ISL Satellite facility located in Fremont and Natrona Counties, Wyoming; and Reynolds Ranch Satellite ISL facility located in Converse County, Wyoming. As satellite facilities, operations at the Highland, Ruth, North Butte, Gas Hills, and Reynolds Ranch facilities shall be limited to shipments of loaded ion exchange (ix) resin or yellowcake slurry which will be transported to the central processing plant at Smith Ranch, as further explained in the commitments, representations, and statements listed in License Condition 9.3.~~

License condition 9.2

License condition 9.2 contains the mailing address for document submissions made to the NRC. This condition has been updated to reflect the correct mailing address for the NRC staff.

9.2 All written notices and reports to NRC required under this license shall be addressed to: ATTN: Document Control Desk, Director, Office of Nuclear Material Safety and Safeguards, U. S. Nuclear Regulatory Commission, Washington, DC 20555-0001. An additional copy shall be submitted to: Deputy Director, Division of Decommissioning, Uranium Recovery, and Waste Programs, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Mailstop *T5A10*~~T8 F5~~, 11545 Rockville Pike, Two White Flint North, Rockville, MD 20852-2738.

License condition 9.6

License condition 9.6 requires the licensee to maintain an agreement for disposal of solid 11e.(2) byproduct material. The NRC staff improved the clarity of the condition by removing redundant mention of the satellite facilities (i.e., the Smith Ranch Highland Uranium Project is already inclusive of the Smith Ranch-Highland-Reynolds Ranch contiguous area and the remote satellites at Ruth, North Butte, and Gas Hills). Also, the clarity of the last sentence is improved by substituting the word "shall" for "will."

9.6 The licensee shall dispose of 11e.(2) byproduct material from the Smith Ranch-Highland Uranium Project~~, Ruth, North Butte, Gas Hills Project, and Reynolds~~

~~Ranch ISL facilities~~ at a site licensed by NRC or an NRC Agreement State to receive 11e.(2) byproduct material. The licensee's approved waste disposal agreement must be maintained on-site. In the event the agreement expires or is terminated, the licensee shall notify NRC in writing, in accordance with License Condition 9.2, within 7 days after the date of expiration or termination. A new agreement shall be submitted for NRC approval within 90 days after expiration or termination unless further delay is justified and approved, or the licensee ~~will~~*shall* be prohibited from further lixiviant injection.

License condition 9.9

License condition 9.9 contains requirements for protection of historic properties. The clarity of the two sentences is improved by substituting the word "shall" for "will." Additionally, the list of eligible sites have been updated to reflect those currently eligible.

9.9 Before engaging in any developmental activity not previously assessed by the NRC, the licensee shall administer a cultural resource inventory. All disturbances associated with the proposed development ~~will~~*shall* be completed in compliance with the National Historic Preservation Act (as amended) and its implementing regulations (36 CFR 800), and the Archaeological Resources Protection Act (as amended) and its implementing regulations (43 CFR 7).

In order to ensure that no unapproved disturbance of cultural resources occurs, any work resulting in the discovery of previously unknown cultural artifacts shall cease. The artifacts shall be inventoried and evaluated in accordance with 36 CFR Part 800, and no disturbance of the area shall occur until the licensee has received authorization from the NRC to proceed.

Before engaging in any development activity in T35N, R74W that would physically disrupt or disturb *an* inventoried cultural site~~s~~ that ha*s*~~ve~~ been designated eligible for the National Register of Historic Places *(NRHP)*, the licensee shall propose mitigation measures, for NRC review and approval, which ~~will~~*shall* preserve the integrity of the~~se~~ site~~s~~, as defined by the Advisory Council on Historic Preservation *(ACHP)*. These include *the* inventoried site ~~48CO352, 48CO1288, 48CO1289. 48CO1291, 40CO2462, 48CO2463, and 48CO2464~~.

Before engaging in developmental activity in T44N, R75W and T44N, R76W that would physically disrupt or disturb an inventoried cultural site that has been designated eligible for the NRHP, the licensee shall propose mitigation measures, for NRC review and approval, which shall preserve the integrity of the site, as defined by the ACHP. These include the inventoried sites 48CA268, 48CA383, 48CA408, 48CA409, 48CA425, 48CA6418, 48CA6419, and 48CA6420.

~~In order to ensure that no unapproved disturbance of cultural resources occurs, any work resulting in the discovery of previously unknown cultural artifacts shall cease. The artifacts shall be inventoried and evaluated in accordance with 36 CFR Part 800, and no disturbance of the area shall occur until the licensee has received authorization from the NRC to proceed.~~

For the Gas Hills Project, the licensee shall comply with the stipulations for cultural resource protection in the Programmatic Agreement provided in the NRC letter to the

Advisory Council on Historic Preservation, dated December 16, 2003 *and amended on May 25, 2012*.

~~For the Reynolds Ranch Project, prior to any developmental activity conducted in the following list of Sections, the licensee shall administer a cultural resource inventory in any area of the Section not previously inventoried: T36N R73W Sec 5, Sec 7, Sec 17, and Sec 18; T36N R74W Sec 11, Sec 12, Sec 13, and Sec 14; and T37N, R73W Sec 30.~~

License condition 9.11

License condition 9.11 requires the licensee to submit a decommissioning plan 12 months before starting decommissioning of an area. License condition 9.11 refers to a "Final (detailed) decommissioning plan." The NRC staff did not intend any difference between this document and the decommissioning plan referred to in 10 CFR 40.42(g)(1). Also, as written, the condition may be construed to mean a final (detailed) decommissioning plan is required for each mine unit or processing facility. However, the NRC staff's intent was to allow a decommissioning plan to be submitted for any portion of the licensed area. Therefore, the NRC staff revised license condition 9.11 to state:

9.11 ~~Final (detailed)~~ *A* decommissioning plan~~(s)~~ for *any portion of* land *areas, equipment, and structures shall* ~~(soil) or facilities will~~ be submitted to the NRC for review and approval at least 12 months before the planned commencement of decommissioning ~~of a wellfield or a processing facility~~.

License conditions 10.1.1 and 10.4.1

License conditions 10.1.1 and 10.4.1 include flow rate limits on facilities in the Smith Ranch-Highland and Reynolds Ranch areas, respectively. Because these are contiguous areas, the NRC staff improved the clarity of the license by combining the separate flow rate limits for Smith Ranch-Highland and Reynolds Ranch into a revised license condition 10.1.1. The clarity of this condition is also improved by explicitly stating the facilities that are included in the flow rate limit.

10.1.1 ~~Commercial processing plant operations for SR-HUP central processing plant and satellite facilities,~~ *The combined average monthly flow rate at the Smith Ranch and Highland processing plants and Satellite #1, Satellite #2, Satellite #3, SR1 Satellite, and SR2 Satellite,* shall not exceed ~~an average monthly flow rates of~~ 20,000 gallons per minute, exclusive of restoration flow. *The average monthly flow rate at the Reynolds Ranch Satellite shall not exceed 6,000 gallons per minute, exclusive of restoration flow.* Annual yellowcake production *at the Smith Ranch and Highland processing plants* shall not exceed 5.5 million pounds as U_3O_8.

License condition 10.1.5

License condition 10.1.5 requires NRC review and approval of new satellites and evaporation ponds. The first sentence is modified slightly to clarify that the condition applies to storage or evaporation ponds and that site characterization data should be included with the design. The clarity of the last sentence is improved by clarifying that Regulatory Guide 3.11 does not contain requirements.

10.1.5 The licensee is prohibited from constructing new satellites or ~~waste water evaporation~~ ponds *(either storage or evaporation)* prior to NRC review and approval of designs *(including site characterization)* and specifications. Pond design and operation shall allow for sufficient reserve capacity in the evaporation pond system to enable the transfer of the contents of any one pond to the other ponds. All retention ponds shall be designed to ~~meet requirements~~ *conform to regulatory positions* of NRC Regulatory Guide 3.11.

License condition 10.1.10

License condition 10.1.10 required that Cameco perform additional testing of aquifer characteristics in the southwestern part of the Smith Ranch Highland license area. PRI submitted a regional scale pump test for the southwest area in 2007 (PRI 2007b). The NRC staff reviewed and approved PRI's submittal (NRC 2007b). As the aquifer characteristics in the southwestern area of the Smith Ranch Highland license area have been reviewed and approved by the NRC, this condition is no longer needed in License SUA-1548 and has not been carried forward to the renewed license.

License condition 10.1.12

License Condition 10.1.12 relates to the processing of third party ion exchange resins at Smith Ranch Highland. In 2008, PRI requested the ability to process uranium laden ion exchange resins from other uranium recovery facilities (Cameco 2008b). The NRC staff reviewed and approved PRI's request and included condition 10.1.12 in the license. Subsequently, the NRC staff issued Regulatory Issue Summary 2012-06 (NRC 2012b). This RIS provided guidance on the NRC staff's 'equivalent feed' policy at NRC licensed uranium recovery facilities. Briefly, the NRC staff's 'equivalent feed' policy allows uranium recovery facilities to process uranium laden ion exchange resins without obtaining a license amendment when the resin is physically and chemically the same as what is currently processed, would be processed on existing equipment, does not exceed the licensee's uranium production limit, and stays within the facility's environmental and safety review envelope. As long as PRI meets these requirements, it can process ion exchange resins from other facilities. License condition 10.1.12 has been overcome by the NRC staff's equivalent feed guidance in RIS 2012-06 and has not been carried forward to the renewed version of license SUA-1548.

License condition 11.1

License condition 11.1 requires the licensee to provide information in its semi-annual effluent and environmental report. The clarity of the requirement is improved by substituting the word "shall" for "will."

11.1 The effluent and environmental monitoring report shall include injection rates, recovery rates, and injection trunk-line pressures for each satellite facility. This data ~~will~~*shall* be provided as monthly averages for the reporting period.

(Deleted) License condition 11.2

License condition 11.2 requires the licensee to document corrective actions in its annual ALARA audit report resulting from investigation of positive bioassay indications in urine samples above 15 micrograms per liter (µg/L) uranium. However, this requirement is redundant because license condition 9.7 requires the licensee to follow the guidance in Regulatory Guide 8.22,

"Bioassay at Uranium Mills," which already requires licensee investigation above the 15 µg/L limit. Therefore, license condition 11.2 is deleted.

(Deleted) License Condition 11.3

License condition 11.3 requires the licensee to provide to NRC within 30 days documentation of corrective actions performed following positive bioassay indications in urine samples equal to or above 35 µg/L uranium for two consecutive samples, or equal to or above 130 µg/L in any one sample. However, this requirement is redundant because license condition 9.7 requires the licensee to follow the guidance in Regulatory Guide 8.22, "Bioassay at Uranium Mills," which already requires licensee investigation above the 35 µg/L and 130 µg/L limits, and reporting to NRC in accordance with 10 CFR 20.2202, "Notification of incidents," and 10 CFR 20.2203, "Reports of exposure, radiation levels, and concentrations of radioactive material exceeding the constraints or limits." Therefore, license condition 11.3 is deleted.

License condition 11.2

License condition 11.2 requires daily visual inspections of ponds. The clarity of the requirement is improved by substituting the word "shall" for "will" in the third sentence. Additionally, as discussed in the SER, the portions of the condition pertaining to the radium settling basins have been removed as they are no longer used to hold liquid byproduct material.

11.2 *The Satellite 1 and Satellite 2 purge storage reservoirs shall have at least 4 feet of freeboard.*

The licensee shall perform and document daily visual inspections of the Smith Ranch, *North Butte, and Gas Hills (once constructed) storage or* evaporation pond embankments, fences and liners, as well as measurements of pond freeboard and checks of the leak detection system. Any time 6 inches or more of fluid is in the leak detection system standpipes, it shall be analyzed for specific conductance and chloride. If, with a second sample, those parameters confirm pond leak, then appropriate actions ~~will~~*shall* be taken as described in the approved license application. The pond level shall be lowered by transferring its contents into an alternate cell or to the plant for disposal through deep well injection, and repairs shall be undertaken.

(Deleted) License condition 11.6

License condition 11.6 requires the licensee to establish a program in accordance with its commitments in a section of a prior license application. This requirement is redundant because license condition 9.3 already requires the licensee to conduct operations in accordance with commitments, representations, and statements contained in the current license application and its supplements. Therefore, license condition 11.6 is deleted.

(Deleted) License condition 11.7

License condition 11.7 requires the licensee to perform daily walk-through inspections with qualified radiation safety staff. This requirement is redundant because license condition 9.3 already requires the licensee to conduct operations in accordance with commitments, representations, and statements contained in the current license application and its

supplements. The daily walk-through inspections were addressed by the licensee in its renewal application. Therefore, license condition 11.7 is deleted.

License condition 12.2

License condition 12.2 requires the licensee to submit an annual report to NRC. The contents of this report are addressed in acceptance criteria 5.2.3(13) of NUREG-1569. Therefore, the NRC staff revised this condition to clarify the requirements for this report.

12.2 ~~An annual report will be submitted to the NRC that includes one of the semiannual effluent and environmental monitoring reports, and the SERP information required under LC 9.4(d).~~ *The annual SERP information required under LC 9.4(d) shall be submitted in the semiannual effluent and environmental report due within 60 days after January 1 of each year, in accordance with 10 CFR 40.65(a)(1). This report shall also include the As Low As Is Reasonably Achievable (ALARA) annual audit report and annual demonstration of compliance with the public dose limits in 10 CFR 20.1301.*

SUBJECT: SAFETY EVALUATION REPORT LICENSE RENEWAL FOR THE SMITH RANCH HIGHLAND URANIUM PROJECT IN VARIOUS COUNTIES IN WYOMING **DATE September 24, 2018**

ADAMS Accession No.: ML18193A540 ***via email**

OFFICE	NMSS/DUWP	NMSS/DUWP	NMSS/DUWP	OGC	NMSS/DUWP
NAME	DMandeville	SAchten	BVonTill	SClark	AKock
DATE	9/4/18	9/4/18	9/4/18	9/20/18	9/24/18

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