Safety Evaluation Report
for the Strata Energy, Inc.
Ross ISR Project, Crook County, Wyoming,
Materials License No. SUA-1601

Docket No. 040-09091
Strata Energy, Inc.

U.S. Nuclear Regulatory Commission

Office of Federal and State Materials and Environmental Management Programs

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF ACRONYMS AND ABBREVIATIONS

ac	acre
ACL	alternative concentration limit
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
ANSI	American National Standards Institute
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
BAT	best available technology
bgs	below ground surface
BLM	Bureau of Land Management
BPT	best practicable technology
Bq	becquerel
CAP	corrective action program
CEDE	committed effective dose equivalent
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
CO_2	carbon dioxide
cpm	counts per minute
DAC	derived air concentration
DC	dose coefficient
DCF	dose conversion factor
DC_r	dose conversion
DDE	deep dose equivalent
DOT	Department of Transportation
dpm	disintegrations per minute
DQO	data quality objectives
EA	environmental assessment
EHS	Environment, Health, and Safety
EHSM	Environment, Health, and Safety Manager
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ER	environmental report
FONSI	finding of no significant impact
FR	*Federal Register*
ft	feet
ft/d	feet per day
ft/s	feet per second
g/cm^3	grams per cubic centimeter
GEIS	Generic Environmental Impact Statement
gpd/ft	gallons per day per foot
gpm	gallons per minute
GPS	Global Positioning System
ha	hectare

List of Acronyms and Abbreviations (continued)

HPIC	high-pressure ionization chamber
HPT	health physics technician
HV	high velocity
HVAC	heating, ventilation, and air conditioning systems
IBC	International Building Code
ICRP	International Commission on Radiological Protection
in	inch
ISR	in situ recovery
IX	ion exchange
JFD	joint frequency distribution
kg	kilogram
km	kilometer
km^2	square kilometers
L	liter
lb	pound
lb/ft^3	pound per cubic foot
LLD	lower limit of detection
Lpm	liters per minute
m	meter
m^2	square meter
m^2/d	square meter per day
m^3	cubic meter
m^3/h	cubic meter per hour
m^3/s	cubic meter per second
m/s	meter per second
ma	million years ago
man-Sv	man-sievert
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum contaminant level
MDC	minimum detectable contamination
mg	milligram
mg/L	milligram per liter
mi	mile
mi^2	square miles
MIT	mechanical integrity testing
mm	millimeter
MOU	memorandum of understanding
mR/hr	milliroengtens per hour
mrem	millirem
mrem/yr	millirem per year
mSv	millisievert
NA	not applicable
$NaHCO_3$	sodium bicarbonate
Na_2CO_3	sodium carbonate
NaI	sodium iodide

List of Acronyms and Abbreviations (continued)

NCDC	National Climatic Data Center
NELAC	National Environmental Laboratory Accreditation Conference
NEPA	National Environmental Protection Act
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation
NWS	National Weather Service
OSHA	U.S. Occupational Safety and Health Administration
Pb-210	lead-210
pCi/L	picocuries per liter
person-rem/yr	person-rem per year
Po-210	polonium-210
PM_{10}	particulate matter less than ten micrometers
PPE	personal protective equipment
ppm	parts per million
psi	pounds per square inch
PV	pore volumes
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
R&D	research and development
Ra-226	radium-226
Ra-228	radium-228
RAI	request for additional information
rem	roentgen equivalent man
RG	regulatory guide
Rn-222	radon-222
RO	reverse osmosis
RWP	radiation work permit
SEIS	Supplemental Environmental Impact Statement
SER	safety evaluation report
SERP	Safety and Environmental Review Panel
SPT	standard penetration tests
SHPO	State Historic Preservation Office
SOP	standard operating procedure
Sv	sievert
Sv/Bq	sievert per becquerel
TAC	technical assignment control
TEDE	total effective dose equivalent
TER	technical evaluation report
Th-230	thorium-230
TLD	thermoluminescent dosimeter
TG	Technical Guide
TR	technical report
TWA	time-weighted average

List of Acronyms and Abbreviations (continued)

UBC	Uniform Building Code
UCL	upper control limit
UIC	Underground Injection Control
µg	microgram
U-nat	natural uranium
U_3O_8	uranium oxide
UO_2	uranium dioxide
UO_3	uranium trioxide
$UO_2(CO_3)_2^{2-}$	uranyl dicarbonate
$UO_2(CO_3)_3^{4-}$	uranyl tricarbonate
UPS	uninterruptible power supply
U.S.	United States
USGS	United States Geological Survey
WDEQ	Wyoming Department of Environmental Quality
WQD	Water Quality Division
WY	Wyoming

INTRODUCTION

On January 4, 2011, Strata Energy, Inc. (hereinafter "Strata" or "the applicant") submitted to the U.S. Nuclear Regulatory Commission (NRC) a license application to construct and operate the Ross Project, which is a proposed uranium *in situ* recovery (ISR) facility located in Oshoto, Crook County, Wyoming (Strata, 2011a). The application consists of a technical report and an environmental report, as amended with supplemental information (Strata, 2011a;b;c;2012a;b;d).

The Atomic Energy Act of 1954, as amended (AEA or "the Act"), authorizes the NRC to issue licenses, either as a general or specific license, to qualified applicants for the receipt, possession and use of byproduct and source materials resulting from the removal of uranium ore from its place of deposit in nature. An NRC specific license is issued to a commercial uranium or thorium ISR facility pursuant to NRC implementing regulations listed in Title 10 of the Code of Federal Regulations (10 CFR) Part 40. In accordance with 10 CFR 40.32, "General Requirements for Issuance of Specific Licenses", the NRC is required to make the following safety findings when issuing a license for an ISR operation:

- The application is for a purpose authorized by the Atomic Energy Act;
- The applicant 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 applicant's proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property; and
- 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 safety evaluation report (SER) documents NRC staff's analyses of the Ross Project license application technical report, and supplemental information, for compliance with requirements listed above, and with applicable requirements and objectives set forth in 10 CFR Part 20 (Standards for Protection Against Radiation), 10 CFR Part 40 (Domestic Licensing of Source Material), and 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). Staff performed its safety review using review procedures and acceptance criteria in NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications" (NRC, 2003). All references to the application in this SER are to the technical report exclusive of the environmental report unless stated otherwise.

Because the issuance of a license is a major federal action, NRC is obligated to address environmental impacts of the proposed action in accordance with the National Environmental Policy Act (NEPA). NRC implementing regulations meeting requirements of NEPA are listed in 10 CFR Part 51. A Supplemental Environmental Impact Statement (SEIS) to the *Generic Environmental Impact Statement (GEIS) for in situ Leach Milling Facilities* (NRC, 2009a) is being prepared in parallel with this SER to address the environmental impacts of the proposed action in accordance with requirements of 10 CFR Part 51.

Staff's findings throughout this SER may refer to actions that the applicant will take after license issuance. For those findings, staff determined that the applicant has met the relevant regulatory requirements for license issuance and that the future actions, based on commitments by the applicant in the application or staff-identified facility-specific issues, require license conditions to ensure operations of the facility will be protective of the public health and safety and the environment. The facility-specific license conditions and the section of this SER to which staff identified the need for the license condition are listed in Table I-1. Standard license conditions that the NRC staff applies to all ISR facilities are presented in Appendix A of this SER. The staff issued a first draft license to Strata on November 6, 2012 (NRC, 2012c). By email dated February 28, 2013, Strata agreed to the license conditions in the fourth draft version (Strata, 2013b). The license conditions listed in this SER are from the fourth draft license.

Table I-1: Facility Specific License Conditions

SER Section	LC	License Condition (LC)
2.3.4	10.12	Prior to conducting tests for a wellfield data package, the licensee will attempt to locate and abandon all historic drill holes located within the perimeter well ring for the Wellfield. The licensee will document such efforts to identify and properly abandon all drill holes in the wellfield data package.
3.1.4	10.14	Facility and Wellfield Inspection. Injection manifold pressures and flow rates shall be measured and recorded daily by the in-line computer system and/or Wellfield Operator. During wellfield operations, injection pressures shall not exceed the maximum operating pressure as specified in Section 3.1.4 of the approved license application. To the extent possible, the weekly inspections shall include visual inspections and document leaks or other abnormalities in the wellfield piping, wellheads, or module buildings in accordance with Section 5.3.3 of the approved license application. The licensee shall conduct the weekly in-plant inspection and audit programs described in Section 5.3.1 of the approved license application. In addition, as described in Section 5.7 of the approved license application and supplements, the RSO shall document that radiation control practices are being implemented appropriately. Requirements for inspections of the on-site retention ponds are listed in LC 10.8.
3.1.4	12.11	Prior to the preoperational inspection, the licensee will provide to the NRC written standard operational procedures (SOPs) required for LC 10.4, which will include information to meet the following specific-site conditions: A) Development and sampling of low-yielding monitoring wells. B) Inspection procedures for the CPP dewatering

SER Section	LC	License Condition (LC)
		system. C) A CPP effluent and environmental monitoring program (if not incorporated into the groundwater detection monitoring program required by LC 10.20). D) An emergency response program that includes hazard assessment of all chemicals used at the facility including an accident analysis for those chemicals. E) Transportation of licensed material outside of the License area.
4.1.4	10.21	Emission Controls (Dryer). The licensee shall maintain effluent control systems as specified in Sections 3.3.1, 4.1, and 5.7.1 of the approved license application, with the following exception: If any of the yellowcake emission control equipment fails to operate within specifications set forth in the standard operating procedures, the drying and packaging room shall immediately be closed-in as an airborne radiation area and heating operations shall be switched to cooldown, or packaging operations shall be temporarily suspended. Packaging operations shall not be resumed until the vacuum system is operational to draw air into the system. All these cessations, corrective actions, and restarts must be reported to NRC Region IV Office, as indicated in Criterion 8A, in writing, within ten days of the subsequent restart.
4.2.4	10.11	The licensee is prohibited from using Pond 2 for the retention of byproduct material until NRC review and verification that the field operations of the CPP dewatering system is consistent with its design as described in TR Addendum 3.1-A of the approved license application.
5.5.4	10.18	The licensee shall ensure radiation safety training is consistent with Regulatory Guides 8.13, "Instruction Concerning Prenatal Radiation Exposure," (as revised) and 8.29, “Instruction Concerning Risks from Occupational Radiation Exposure," (as revised) in addition to the requirements in Section 2.5 of Regulatory Guide 8.31 (as revised), as described in Section 5.5 of the approved application, or NRC-approved equivalent.
5.7.2.4	10.15	The licensee will use calibrated radiation instruments that can

SER Section	LC	License Condition (LC)
		measure the full range of radiation exposure rates or dose rates for radiological parameters that are reasonably expected at an ISR facility to ensure the magnitude and extent of radiation levels are measured in accordance with 10 CFR 20.1501(a)(2)(i). The instruments used to measure airborne concentrations of radioactive materials will allow for a lower limit of detection (LLD), as described in Regulatory Guide 8.30 (as revised), to provide a 95 percent confidence that measurements are in conformance with 10 CFR 20.1201, 20.1204, 20.1301, 20.1501, and 20.1502.
5.7.2.4	10.17	Any area with exposure rates that exceed 2 millirem in any one hour must be immediately treated as a restricted area in accordance with 10 CFR 20.1301(a)(2).
5.7.3.4	10.16	The licensee shall conduct radiological characterization of airborne samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 for each restricted area air particulate sampling location at a frequency of once every 6 months for the first two years, and annually thereafter to ensure compliance with 10 CFR 20.1204(g). The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required for compliance with 10 CFR 20.1204(g).
5.7.4.4	12.9	Prior to the preoperational inspection, the licensee shall submit to the NRC staff, for review and verification, procedures by which it will ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C.
5.7.6.4	12.8	Prior to the preoperational inspection, the licensee shall develop a survey program that will meet the requirements of 10 CFR Part 20, Subpart F to detect beta-gamma contamination on personnel exiting restricted areas and to detect beta-gamma contamination in unrestricted and restricted areas. The licensee shall provide, for NRC staff review and approval, the surface contamination detection capability (scan MDC) of the radiation survey meters used in surveys for releasing equipment and materials to unrestricted use or personnel contamination. In the scanning mode, the detection capability for any expected alpha and beta radiation shall be provided in terms of dpm per 100 cm^2.

SER Section	LC	License Condition (LC)
5.7.7.4	12.7	Prior to the preoperational inspection, the licensee shall provide the following information in its airborne effluent and environmental monitoring program: A) Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring. B) Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2. C) Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire License Area from licensed operations will be accounted for, and verified by, surveys and/or monitoring.
5.7.8.4	10.13	Wellfield Package. Prior to conducting principal activities in a new wellfield, the licensee shall submit a hydrologic test data package (wellfield package) to the NRC. The initial wellfield package will be submitted for NRC staff review and verification. Each wellfield package shall be submitted at least 60 days prior to the planned start date of lixiviant injection. In each wellfield data package, the licensee will document that: (1) all perimeter monitoring wells are screened in the appropriate horizon in order to provide timely detection of an excursion; and (2), the baseline values to establish groundwater protection standards and UCLs for the Wellfield in accordance with LC 11.3. The wellfield package will adequately define heterogeneities that may affect the chemical signature and groundwater flow paths within the ore zone as described in Sections 2.7.3.2.3, 3.1.1 and 5.7.8.1 of the approved license application.
5.7.8.4	10.19	The licensee shall confine its operations to wellfields located north of Little Missouri River within the area delineated as “Mine Unit 1” on Figure 3.1-1 of the approved license application until use of the three industrial wells, designated as “19XX18”, “22x-19” and “789V” in the approved license application, as water supply sources for the oil field flooding operations have ceased or diminished to an acceptable level, which has been reviewed and verified by NRC staff. For wellfields south of the Little Missouri River, the licensee must demonstrate in the wellfield package that the proposed operations are outside of the area of influence of the industrial wells. The location of a wellfield or a portion of a wellfield shall

SER Section	LC	License Condition (LC)
		not include any of the industrial wells if the well has not been properly abandoned. If the licensee's principal activities are being conducted at a wellfield on the Ross Project and operations of the onsite industrial water supply wells have not been discontinued, the effluent monitoring program will include monthly sampling of water pumped from the industrial wells.
5.7.8.4	10.20	The licensee shall conduct a groundwater detection monitoring program for the retention ponds that meets requirements of Criteria 5 and 7A of 10 CFR Part 40, Appendix A. The elements in this program will be documented in the licensee's SOPs.
5.7.8.4	12.12	Prior to construction of the retention ponds, the licensee shall submit, for NRC review and verification, a groundwater detection monitoring program plan for the retention ponds that meets requirements of Criteria 5 and 7A of 10 CFR Part 40, Appendix A. The plan will include specificity of elements discussed in Section 5.7.8.2 (Operational Monitoring-CPP Area) of the approved license application (e.g., monitoring dewatering effluent quality and water level, and water quality monitoring of monitoring wells along the containment barrier wall).
5.7.9.4	12.10	At least 60 days prior to the preoperational inspection, the licensee will submit a completed Quality Assurance Plan (QAP) for NRC staff review and verification. The QAP will include the requirements in 10 CFR 20.1703(c)(4)(vii), and be consistent with guidance for a Quality Assurance Project Plan (QAPP) in Regulatory Guide 4.15 (as revised). The portion of the QAP fulfilling requirements of 10 CFR 20.1703(c)(4)(vii) may be included as a section or attachment in the applicable SOP(s).
6.1.4	10.10	The licensee shall submit to NRC staff for review and approval plans for equipment and procedures prior to the use, storage, handling and transport of biological or chemical materials for reductant injections during restoration.

The NRC staff finds that the application for the Ross Project material license complies with the standards and requirements of the Act and the Commission's regulations, and based on its review as documented in this SER, staff concludes that the proposed facility meets applicable requirements for a license issuance in 10 CFR Parts 20 and 40. More specifically, the staff finds that Strata is qualified by reason of training and experience to use source material for its

requested purpose, and that Strata's proposed equipment and procedures at its Ross Project facility are adequate to protect public health and minimize danger to life or property in accordance with 10 CFR 40.32(b)-(c). Therefore, pursuant to 10 CFR 40.32(d), the staff finds that issuance of a license to Strata for the Ross Project will not be inimical to the common defense and security or to the health and safety of the public.

References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, "Standards for Protection against Radiation," U.S. Government Printing Office, Washington, DC.

10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40, "Domestic Licensing of Source Material," U.S. Government Printing Office, Washington, DC.

10 CFR Part 40, Appendix A. *Code of Federal Regulations*, Title 10, *Energy*, 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 ," U.S. Government Printing Office, Washington, DC.

Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2011 et seq.

NRC, 2003. NUREG-1569, "Standard Review Plan for In-Situ Leach Uranium Extraction License Applications—Final Report", Washington, DC., June 2003.

NRC, 2009a. NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities", Washington, DC., May 2009.

NRC, 2012c. Letter to Ralph Knode (Strata Energy, Inc.) "Draft Materials License, Strata Energy Inc., Ross Project, Oshoto, Crook County, Wyoming, (TAC NO. J00649)", Docket No. 040-09091, ADAMS Accession No. ML12297A097, November 2012.

Strata, 2011a. Ross ISR Project USNRC License Application, Crook County, Wyoming, prepared by Strata Energy, Inc., Docket No. 040-09091. ADAMS Accession No. ML110120063, January 2011.

Strata, 2011b. Submittal of Revised Figures, Addendum 2.9-D and Addendum 3.6-B for the Ross ISR Project USNRC License Application, Crook County, Wyoming, prepared by Strata Energy, Inc, Docket No. 040-09091. ADAMS Accession No. ML110800187, February 2011.

Strata, 2011c. Submittal of Revised Addendum 3.8 for the Ross ISR Project USNRC License Application Environmental Report, Crook County, Wyoming, prepared by Strata Energy, Inc, Docket No. 040-09091. ADAMS Accession No. ML113050501, September 2011.

Strata, 2012a. Responses to the Request for Additional Information (RAI) for the Ross ISR Project Environmental Review Docket No. 040-09091. ADAMS Accession No. ML121030404, March 2012.

Strata, 2012b. Responses to the Request for Additional Information (RAI) for the Ross ISR Project Technical Review, Docket No. 040-09091. ADAMS Accession No. ML121020343, April 2012.

Strata, 2012d. Letter to John Saxton (NRC) from Ben Schiffer (WWC) to clarify TR RAI 23(f) Response, Docket No. 040-09091. ADAMS Accession No. ML12227A369, August 2012.

Strata, 2013b. Email to John Saxton (NRC) from Ben Schiffer (WWC (Strata)) agreeing with license conditions as provided in the fourth draft license, Docket No. 040-09091. ADAMS Accession No. ML13059A350, February 2013.

1.0 PROPOSED ACTIVITIES

1.1 REGULATORY REQUIREMENTS

General requirements for contents of an application for a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.31, and general requirements for approval of an application and issuance of a license are listed in 10 CFR 40.32. The contents of an application for a license to receive, possess, and use source or byproduct material for uranium milling must: (1) be accompanied by an Environment Report required pursuant of subpart A of 10 CFR Part 51; and (2), include written specifications relating to operations and disposition of byproduct material to achieve requirements and objectives set forth in Appendix A of 10 CFR Part 40. The requirements for approval of an application include: (a) that the application is for a purpose authorized by the AEA, (b) that the applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner to protect health and minimize danger to life or property; (c) that the proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property; and (d), that issuance of a license will not be inimical to the common defense and security or to the health and safety of the public.

Based on guidance in Regulatory Guide 3.46, *Standard Format and Content of License Applications, including Environmental Reports, For In Situ Uranium Solution Mining* (hereinafter NRC, 1982b or RG 3.46) and Section 1 of the Standard Review Plan (hereinafter (NRC, 2003) or SRP), generalized information on the proposed activities should be provided in the first chapter of a source and byproduct material license application in order for staff to properly review the remaining sections of that application.

Staff is required to determine if the application provides sufficient data on the proposed activities to meet the above regulatory requirements for contents of an application (10 CFR 40.31) and that the proposed activities are for a purpose authorized by the AEA (10 CFR 40.32(a)).

1.2 ACCEPTANCE CRITERIA

Staff reviews the application for compliance with the applicable requirements of 10 CFR Part 40.31 and 40.32, using acceptance criteria in Section 1.3 of the SRP (NRC, 2003).

1.3 STAFF REVIEW AND ANALYSIS

Unless otherwise stated, information in this section of the SER is from Section 1 of the Technical Report (Strata, 2011a).

The proposed activities consist of constructing and operating an ISR facility at the Ross Project located in Oshoto, Crook County, Wyoming (Strata, 2011a) (SER Figure 1-1). Strata Energy, Incorporated (Strata or the applicant), is a U.S.-based corporation registered in Wyoming. Strata is a wholly owned subsidiary of Peninsula Energy Limited, an Australian registered company. Peninsula Energy is a publicly traded corporation on the Australian Securities Exchange. For this Application, Strata is the applicant.

Crook County is located in the northeastern corner of Wyoming, abutted by Montana to the north, South Dakota to the east, Weston County, Wyoming, to the south, and Campbell County,

Wyoming to the west (SER Figure 1-1). The total area encompassed by Crook County is 2871 square miles. Land use in Crook County is rural in nature consisting largely of rangeland, pastures and cropland (Strata, 2011a). Based on recent census data, the population of Crook County is 7083 persons resulting in a county population density of 2.5 per capita per square mile.[1] The nearest town to the project is Moorcroft, which is located approximately 22 miles south of the Ross Project. The closest community is Oshoto, which includes 11 residences located within 2 miles (mi) [3.2 kilometers (Km)] of the project area (Strata, 2011a). In addition to Moorcroft, the other nearest major urban centers include Sundance, Hulett, and Pine Haven, all of which are located in Wyoming. The largest population in those nearby urban centers is in Sundance with a 2010 population of 2602 persons (Strata, 2011a).

The public natural resources located within Crook County include portions of the Black Hills National Forest, Devils Tower National Monument, Missouri Buttes, and the Keyhole Reservoir State Park (Strata, 2011a). Devils Tower National Monument and Missouri Buttes are located approximately 12 miles east of the Ross Project. The Keyhole Reservoir State Park is located approximately 18 miles south-southeast of the Ross Project. In addition to uranium mining, other mineral resources in Crook County include oil and gas, and bentonite mining (Strata, 2012a).

Access to the project is through several county roads including Road 68 (D Road) and Road 164 (New Haven Road), all of which are gravel capped (Strata, 2011a). The closest interstate highway is Interstate 90; the closest point to the interstate highway is located at Moorcroft, Wyoming.

In Section 3.1 of the Environmental Report (Strata, 2011a), the applicant states that the Ross Project comprises approximately 696 hectares (ha) [1,721 acres (ac)]. Surface ownership of land located within the Ross Project is as follows: private entities, 553 ha [1367.2 ac]; State of Wyoming, 127 ha [314.1 ac]; and the Federal Government as administered by the Bureau of Land Management (BLM), 16 ha [40.0 ac]. The distribution of land ownership within the Ross Project is shown on SER Figure 1-2. Mineral rights are owned by the same entities as the surface rights; however, the distribution differs slightly from that of the surface ownership in that federal mineral rights ownership occurs in several sections for which surface land is owned by private entities (Strata, 2011a).

In Section 2.1 of the Technical Report (Strata, 2011a), the Ross Project includes parts of the following sections of the Public Land Survey System:

Section[2]	**Township**	**Range**
7,17,18 &19	53 North	67 West
12, 13 & 24	53 North	68 West

In decreasing order of usage, current land usage within the Ross Project consists of herbaceous and mixed rangeland, cropland and pasture, reservoirs, roads/utilities and industry (primarily oil well sites). The major reservoir in the area is the Oshoto Reservoir, which is a privately owned, man-made impoundment on the Little Missouri River, the major watershed that bisects the Ross Project area. The roads/utilities consist of Road 68 (D Road) Road 211 (Deadman Road), and Road 193 (Oshoto Connection). The industrial land use is limited to oil and gas well sites.

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[1] Source: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1.

[2] The applicant did not list Section 17, T53N, R67W in Section 2.1 of the Technical Report but did so in Section 1.2.3 of the Environmental Report.

The Ross Project also includes an area used in the 1980s as a former NRC-licensed research and development (R&D) ISR site. The site is referred to as the Nubeth R&D Site.[3] Based on Figure 1.4-2 of the Technical Report (Strata, 2011a), the footprint of the former Nubeth R&D Site is approximately 15 acres or 0.9 percent of the Ross Project. The applicant provides a historical account of activities at the former Nubeth R&D site and includes data from that site in developing its conceptual model for the setting at, and processes for the Ross Project (see SER Section 2.0).

The proposed activities for the Ross Project include the construction of wellfields and a central processing plant with ancillary equipment (see SER Section 3.0). The ancillary equipment includes underground piping from the wellfield to the central processing plant (CPP) and from the CPP to the deep disposal wells, 15 to 25 header houses, an administrative and warehouse/maintenance building, chemical and equipment storage area, lined retention ponds, and deep disposal wells (Strata, 2011a). Except for the wellfields, header houses, deep disposal wells and piping, most of the development is limited to a 50-acre area referred to as the "CPP area" within the project.

The main ore body at the Ross Project is located within the subsurface, saturated permeable sandstones of the Late Cretaceous Age (65 ma) Lower Lance and Upper Fox Hills formations. In Section 3.1 of the Technical Report (Strata, 2011a), the applicant states that the uranium ore consists of stacked roll fronts and tabular ore bodies distributed throughout the project area. The average depth to the ore body is 149 meters (m) [490 feet (ft)], with depths ranging from 91 m [300 ft] to 213 m [700 ft]. In Section 2.6 of the Technical Report (Strata, 2011a), the applicant reports two main mineralized horizons within the targeted ore body. The average ore thickness within the Ross Project is 2.7 m [8.9 ft]. In Section 2.6 of the Technical Report (Strata, 2011a), the applicant states that the average dimensions of mineralized roll fronts and tabular bodies are 35 meters [115 feet] in width, 4.2 meters [14 feet] in thickness, and 610 to 914 meters [2000 to 3000 feet] in length. The average grade of the ore is 500 parts per million equivalent U_3O_8 (ppm eU_3O_8), or 0.05 percent. The currently estimated total ore resource within the project area is 5.5 million pounds of uranium (Strata, 2011a).

The applicant proposes in situ recovery processes for this project. The ISR process involves extracting uranium from underground ore bodies without bringing the ore bodies to the surface by injecting a leaching solution through wells into underground ore bodies to dissolve the uranium (see (NRC, 2009a)). The applicant's proposed leaching solution consists of native groundwater fortified with an oxidant, oxygen (e.g. O_2 gas) or hydrogen peroxide (H_2O_2), and a complexing agent, sodium carbonate (Na_2CO_3) or carbon dioxide (CO2) (see SER Section 3.1). The area encumbered by the injection and production wells (and surrounding monitoring wells) is referred to generically as a wellfield. Strata proposes to use patterns to the production wells within in its wellfields that consist of either six injection wells at the vertices of a hexagon with a single extraction well in the center of the hexagon (7-spot pattern), a rectangular 5-spot pattern, staggered line drives (alternating rows of injection and extraction wells), or direct line drives (one row of alternating injection and extraction wells) (Strata, 2011a).

The leaching solution is recovered from the subsurface through the extraction wells and piped to the CPP through a system of underground piping. At the CPP, two generic processes produce the final product, which is referred to as yellowcake. The first process consists of pumping the

[3] Documents for the R&D facility can also found by the following information: Sundance Project, NRC License SUA-1331, NRC Docket Number 040-08663, Nuclear Dynamics, Inc., and ND Resources.

uranium-rich leaching solutions through resins, which selectively captures the uranium from the solutions, then refortifying the now-uranium-barren solutions with the oxidizing and complexing agents, and returning the refortified solutions through underground piping to the wellfields for additional leaching of uranium from the ore bodies. The second process at the CPP consists of chemically capturing the uranium from the resins once the resins are saturated with uranium, and further chemical processing to ultimately produce the yellowcake (Strata, 2011a).

The applicant requests that the Ross Project be licensed to process 28,400 liters per minute (Lpm) [7,500 gallons per minute (gpm)] of leaching solution through the resins and produce 1.36 million kilograms (kg) [3 million pounds (lbs)] per year of yellowcake at the CPP.

From the initial construction to final decommissioning, the applicant proposed timeline for the Ross Project is approximately 10 years; however, the applicant also requests processing of uranium-rich resins derived from other ISR operations (either a future Strata facility or a facility operated by another licensee) or other entity (e.g., water treatment resins)[4]. The applicant states that processing of resins outside sources could extend the life of the CPP to 20 years.

The applicant proposes three uses for excess wastewater from the project activities (see SER Section 4.0). The proposed uses include surface discharges, plant make-up water or deep disposal wells. The first option would require treatment to ensure the quality of the wastewater is acceptable as well as permits from the appropriate state agency. Disposal of the poorest quality wastewater would occur only in the deep disposal wells. Based on anticipated quality, the poorest quality wastewater would contain radiological constituents, and so would be considered 11e.(2) byproduct waste as defined by Section 11e.(2) of the Atomic Energy Act , which is not considered hazardous waste (Strata, 2011a).

The lined retention ponds are part of the wastewater storage system used to manage wastewater inflows, optimize disposal techniques and provide storage backup capabilities during emergencies (Strata, 2011a). Solid byproduct material, such as production equipment and piping, will be disposed of at an off-site licensed mill tailings or other licensed facility. Other waste streams consist of domestic solid waste (e.g., office trash), domestic sanitary waste and other liquid non-byproduct wastes such as used oil, cleaners and spent solvents. The liquid non-byproduct wastes may include hazardous waste; however, the volume of all other waste streams is anticipated to be small; the waste will be disposed of off-site except for the domestic sanitary waste, which will be disposed of on-site through a subsurface conventional septic/leach field (Strata, 2011a).

The applicant proposes various operational designs, controls and monitoring during operations to ensure that its possession of source and byproduct material is confined to the locations and purposes documented in its application, which the staff describes and evaluates in SER Section 5.0. The monitoring ensures that the measures undertaken are protective of public and workers' health and safety and the environment.

The applicant proposes restoration of the production aquifer by groundwater sweep, groundwater transfer, groundwater treatment, groundwater recirculation and stability monitoring, which the staff describes and evaluates in SER Section 6.0. Restoration of portions of wellfields may occur simultaneously with operations (recovery of uranium) at other wellfields. After restoration is completed and approved by NRC staff, the wellfields will undergo decommissioning and reclamation by removing the piping and other ancillary equipment. Upon

[4] The processing of resin from an off-site source has been referred to as toll-milling or equivalent feed.

completion of operations, all surface facilities that were installed for the Ross Project will be decommissioned to allow unrestricted future use of the property. All equipment not fully decontaminated for unrestricted use will be disposed of at an NRC- or Agreement-State-licensed facility.

Several Federal, State, and local permits, licenses and approvals are required prior to the possible start of operations including:

- Permit to Mine issued by the Wyoming Department of Environmental Quality (WDEQ)
- Source Materials License issued by the NRC
- Plan of Operations approved by the U.S. Bureau of Land Management (BLM)
- UIC permit for the Class I & Class III wells from the WDEQ
- Aquifer exemptions from the U.S. Environmental Protection Agency (EPA)
- Permit to construct holding (storage) ponds (40 CFR 61.07) (EPA)

Should the Commission issue a source material license, the applicant proposes to initiate construction immediately thereafter. At the present time, Strata has a WDEQ permit for the deep disposal wells, which is a UIC permit for Class I wells (Wyoming Permit 10-263) (WDEQ, 2011).

The applicant commits to having an approved financial assurance arrangement in place prior to startup of operations (Strata, 2011a). The financial assurance arrangement will be consistent with requirements of 10 CFR Part 40, Appendix A, Criterion 9, and will include estimated costs for ground water restoration, radiological decontamination, facility decommissioning, and surface reclamation of sites, structures, and equipment used during operation of the Ross Project (see SER Section 6.5).

The applicant indicates that the Ross Project is likely the first licensed area in what Strata refers to as the Lance District. The Lance District is an approximately 56 square mile area in which known uranium deposits occur and may be economically viable as ore bodies. Strata has ongoing exploration in the Lance District and identified three probable additional areas for future development. Although the areas of future development are not part of this application, any future expansion may extend the life of the Ross CPP through toll milling.

In Section 1 of the technical report, the applicant briefly mentions two aspects that are unique to the project from an engineering perspective. Those two aspects include: (1) a proposed hydraulic control system in the area of the CPP; and (2) operation of on-site water supply wells for water flooding operations in an oil and gas wellfield. The unique aspects to this project are described and evaluated by staff in later sections of this SER.

1.4 EVALUATION FINDINGS

The staff finds that the applicant provided a summary of the proposed activities at the Ross Project in accordance with review procedures in Section 1.2 and acceptance criteria in Section 1.3 of the SRP (NRC, 2003) because the information adequately describes the proposed activities, is consistent with information provided in other sections of the application (and reviewed in greater depth by staff in this SER), and provides staff with a basic understanding of the application and likely consequences of any health, safety and environmental impact as required by 10 CFR 40.31. The information includes: (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 reclamation plans, and (10) financial assurance. Staff will include the following standard license conditions to document staff's findings:

Standard License Condition 9.1

> The authorized place of use shall be the licensee's Ross Project in Crook County, Wyoming. The licensee shall conduct operations within the license area boundaries shown in Figure 1.4-2 of the approved license application.

Standard License Condition 9.2

> The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license application dated January 4, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML110120063), which is supplemented by submittals dated February 28, 2011 (ML110800187), March 30, 2012 (ML121030404), April 6, 2012 (ML121020343), August 10, 2012 (ML12227A369) and January 18, 2013 (ML130370654). The approved application and supplements, hereby, are incorporated by reference, except where superseded by specific conditions in this license. The licensee must maintain the approved, updated, license application on site.
>
> Whenever the word "will" or "shall" is used in the above referenced documents, it shall denote a requirement. The use of "the Wellfield" in this license is synonymous with the use of mine unit as defined in the approved license application. The use of "verification" in this license with respect to a document submitted for NRC staff review means a written acknowledgement by U.S. Nuclear Regulatory Commission (NRC) staff that the specified submitted material is consistent with commitments in the approved license application, or requirements in a license condition or regulation. A verification will not require a license amendment.

Standard License Condition 9.3

> All written notices and reports sent to the NRC as required under this license and by regulation shall be addressed as follows: ATTN: Document Control Desk, Director, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. An additional copy shall be submitted to: Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Mail Stop T-8F5, 11545 Rockville Pike, Two White Flint North, Rockville, MD 20852-2738. Incidents and events that require telephone notification shall be made to the NRC Operations Center at (301) 816-5100 (collect calls accepted).

Standard License Condition 9.11

> The licensee is hereby exempted from the requirements of 10 CFR 20.1902(e) for areas within the facility, provided that all entrances to the facility are conspicuously posted with the words, "CAUTION: ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

Standard License Condition 12.1

> Prior to commencement of operations, the licensee shall obtain all necessary permits and licenses from the appropriate regulatory authorities. The licensee shall submit a copy of the permits it has obtained from other regulatory agencies for any effluent or waste disposal that includes treated or non-treated byproduct material, as well as documents clearly delineating the approved aquifer exemption areas and boundaries for the Class III UIC wells to the NRC.

On the basis of the proposed activities presented in the application, and the above license conditions, staff concludes that the proposed activities are for a purpose authorized by the AEA thus meeting requirements of 10 CFR 40.32(a).

1.5 REFERENCES

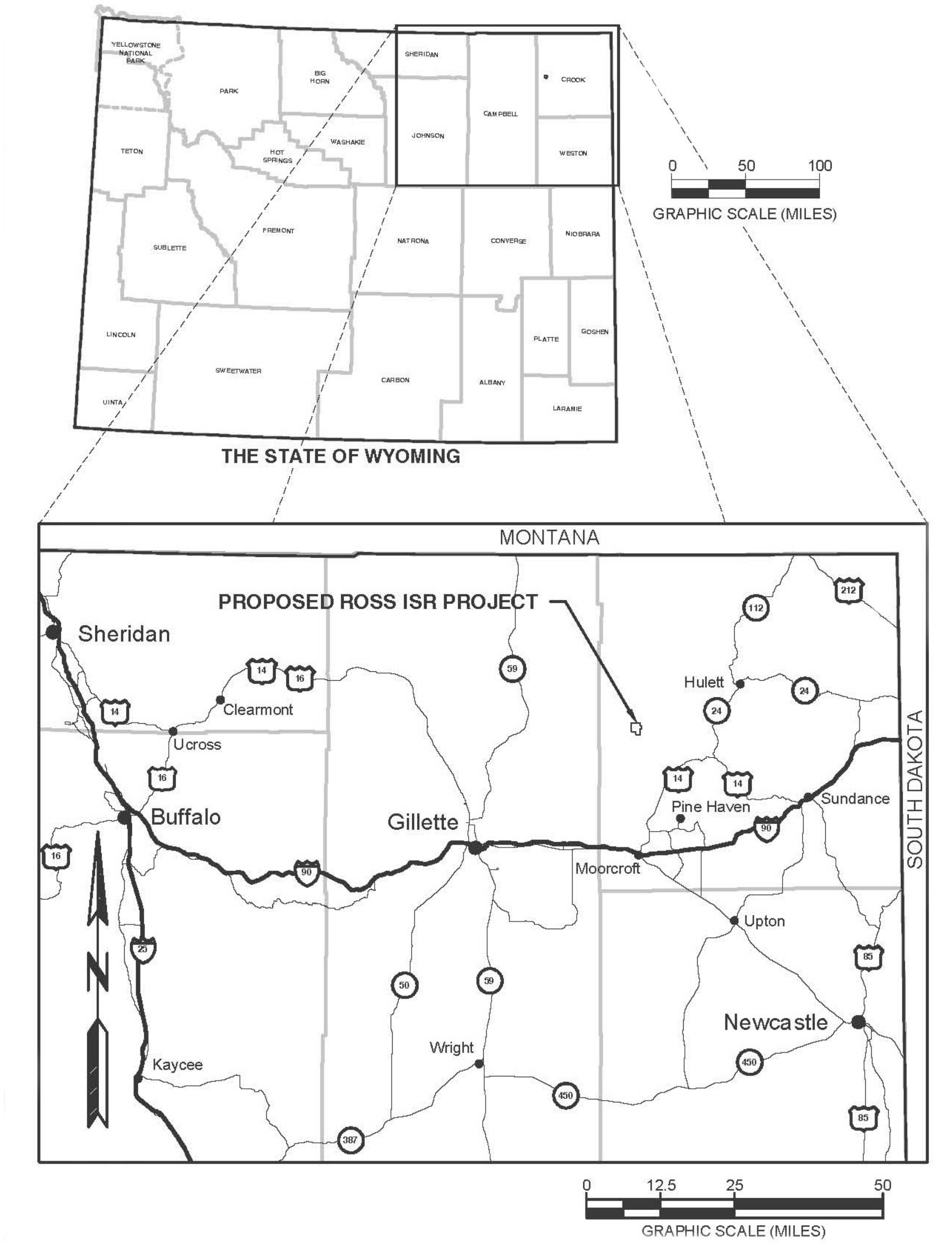
NRC, 2003. NUREG-1569, "Standard Review Plan for In-Situ Leach Uranium Extraction License Applications—Final Report", Washington, DC., June 2003.

NRC, 2009a. NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities", Washington, DC., May 2009.

Strata, 2011a. Ross ISR Project USNRC License Application, Crook County, Wyoming, prepared by Strata Energy, Inc., Docket No. 040-09091. ADAMS Accession No. ML110120063, January 2011.

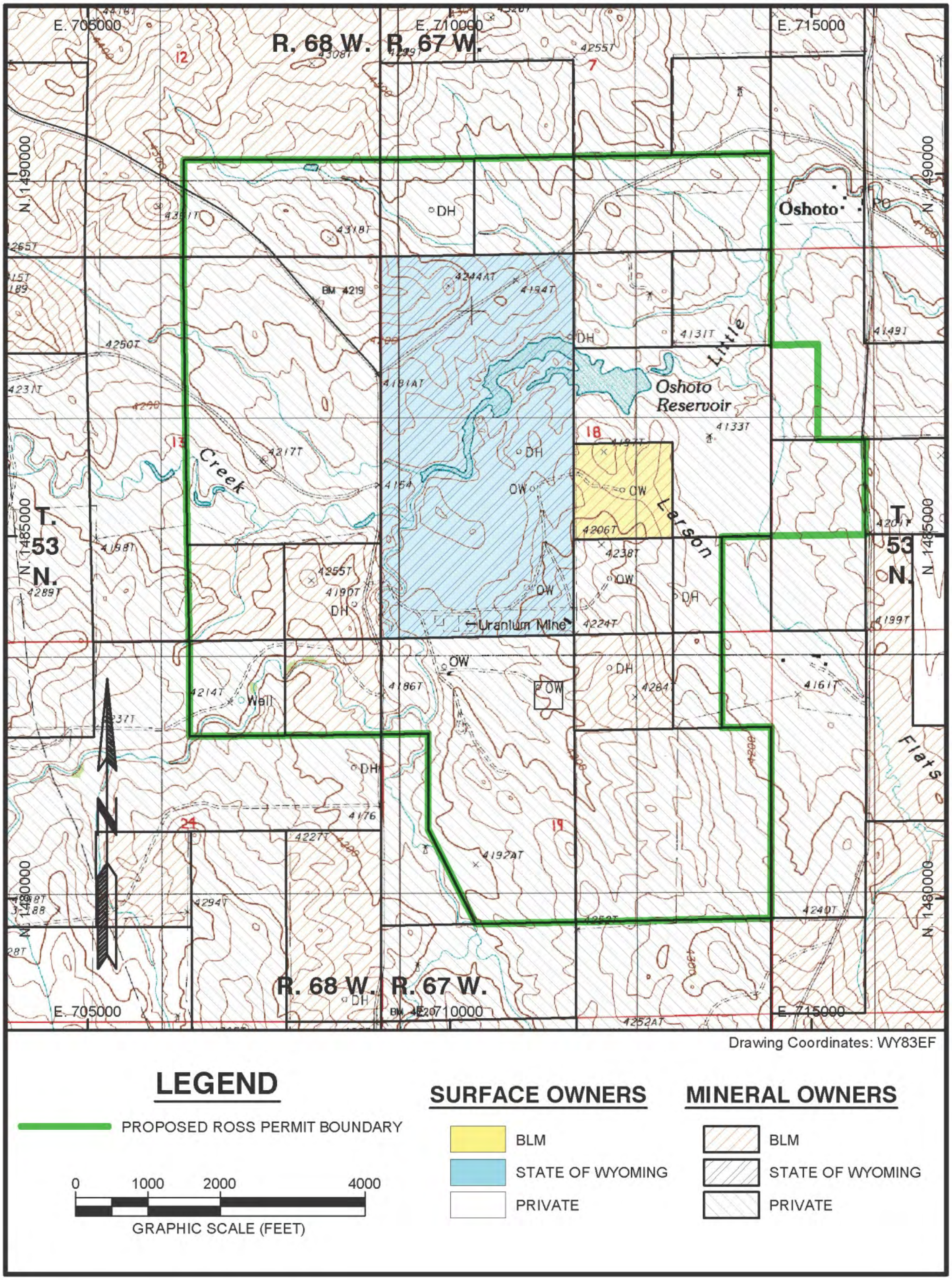
Strata, 2012a. Responses to the Request for Additional Information (RAI) for the Ross ISR Project Environmental Review Docket No. 040-09091. ADAMS Accession No. ML121030404, March 2012.

WDEQ, 2011. Letter to A. Simpson (Strata Energy, Inc) from J. Passehl (Wyoming Department of Environmental Quality/Water Quality Division (WDEQ/WQD)) forwarding the UIC Class I Permit for the Ross Project, ADAMS Accession No. ML111380015, April 13, 2011.



Source: Figure 1.4-1 of the technical report (Strata, 2011a)

Figure 1-1 Ross Project Location Map



Source: Figure 2.1-1 of the technical report (Strata, 2011a)

Figure 1-2 Distribution of Land Ownership within the Ross Project

2.0 SITE CHARACTERIZATION

2.1 SITE LOCATION AND LAYOUT

2.1.1 REGULATORY REQUIREMENTS

General requirements for contents of an application for a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(f) specifies that an application must include an environmental report pursuant to subpart A of 10 CFR Part 51. Pursuant to 10 CFR 51.45, an application must include descriptions containing sufficient data on the affected environment to aid the Commission in its conduct of an independent analysis.

The staff determines whether or not the application includes sufficiently clear, complete, and valid data on the site characterization to aid the Commission in performing its independent review.

2.1.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with applicable requirements of 10 CFR Part 40 using acceptance criteria in Section 2.1.3 of the SRP (NRC, 2003).

2.1.3 STAFF REVIEW AND ANALYSIS

Review procedures guidance in Section 2.1.2 of the SRP recommends that a reviewer:

- Establish the validity and completeness of the basic data.
- Determine that the proposed site location and layout are sufficiently and accurately portrayed.
- Conduct a site visit to develop an acceptable familiarization and verify general aspects documented in the application.

The acceptance criteria in Section 2.1.3 of the SRP focus on two areas. First, staff should verify that mapping in application is clear, readable and at a sufficient scale to depict features of the proposed activities relative to existing geological, geographical or political features in the region. Second, staff should verify that the data sources, whether they are published sources or generated by the applicant, are properly documented.

In Section 2.1 of the Technical Report (Strata, 2011a), the applicant characterizes the proposed activities, in both narrative and mapping forms, relative to features noted in the acceptance criteria in Section 2.1.3 of the SRP. The narratives and figures are general overviews; more-detailed descriptions and mapping are found in other sections of the Technical Report, which are evaluated in depth by staff in other relevant sections of this SER (e.g., the proposed activities relative to geologic features are evaluated in SER Section 2.3). Staff finds that the narrative and mapping presented in Section 2.1 of the technical report are consistent with those in other sections of the application (both technical and environmental reports) and that the narrative and mapping throughout the application has sufficient clarity and readability meeting acceptance criteria in Section 2.1.3 of the SRP.

Although locations of all injection and production wells were not provided on any mapping, the applicant did provide an outline of the proposed wellfields based on its current understanding

(Strata, 2012b). Guidance in Section 2.1.2 of the SRP instructs staff to “not expect that information needed to fully describe each aspect of all the operations will be available in the initial application” (NRC, 2003). Staff finds that the mapping provided in the application is based on the current knowledge of the applicant and thus consistent with the instructions/guidance of the SRP.

With respect to data sources, the applicant provides data based on information obtained from published sources, obtained from non-published sources and/or generated by the applicant to support its conceptual model of the setting and/or designs for the facility. Staff finds the applicant provided adequate references for data from published sources (e.g., U.S. Geological Survey (USGS), the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), the U.S. Census Bureau, BLM, University of Wyoming (UWYO) and the Wyoming Game and Fish Department (WGFD). In several cases, the sources for information cited by the applicant consist of non-published or copyrighted material which is not readily available to staff and/or public (e.g., Wyoming Geologic Association Guidebooks and Memoirs). The applicant provides copies of several non-published, non-proprietary documents in the application (e.g., Buswell (1992), Nubeth restoration approval documents). In cases where the source is non-published or not readily available due to copyright or other issues, NRC staff verified the information from available public sources, and, to the extent possible, posted copies of those sources on the NRC’s Agencywide Document Accessibility and Management System (ADAMS). Sources that are copyrighted and/or proprietary documents (e.g., (ASTM, 2005; Hamilton, 1977; Mears, 1993)) could not be posted on ADAMS.

With respect to site visits, staff conducted several site visits including an October 2010 pre-application-submission audit (ML103210247) and an August 2011 Information Gathering (ML112980194). Two site visits were conducted in fall of 2011 the purposes of which were to aid the National Historic Preservation Act Section 106 Consultation process. Due to nature of those consultations, no publically available trip report is available for those visits. Through the site visits, staff verified that the general aspects of the application, (e.g., geographic setting, location of the meteorological station) are consistent with descriptions and mapping in the application.

Finally, review procedures guidance in Section 2.1.2 of the SRP instructs staff to verify the total acreage owned or leased by the applicant (NRC, 2003). In the application (Strata, 2011a), the applicant reports that land ownership within the Ross Project consists of either private land owners, the State of Wyoming, or the Federal Government through the Bureau of Land Management (BLM). After the application was submitted, the applicant purchased land in and around the proposed CPP. NRC staff was informed of this development by the applicant (Strata, 2012c).

2.1.4 EVALUATION FINDINGS

The staff has reviewed the site location and layout of the Ross Project in accordance with the review procedures in SRP Section 2.1.2 and the acceptance criteria in SRP Section 2.1.3. Staff finds that the applicant 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 staff, as indicated above, the information provided in the application meets the applicable acceptance criteria of SRP Section 2.1.3 and requirements of 10 CFR 40.31(f) and 10 CFR 51.45.

2.2 METEOROLOGY

This section discusses meteorological conditions of the region surrounding and including the applicant's facility. Meteorological data are used for the selection of environmental monitoring locations, assessing impacts of operations on the environment, and determining radiological dose assessments as required in 10 CFR Part 20. The information presented in SER Section 2.2, unless stated otherwise, is from Section 2.5 of the Technical Report (Strata, 2011a).

2.2.1 REGULATORY REQUIREMENTS

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

2.2.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using acceptance criteria in Section 2.5.3 of the SRP (NRC, 2003).

2.2.3 STAFF REVIEW AND ANALYSIS

The following sections present the staff's review and analysis of various aspects of the meteorological conditions and monitoring at the Ross Project. The aspects reviewed in the following sections include meteorological data acquisition, general site conditions, atmospheric dispersion, and meteorological data quality.

2.2.3.1 Meteorological Data Acquisition

According to Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting," (RG 3.63 or (NRC, 1988a)), an onsite meteorological measurement program employs instrument systems physically located on or near the site that are capable of measuring meteorological information representative of the site vicinity. Guidance in RG 3.63 recommends that an applicant collect meteorological measurements at locations that can provide data representative of the atmospheric conditions into which material will be released and transported. An applicant can then use this information to estimate the maximum potential annual radiation dose to the public and environmental impacts resulting from routine release of radioactive materials in gaseous and particulate effluents.

The applicant describes its Meteorological Monitoring and Air Sampling Plan in Addendum 3.6-A of the Environmental Report (Strata, 2011a;b). Strata installed a meteorological station 0.3 km [0.2 mi] northwest from the proposed licensed area in January 2010 (see location MET in SER Figure 2.2-1). In Addendum 3.6-A of the Environmental Report, the applicant states that the location was chosen so that it was upwind of the plant and so that "... no pronounced topographic features in the area would create weather conditions significantly different between the meteorological station and the plant site" (Strata, 2011a). However, the staff finds that Strata did not provide sufficient justification for, or rationale behind, locating the meteorological station "upwind" in the application. The applicant did not discuss the expected differences in placement of the station 3.2 km [2 mi] from, and 45.7 m [150 ft] higher than the proposed CPP, in the application (Strata, 2011a). The NRC staff notes that Regulatory Guide

3.63, Section C.1 states that meteorological data should be compiled in joint frequency and joint relative frequency (i.e., decimal frequency) form for heights representative of effluent releases (NRC, 1988a).

Additionally, the staff notes that meteorological data are fundamental parameters used in calculations by MILDOS to estimate effluent concentrations that are then used to calculate radiation doses (NRC, 1982a;1987; Strenge and Bander, 1981). As stated in TR Sections 4.1.2 and 5.7.7.2, Strata used MILDOS calculations to estimate the maximum potential annual radiation dose to the public and will use the pre-operational baseline environmental monitoring program during operations to demonstrate compliance with 10 CFR Part 20 and Criterion 8 of Appendix A to 10 CFR Part 40 (Strata, 2011a). Strata provided additional justification for placement of the station 2.2 km [1.4 mi] away from and at an elevation of 45.7 m [150 ft] above the location of the CPP (Strata, 2012b). In this additional information, Strata stated that most of the projected wellfield activity will occur between the meteorology station and the CPP, and that the applicant intended for the meteorological station to be representative of effluents released from the entire project area for use in MILDOS modeling. The applicant stated that MILDOS model results show that the wellfield is expected to contribute over 75% of the radon-222 emissions and that the centroid of the wellfield is approximately 2 km [1.2 mi] from the meteorological station. The applicant stated it chose a relatively high spot for the meteorological station location to minimize terrain influences that may vary from point to point over this area (Strata, 2012b). The staff finds the applicant's rationale for locating the meteorological station off-site at a higher elevation adequate to meet the recommendations in Regulatory Guide 3.63 that state the instrument tower should be approximately the same elevation as the facility operation and located such that natural or man-made obstructions will have little or no influence on meteorological measurements (NRC, 1988a).

Strata submitted data collected between January and December 2010 to describe the onsite meteorological conditions at the Ross ISR Project (Strata, 2011a;b). Strata collected additional data at the Ross ISR Project thru December 2011 and included these data in the applicant's revised technical report (Strata, 2012b). The applicant stated in Addendum 3.6-A of the environmental report that data was collected, maintained, and reported by IML Air Science (Sheridan, WY) The applicant described data collection methodology in Table 1 of Addendum 3.6-A (Strata, 2011a). The applicant measured temperature using a temperature and relative humidity probe at 2 m (6.6 ft) above ground. The applicant measured precipitation with a Hydrological Services rain gauge (Model TB3/0.01 P) located 1 m (3.3 ft) above ground. The applicant used an RM Young model 05305 Winder Monitor AQ to measure wind speed and direction at 10 m (33 ft). Evaporation and evaporative pan measurements were collected at 1 m (0.33 ft) above ground using a Novalynx 255-100 evaporation gauge and a Fenwal 107 temperature probe, respectively. The applicant recorded instrument measurements with a continuous data logger (Campbell Scientific model CR1000). According to the applicant, the data logger polls instruments every second and that any data missing for more than 10 seconds in any hour is invalidated for that hourly record (Strata, 2011a). The NRC staff concludes that the applicant collected on-site data consistent with the recommendations for placement of instrumentation in Regulatory Guide 3.63 (NRC, 1988a), and thereby meets SRP Section 2.5.3 acceptance Criterion (1) (NRC, 2003).

Regulatory Guide 3.63 defines the minimum amount of meteorological data needed to be that amount of data collected 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 characteristic 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 (NRC, 1988a).

For this comparison, the applicant (Strata, 2011a) chose to compare the meteorological data collected from the Ross ISR meteorological station to data from the nearby Thunder Basin National Grassland (TBNG) and the Gillette Airport (Gillette AP) station. Table 2.5-1 in the technical report provides the station ID, coordinates, and period of operation for all sites (Strata, 2011a). The applicant illustrates the station locations in Figure 2.5-1 of the technical report. The applicant used 2003 to 2007 data from the TBNG, which is located about 18 miles from the Ross ISR Project. According to the applicant, the Gillette AP site, located 35 miles from the project site, is the closest NWS operated station that continuously records all weather parameters (Strata, 2011a). The staff finds that in its initial submission, Strata did not demonstrate that the collection period for the on-site data was representative of long-term conditions consistent with guidance in Regulatory Guide 3.63 or with SRP Section 2.5.3 acceptance Criterion (3) (NRC, 2003). The staff finds that in the initial submission, Strata compared the data collected at the Ross ISR Project to the data collected at the Gillette AP meteorology station. However, to demonstrate that the on-site data are representative of long-term conditions, Strata needed to demonstrate that the data collected at the Gillette AP station during the period of time in which the Ross data were collected are consistent with the long-term data collected at the Gillette AP as recommended in the regulatory guide. The applicant needs to provide this information to demonstrate that it collected adequate background data per 10 CFR Part 40, Appendix A, Criterion 7.

The applicant later provided an analysis of short and long-term data collected at the Gillette AP NWS and Dry Fork Mine (DRM) meteorological stations (Strata, 2012b). According to the applicant, the DFM is located 25 miles from the proposed Ross ISR Project to the west-southwest and is a meteorological station that conforms to the EPA's On-Site Meteorological Program Guidance for Regulatory Modeling Applications. Strata obtained Gillette AP data from mid-1998 through December 2011 from the National Climatic Data Center (NCDC 2012). The applicant constructed a 13-year period of record for hourly average wind speeds and wind directions, which is presented in SER Figures 2.2-2 and 2.2-3 respectively (Strata, 2012b). SER Figure 2.2-2 shows the wind rose for the 13-year period at the Gillette AP and SER Figure 2.2-3 shows the Gillette AP data during the baseline-monitoring year of 2010. The applicant stated that wind speeds and directions collected during the 13-year and 1-year monitoring periods at the Gillette AP were similar, and segregated wind speed and wind direction variables to correlate short-term and long-term frequency distributions. The applicant stated that this correlation enables an assessment of how closely the distributions of wind speed class and wind direction frequencies from one year of monitoring at a specific location represent the long-term distributions at that same location (Strata, 2012b).

SER Figures 2.2-4 and 2.2-5 compare the wind speed and the wind direction frequency distributions of the 13-year and 1-yr baseline periods at the Gillette AP, respectively (Strata, 2012b). The applicant stated that the amount of time the wind speed falls within each of the seven wind speed classes and the amount of time the wind blows from each of the 16 cardinal directions is quite similar for the two monitoring periods. The applicant conducted linear regression analysis to assess the degree of correlation between 13-year and 1-yr baseline periods at the Gillette AP, which SER Figures 2.2-6 and 2.2-7 illustrate, respectively. The regression lines in SER Figures 2.2-6 and 2.2-7 represent the least squares fit to data points. The applicant concluded that the corresponding coefficient of determination or R^2 value of 97.8%, implies very strong linear correlation because it is close to 100% (Strata, 2012b). The

NRC staff notes that the corresponding R^2 value for the wind direction has a somewhat less least square fit with a correlation value of 91.0%.

The applicant attributed the lower wind direction correlation to poor data resolution (Strata, 2012b). The applicant stated that NWS records hourly average wind directions, or azimuth angles, to the nearest 10°, but that each wind direction category spans only 22.5°; therefore, the coarse resolution limits correlation analysis between short and long-term wind directions. The applicant repeated the correlation analysis for the wind speed and wind direction comparing a 17-year period of record to the baseline period of 2010 at the DRM station. SER Figures 2.2-8 and 2.2-9 show R^2 values of 98.7% and 96.5% for the wind speed and wind direction correlation, respectively. Strata concluded that in 2010 DRM experienced wind conditions representative of long term conditions at that site (Strata, 2012b).

SER Figures 2.2-10 and 2.2-11 compare the applicant's 2011 on site wind speed and wind direction data to the 2010 on site data and calculated R^2 values of 97.5% and 96.7%, respectively (Strata, 2012b). The applicant concluded that the data presented at the DRM station demonstrates that the 2010 baseline sampling period is representative of long-term conditions at the DRM station and therefore, the one-year baseline monitoring represents long-term meteorological conditions at the Ross ISR Project site (Strata, 2012b). The staff finds that the applicant demonstrated that the meteorological data used for assessing impacts are substantiated as being representative of expected long-term conditions at and near the Ross ISR Project site and thereby meets SRP Section 2.5.3 acceptance Criterion (3) (NRC, 2003).

2.2.3.2 General Site Conditions

This project is located in north-east Wyoming. According to the information provided by the applicant (Strata, 2011a;b), the average annual temperatures range from a low of -1.1 degrees Celsius (°C) (30 degrees Fahrenheit [°F]) to a high of 16 °C (60 °F). The staff observed that August was the warmest month recorded at the Ross ISR Project station and the average maximum and minimum warmest daily temperatures measured during that time were 37 °C (98 °F) and 8 °C (46 °F). The staff observed that February was the coldest month recorded (average temperature) at the Ross ISR Project station; average maximum and minimum coldest daily temperatures measured were 5 °C and -23 °C (41 °F and -9 °F). The staff finds that in contrast to the Ross ISR Project site, the highest and lowest average regional temperatures were in July and December, respectively (Table 1 in ER Addendum 3.6-B (Strata, 2011b)).

The applicant reported that the average relative humidity measured during the baseline period at the Ross ISR Project station was 66.7 percent, with a maximum and minimum of 99.7 and 7 percent (Figure 1 in ER Addendum 3.6-B (Strata, 2011b)). Wind speed averaged 18.7 kilometers per hour (kph) (11.5 mph), ranging from 0.8 to 23.4 kph (0.5 to 45.6 mph). Total precipitation was 27.2 cm (10.69 in) with a maximum of 0.7 cm (0.29 in).

The applicant provided illustrations comparing Ross ISR Project pan evaporation rates measured between July and October 2010 to those measured at Gillette AP between April and October 2010 (Figure 22 in ER Addendum 3.6-B (Strata, 2011b)). Strata also provided a chart illustrating the correlation of the Ross ISR Project evaporation pan water temperature to the surrounding air temperature during the first 15 days of July 2010 (Figure 23 in ER Addendum 3.6-B (Strata, 2011b)). The staff finds the applicant did not discuss the evaporation results, but collected and presented the data following the recommendations in Regulatory Guide 3.63

(NRC, 1988a), and thereby meets the SRP Section 2.5.3 acceptance Criterion (1) (NRC, 2003). Additionally, the staff finds that the applicant meets SRP Section 2.5.3 acceptance Criterion (2) by examining the relationships between regional weather patterns and on-site meteorological conditions based on weather station data and the on-site monitoring by providing the following (Strata, 2011b):

- Summarizing the annual meteorological data collected at the Ross ISR Project and the Gillette AP stations (Figure 2 in ER Addendum 3.6-B)

- Comparison of average monthly temperatures at the Ross ISR Project to the Gillette AP (Figure 4 in ER Addendum 3.6-B)

- Comparison of average monthly wind speeds at the Ross ISR Project to the Gillette AP (Figure 11 in ER Addendum 3.6-B)

- Comparison of average monthly precipitation at the Ross ISR Project to the Gillette AP (Figure 21 in ER Addendum 3.6-B)

2.2.3.3 Atmospheric Dispersion

Dispersion is the transport and diffusion of effluents that can result in dilution and deposition of a contaminant on the ground and in the breathing zone. Dispersion and deposition are dependent on wind speed, wind direction, atmospheric stability, and mixing height, as well as the type of terrain and height and density of structures near the release site. Mixing height is the vertical distance of a homogenous layer in the atmosphere between the Earth's surface and a temperature inversion. Temperatures usually decrease with altitude; an increase in temperature with altitude creates a temperature inversion. Turbulence generated within the mixing layer from interaction between the atmosphere and the Earth's surface or heating and cooling of the Earth's surface, further mixes air, and thus effluent. Mixing heights typically undergo large diurnal and seasonal variations that increase and decrease in depth proportionally with solar heat. Static stability occurs within the inversion layer, which impedes vertical and/or horizontal mixing and immobilizes the contaminant beneath the inversion. The stability class can vary from extremely unstable to extremely stable, and can be determined by temperature differences between two heights or the fluctuation of horizontal wind direction at a given height.

Joint frequency distribution (JFD) illustrates the frequency in which a joint frequency category occurs in a specified period. Each joint frequency category represents a range of wind speeds, directions, and stability conditions. The average morning and afternoon mixing heights and JFD are meteorological characteristics used as input parameters in atmospheric dispersion and transport computer codes, such as MILDOS-AREA, to calculate the concentration of a contaminant and the radiation dose commitments at a receptor point from the release site.

The applicant collected wind speed, wind direction, precipitation, temperature, relative humidity, and stability data between January 5, 2010 and January 15, 2011 (Strata, 2011b) and continued through December 2011 (Strata, 2012). The applicant reported an annual average wind speed was 18.7 kilometers per hour ([kph] [11.5 mph]), and stated that the prevailing wind direction is from southerly and south-southeasterly direction. The applicant stated that these winds are characteristic of northeastern Wyoming (Strata, 2012b).

SER Figures 2.2-12 and 2.2-13 illustrate the JFD of wind speed and direction for Ross ISR Project 2010 and 2011 data, respectively. Strata stated that it used the sigma-theta ($\sigma\theta$) method to determine the Pasquill-Gifford stability class (Gifford, 1961;1976; Pasquill, 1961), where $\sigma\theta$ refers to the standard deviation of the horizontal wind azimuth angle in degrees (Strata, 2012b). The applicant stated that this method is a lateral turbulence-based method, which uses the standard deviation of the wind direction in combination with the scalar mean horizontal wind speed. The applicant stated that the $\sigma\theta$ method is a wind fluctuation approach and therefore qualifies as an appropriate method for the Ross ISR Project application because Regulatory Guide 3.63 (NRC, 1988a) states that an applicant/licensee may use a wind fluctuation method to obtain an indication of the atmospheric stability. The applicant stated that using this methodology, it assigned initial stability classes based solely on the standard deviation of wind direction, $\sigma\theta$. The applicant stated that it adjusted the initial assignments for horizontal wind speed, which is dependent on the time of day that the measurement is collected (e.g., day or night hours) because a diurnal dependency varies with the time of year (Strata, 2012b).

The applicant illustrated the stability class distribution data collected during the baseline year, 2010, in Figure TR RAI 4-5 in the applicant's response to the NRC staff's request for additional information (RAI) and found that the predominant stability class in 2010 at the Ross ISR Project was class D (Strata, 2012b). The applicant continued to collect data through calendar year 2011. The applicant compared the stability class distribution data collected (1) on-site during 2011, (2) at the DRM meteorological station in 2010, and (3) at the DRM during the 17 year period (i.e., long-term) to the stability class distribution data collected on-site during the baseline year. The applicant presented the results using the $\sigma\theta$ method in Figure TR RAI 4-6 in the applicant's response to the NRC staff's RAI. The applicant stated that although somewhat more stable air, such as stability classes E and F, occurred at the DRM, stability class D was dominant and typical of the region (Strata, 2012b).

The applicant compared the $\sigma\theta$ method and the Solar Radiation Delta Temperature (SRDT) method to demonstrate the $\sigma\theta$ method's reliability in determining the stability class (Strata, 2012b). The SRDT method uses surface layer wind speed in combination with measurements of total solar radiation during the day and a vertical temperature difference at night (EPA, 2000). The applicant compared data collected at a site in western Wyoming where concurrent wind parameters, hourly solar radiation, and temperature gradient data were publicly available for the last five years (Strata, 2012b). The applicant found similar distributions in the stability classes using both methods and concluded that MILDOS model results would be similar at the Ross ISR Project using either method (Strata, 2012b).

The staff notes that EPA guidance states that routine monitoring of the mixing height is by and large impractical (EPA, 2000). The EPA recommends alternative methods for estimating the mixing height using available data. The EPA recommends the Holzworth method (Holzworth, 1972) when characteristic NWS upper air data is available (EPA, 2000). The applicant stated that the nearest NWS upper-air data available are from Rapid City, South Dakota, approximately 100 miles southeast of, and 304.8 m (1000-ft) lower in elevation than the proposed Ross ISR Project site (Strata, 2011a). Because of these differences and that the Black Hills are between the proposed licensed site and the NWS station, the applicant concluded that the mixing heights provided by the WDEQ Air Quality Division (AQD) would be more appropriate. The WDEQ/AQD recommends these mixing heights be used in dispersion modeling with the Industrial Source Complex (ISC3) model, which are based on the Holzworth methods (1972) as applied to Lander, WY, as follows:

- Class A 3,450 meters
- Class B 2,300 meters
- Class C 2,300 meters
- Class D 2,300 meters
- Class E 10,000 meters
- Class F 10,000 meters

The applicant described bodies of water and special terrain features that could affect the meteorology of the Ross ISR Project site (Strata, 2011a). The applicant stated that two bodies of water, the Keyhole and Oshoto Reservoirs, are located 20 miles south and within the proposed licensed area, respectively. The applicant stated that evaporation from these reservoirs and the predominant southerly breezes could to some extent influence relative humidity measurements in the Ross ISR Project area, but the applicant suspects that this influence will not be substantial. The applicant stated that the two nearest mountain ranges to the Ross ISR Project site are the Bighorn Mountains and the Black Hills, located approximately 100 miles to the west and 20 miles to the east, respectively. The applicant stated that the Black Hills exert some effect on the meteorology of the Ross ISR Project site by shielding easterly wind and channeling predominant winds into a north-south pattern. The applicant stated that the Black Hills contributes to cooling of the air and moisture condensation as upslope air movement from storms track from west to east (Strata, 2011a).

The staff finds that the applicant followed the recommendations in Regulatory Guide 3.63 by reporting the relative frequency of each stability class and described how the atmospheric stability class was determined, which meets SRP acceptance Criterion (1). The applicant described its assessment of the impacts of terrain and nearby bodies of water on local meteorology thus meeting SRP acceptance Criterion (2). The staff finds that the applicant provided the sources of all meteorological data used and thereby, meets SRP acceptance Criterion (5) (NRC, 2003).

2.2.3.4 Meteorological Data Quality

The applicant provided a description of the types and specifications for the meteorological instrumentation in ER Addendum 3.6-A (Strata, 2011a). The applicant reported that its contractor inspected the Ross ISR Project meteorological station on a weekly basis and calibrated instruments upon installation in January 2010 and again in July of 2010. The applicant included calibration and audit records for all meteorological instruments, as well as the specified tolerances for each parameter measured in Appendix 1 to ER Addendum 3.6-A. The applicant stated that the instruments met the accuracy and threshold specifications listed in the EPA's "On-Site Meteorological Program Guidance for Regulatory Modeling Applications," and presented these specifications in Table 1 in ER Addendum 3.6-A for each instrument. The applicant followed the audit procedures as specified in EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 4: Meteorological Measurements. All Standard Operation Procedure (SOP) used to collected meteorology data was included in Appendix 3 to ER Addendum 3.6-A (Strata, 2011a).

The applicant stated that all hourly data were downloaded weekly from the data logger to its contractor's relational database, which provided for quality assurance, invalidation of suspect or erroneous data, and various forms of data presentation (Strata, 2011a). The applicant stated that meteorology data, data recovery statistics, and diagnosis of invalidated records were summarized in the contractor's weekly reports. The applicant reported that data recovery for

the Ross ISR Project was over 95% for wind data and over 97% for other parameters (Strata, 2011a).

The staff finds that the instruments, placement, and accuracies of the systems were consistent with guidance provided in Regulatory Guide 3.63 (NRC, 1988a). The staff finds that Strata provided instrument calibration sheets (Strata, 2011a) in accordance with recommendations in Regulatory Guide 3.63. The NRC staff has concluded that the applicant collected data in accordance with Regulatory Guide 3.63 and has described meteorological data sufficiently. The staff finds that the meteorological data quality is acceptable to use in calculations to determine effluent concentrations and radiation doses as required in 10 CFR 20.1301 and § 20.1302. The staff concludes the data are acceptable because the information meets SRP Section 2.5.3 acceptance criteria (1) and (5) (NRC, 2003).

2.2.4 EVALUATION FINDINGS

Staff reviewed the monitoring of meteorological conditions at the Ross ISR Project in accordance with SRP Section 2.5.3 (NRC, 2003). The applicant used data from various NWS meteorological stations and one adjacent to the Ross ISR Project to represent conditions at the proposed licensed area. The licensee provided data to show that data collected adjacent to the Ross ISR Project is representative of long-term trends and support atmospheric dispersion modeling. The joint-frequency data presented are for a minimum of 1 year, with a joint data recovery of 90 percent or more. The applicant has described any effect of nearby water bodies or terrain on meteorological measurements.

Based upon the review conducted by the staff as indicated above, the information provided in the application, the staff concludes that the information is acceptable to allow evaluation of the spread of airborne contamination at the site. The staff concludes that the information provided may be used in the development of conceptual and numerical models, and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis. The characterization meets the applicable acceptance criteria of SRP Section 2.5.3 (NRC, 2003) and the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.3 GEOLOGY AND SEISMOLOGY

2.3.1 REGULATORY REQUIREMENTS

General requirements for contents of an application for a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(h) specifies that an application must clearly demonstrate how requirements and objectives set forth in 10 CFR Part 40 Appendix A are addressed. Technical Criteria 1, 5B, 5F, 5G & 7 of 10 CFR Part 40 Appendix A set forth requirements and objectives for a suitable geologic and seismologic setting at a uranium recovery facility[5]. Furthermore, 10 CFR 40.41(c) requires that a Part 40 licensee has the ability

[5] Criteria in Appendix A are written for conventional mill setting. The conventional mill setting differs from an ISR setting in that (1) at a conventional mill, all activities conducted under the license are performed above ground whereas at ISR settings, the uranium extraction from the ore is performed in situ (or in the subsurface), and (2) at a conventional mill, a solid byproduct material, the mill tailings, is stored above ground in a tailing pile whereas at ISR settings, no mill tailings are generated. Staff is applying these criteria to ISR facilities because 10CFR 40.31(h) specifies that not only the requirements but objectives of the technical criteria in Appendix A are met.

to confine the licensee's possession and use of source and byproduct material to locations and purposes authorized by the license. At an ISR facility, meeting these requirements includes determining that the geological and seismological settings are appropriate to confine the regulated material to the designated areas in the subsurface.

Based on guidance in RG 3.46 (NRC, 1982b) and Section 2.6 of the Standard Review Plan (NRC, 2003), an application should provide sufficient descriptions of the geologic and seismologic settings and a demonstration of the licensee's thorough understanding of those settings.

2.3.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviews the application for compliance with applicable requirements of 10 CFR 40.31(h), 10 CFR 40.41(c) and 10 CFR Part 40 Appendix A Criteria 1, 5B, 5F, 5G & 7, using review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the Standard Review Plan (NRC, 2003).

Information in the application, as reviewed and verified by staff, will be deemed acceptable provided staff determines, with reasonable assurance, that a license issued based on the application meets the above regulatory requirements, and, pursuant to 10 CFR 40.32, can conclude that (1) the proposed project is for a purpose authorized by the AEA, (2) the applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner to protect health and minimize danger to life or property; (3) the proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property; and (4), issuance of a license will not be inimical to the common defense and security or to the health and safety of the public.

2.3.3 STAFF REVIEW AND ANALYSIS

Unless otherwise stated, information reported in this SER Section is from Section 2.6 of the technical report (Strata, 2011a).

The following subsections present staff's review and analysis of various aspects of the geology and seismology at the Ross Project. The information reviewed for the following subsections includes geographic setting, regional geology, site geology, soils, and seismology.

2.3.3.1 Geographic Setting

The Ross Project is located along the margin of two regional geotectonic provinces, the Powder River Basin and the Black Hills Uplift, specifically, the Ross Project is located along the eastern perimeter of the Powder River Basin (Strata, 2011a). The Powder River Basin is a geological structural basin located in the Northern Great Plains in northern Wyoming (Anna, 1986). The Powder River Basin is widely known for its mineral resources including coal, coal-bed methane, oil and gas production and uranium (Anna, 1986; Strata, 2011a). As the name implies, the Powder River is the principal drainage for the basin; however, several smaller drainages not directly associated with the Powder River (i.e., tributaries) drain various localized areas of the basin. Specifically, in the case of the Ross Project, the drainage in this area of the basin consists of the upper reaches of the Little Missouri River (Strata, 2011a).

The topography throughout most of the Powder River Basin, including that at the location of the Ross Project, consists of rolling hills with little topographic relief with elevations between 1067

and 1828 meters above mean sea level (m-MSL) [3500 and 6000 feet above mean sea level (ft-MSL)] (ENSR, 2006). The topographic elevation at the Ross Project ranges between 1250 and 1310 m-MSL [4100 and 4300] ft-MSL (Strata, 2011a).

Structurally, the Powder River Basin is an asymmetrical synclinal structure (i.e., the structural axis is located nearer its western perimeter rather than being located in the center of the basin) with a thick (up to 5200 m [17000 ft]) accumulation of Phanerozoic age (younger than 540 ma) sedimentary consolidated rocks (Strata, 2011a). In general, thickness of the sedimentary rocks in the Powder River Basin increases significantly towards the south (e.g., thickness of the Fox Hills and Lance formation increases from 213 meters [700 feet] in the north to over 1005 meters [3300 feet] in the south) and relatively constant thickness in the east-west direction (Connor, 1992; Strata, 2011a).

The eastern margin of the Powder River Basin is defined by areas of higher relief associated with the Black Hills. The Black Hills developed in response to uplift of basement rocks during the Laramide Orogeny (65 to 43 million years ago [ma]) (Bates and Jackson, 1984; Lisenbee and DeWitt, 1993; Redden and DeWitt, 2008; Strata, 2011a). The current topography within the Black Hills uplift region includes ridges up to elevations of 7000 ft-MSL, most notably the granite ridge that forms Harney Peak (Redden and DeWitt, 2008). Uplift to those elevations has contributed and continues to contribute to increased precipitation causing appreciable erosion of younger rocks (Darton and Page, 1925). As a result, the older lithologies presently exposed in the core of the Black Hills are found deep below the ground surface within the Powder River Basin.

In general, the rheologic properties of the older rocks are more resistant to erosion compared to those for the shale lithologies exposed at ground surface throughout most of the Powder River Basin (Lisenbee and DeWitt, 1993; Redden and DeWitt, 2008). Consequently, the geographic setting for the Black Hills, which is in close proximity to the Ross Project, contrasts sharply with the rolling hills found throughout the Powder River Basin, including the location of the Ross Project (Strata, 2011a).

Staff reviewed information provided by the applicant on the geographic setting and finds that the description and characterization as presented by the applicant is consistent with published data. The geographic divisions of the observed landforms at earth's surface provide a constraint on the conceptual model for the geologic, hydrogeologic and seismologic setting. Staff finds that geographic setting is consistent with the applicant's conceptual model of the geologic and seismologic model for the Ross Project as discussed below.

2.3.3.2 Regional Geology

The applicant discusses the regional geology in terms of stratigraphy and structural features (Strata, 2011a). The applicant reports that the regional stratigraphy consists of the following (Strata, 2011a):

- a regional basement of Precambrian-age (older than 540 ma) crystalline metamorphic and igneous lithologies;
- a significant thicknesses of Phanerozoic-age (540 to 2 ma) sedimentary lithologies, primarily fine grained siliciclastic consolidated rocks;
- localized intrusions of Tertiary-age (58 to 25 ma) igneous lithologies (outside of the Powder River Basin province); and

- a thin veneer of Quaternary age (less than 2 ma) unconsolidated colluvium or alluvium the most significant thicknesses limited largely to the present-day drainages.

The regional stratigraphic column as presented in the application is depicted on SER Figure 2.3-1.

The applicant provides limited discussions on the Precambrian age basement rocks primarily because of the lack of exposures of the basement throughout the region; the nearest exposure of Precambrian basement is in the central core area of the Black Hills uplift (Strata, 2011a). Based on mapping provided by the applicant (Strata, 2011a), the Precambrian basement rocks are found at depths between 1219 and 1524 meters [4000 and 5000 feet] below grade in the western flank of the Black Hills uplift immediately west of the Ross Project (SER Figure 2.3-2). In the application (Strata, 2011a), the applicant reports an estimated depth to the Cambrian formations of approximately 2621 meters [8600 feet] below grade at the Ross Project, which requires that the Precambrian basement is found at slightly greater depths (approximately 2743 meters [9000 feet] below grade). The basement gradually becomes deeper towards the west (center of the Powder River Basin).

The regional Phanerozoic lithologies consist of Cambrian to Tertiary age sedimentary rocks (Strata, 2011a). The applicant reports that (1) the pre-Mississippian Age lithologies are not exposed (are found only in the subsurface) on the northern and western flanks of the Black Hills uplift; (2) sediments exposed in the Lance District (including the location of the Ross Project) are Early to Late Cretaceous age or Quaternary age sediments; and (3) the majority of Tertiary age sediments that may have been deposited on the Cretaceous age sediments have been eroded (Strata, 2011a). A geologic cross-section depicting depths to various geologic formations in the area is shown on SER Figure 2.6-2.

The applicant reports that the Black Hills uplift and the final deformation of the Powder River Basin developed during the Laramide Orogeny (Strata, 2011a). The Laramide Orogeny occurred between 65 and 43 ma in this area of Wyoming (Redden and DeWitt, 2008). The applicant provides a detailed regional geologic history during the Laramide Orogeny, including depositional environments and the resulting sediments that accumulated during that period of time (Strata, 2011a). The sediment that was deposited during that period of time ultimately was consolidated into the Pierre Shale, which consists of a thick sequence of shales deposited in a marine environment, the Fox Hills Formation, which consists of fine-grained mudstones, siltstones and sandstones deposited in near shore marine environment reflecting a transition from marine (older) to non-marine (younger) environments, and the Lance Formation, which consists of fine-grained mudstones, siltstones and sandstones deposited in near shore non-marine environment (Strata, 2011a).

The applicant states that coal beds are largely absent in the Lance Formation; however, upper portions of the overlying Fort Union Formation contain rich coals seams, which are mined principally for the coal within the center of the Powder River Basin approximately 28 miles west of the Ross Project (Strata, 2012a). The Fort Union Formation is Early Tertiary age with the Cretaceous/Tertiary boundary assigned to the contact between the Lance and Fort Union formations. Based on mapping by the applicant (Strata, 2011a), the nearest surface expression of the Fort Union Formation is mapped at least 2 miles west of the Ross Project (SER Figure 2.3-3).

The applicant provides brief discussions on several additional Tertiary age sedimentary formations that are younger than the Fort Union Formation. Those formations are the Wasatch

Formation and the White River Group (Strata, 2011a). The applicant states that the White River Group sediments were deposited at a time of extensive volcanism that covered the Powder River Basin, including the Black Hills, with tuffaceous material. That material has been subsequently eroded by major regional uplifts resulting in the present-day Black Hills (Strata, 2011a). Staff notes that the Wasatch Formation is found within the center of the Powder River Basin and is the host formation for uranium deposits undergoing ISR operations under NRC licenses (PRI-Highland and Smith Ranch, Willow Creek-Christensen Ranch and Irigaray facilities).

The Tertiary age intrusive lithologies include the Missouri Buttes and Devils Tower within the Black Hills uplift (Robinson et al., 1964). The applicant did not include in depth discussions on the intrusive lithologies because they are not located within the Powder River Basin within the area of influence for the Ross Project. Staff expects that the Tertiary age lithologies will not have an impact on the geologic or hydrogeologic setting for the Ross Project.

The applicant reports that the primary regional geologic structures consist of the Black Hills monocline and the Powder River syncline (Strata, 2011a). The applicant states that Black Hills monocline has been mapped for at least 150 miles along the western flank of the Black Hills uplift (see SER Figures 2.6-2 and 2.6-3). The monocline consists of a narrow area over which the orientation of gently westerly dipping strata along the western flank of the Black Hills uplift steepens to a nearly vertical dip over a short distance, with the overlying strata returning to a gentle western dip west of the monocline within the Powder River Basin. This monocline is the demarcation of the western block of the Black Hills uplift (Strata, 2011a). The applicant provides a regional cross-section depicting the monocline (see SER Figure 2.6-2), and reports that outcrops of the Lance Formation near the Ross Project have 1 to 2 degree basinward dips towards the synclinal axis of the Powder River Basin.

The synclinal axis of the Powder River Basin is asymmetrical being located closer to the western margin of the Powder River Basin then the eastern margin (Strata, 2011a). The applicant notes that the impressive topographic expression of strata observed along the western flank of the Powder River Basin (in the area of the Big Horn Mountains) contrasts sharply with the indistinguishable topography along the eastern flank (in the vicinity of the Ross Project).

The applicant reports that Crook County has an abundance of mineral resources including coal, oil, gas, bentonite, sand and gravel, gypsum, limestone, uranium and vanadium (Strata, 2011a). The applicant reports that 192 oil and gas wells are located within two miles of the Ross Project of which only 19 wells are producing wells. Those wells target the Minnelusa Formation (Strata, 2011a). The majority of the remaining oil and gas wells are plugged and abandoned (Strata, 2011a). The applicant states that three operating oil and gas wells are located within the Ross Project and that no future oil and gas wells are expected in the future (Strata, 2011a;2012b).

The applicant reports that bentonite mining does occur within 80 km (50 mi) of the Ross Project (Strata, 2011a;2012b), no coal or coal-bed-methane production occurs within 80 km (50 mi) of the Ross Project (Strata, 2011a;2012b) and no nuclear fuel cycle facility or operational uranium recovery facility exists within 80 km (50 mi) of the Ross Project (Strata, 2011a). The applicant reports that four potential uranium recovery projects (other than those owned by the applicant) are within 80 km (50 mi) of the Ross Project (Strata, 2011a). Those potential projects include the Powertech's Aladdin ISR project, Bayswater's Elkhorn Project, Bayswater's Alzada (Montana) Project and the UR-Energy/Bayswater's Huber Project (Strata, 2011a;2012b). In response to staff's RAIs (Strata, 2012b), the applicant provided additional information on the nearby potential uranium projects. Most of the nearby projects target the Lower Cretaceous Fall

River and Lakota Formations, which are found stratigraphically below the Pierre Shale, and will not be impacted by or have impacts to the Ross Project (Strata, 2012b).

The applicant's future projects include several located in the applicant's defined Lance District. The Lance District is a 56 square mile area that coincides with the surficial outcropping of the Lance Formation. The Ross Project is located in the northernmost portion of the Lance District and the future projects for the applicant in the Lance District extends to a distance of approximately 20 miles from the Ross Project (Strata, 2012b). The future projects in the Lance District are ISR operations in the Lance Formation and thus may impact or be impacted by the Ross Project.

Staff verified the applicant's information through an independent review of published sources referenced in the application as well as sources identified by staff during its review (Connor, 1992; Dodge and Powell, 1975; Mears, 1993; Redden and DeWitt, 2008; Robinson et al., 1964; Whitcomb and Morris, 1964) and others (Darton and Page, 1925; Dobbin and J B Reeside, 1929; Downey, 1986; Harris et al., 1992; Merewether, 1996; Redden and DeWitt, 2008; Seeland, 1992). Staff finds that the information portrayed by the applicant accurately reflects information in those sources. Based on this review, the staff finds that the applicant has provided adequate description of the regional geologic setting consistent with the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the SRP (NRC, 2003), thus they would meet requirements of 10 CFR 40.41(c), if issued a license.

The applicant's discussions in Section 2.6 of the application did not emphasize several regional geological features that provide additional context to the applicant's site conceptual model. As noted above, the applicant reports that the thickness of the Upper Cretaceous Fox Hills/Lance Formation in the Powder River Basin increases to the south. In Technical Report Table 2.7-19 (Strata, 2011a), the applicant notes that thickness of the Upper Cretaceous Pierre Shale also increases in the southerly direction. An increase in thickness of the Upper Cretaceous formations affects the regional hydrogeologic setting as discussed in SER Section 2.4.4.

In addition to an increase in thickness, the source of material deposited that ultimately forms the Upper Cretaceous Age lithologies are significant to the conceptual geologic model. The applicant reports that the source of sediment in the Lance Formation was from upland areas in western Montana, and that the source of volcanic material for the Tertiary volcanic deposits, which is now eroded but attributed to the source for the uranium in the roll deposits at the Ross Project, was located also west of the Powder River Basin (Connor, 1992; Dodge and Powell, 1975; Merewether, 1996; Seeland, 1992; Strata, 2011a). However, the applicant did not discuss the fact that the likely source areas for the Pierre shale were areas also west and north of the Ross Project. The source area is important in the context of the Pierre Shale lacking permeable zones in the region near the Ross Project. The applicant did state that "oil wells typically indicate the absence of water-bearing zones" and "[l]ocally, the upper Pierre Shale is void of any permeable water-bearing strata" but without specific references for that statement (Strata, 2011a). The published data indicate that the regional source for material comprising the Upper Pierre Shale was to the north and west, and that the more permeable, water bearing zones used to record regressions/transgressions of the Cretaceous Sea are largely limited to areas in western Powder River basin (Anna, 1986; Downey, 1986; Merewether, 1996). Staff finds that the applicant's statement is indeed consistent with published data.

Third, the applicant reports that bentonite mining occurs in the area; however, the applicant did not include in its discussions that bentonite from this area of Wyoming, especially bentonite found in the Early and Late Cretaceous formations, is sodium-rich (Downey, 1986; Harris et al.,

1992). This fact supports the applicant's discussion on geochemistry of the clay mineralogy in the ore deposits in its response to staff's RAIs (Strata, 2012b).

Finally, the applicant reports potential future uranium recovery facilities that may be pursued within the region (Strata, 2011a;2012b). The applicant correctly references the sources of information as the ISR GEIS (NRC, 2009a) for one project and the future operator/exploration company for the others. Staff acknowledges that the information is correct with regard to the sources, but also acknowledges that letters of intent are not currently on record at NRC for any of the applicant's future potential uranium recovery facilities in the Lance District or the other projects listed by the applicant. Staff agrees with the applicant that the future potential uranium recovery facilities located outside of the Lance District will likely target the Inyan Kara Group (Fall River and Lakota Formations) because of the historic mining that took place during the 1950s in those areas (Robinson et al., 1964).

2.3.3.3 Site-Specific Geology

The applicant reports that the stratigraphy significant to the proposed activities at the Ross Project consists of the recently deposited unconsolidated surficial deposits and the Upper Cretaceous-age lithologies comprised of, in order of increasing age (depth), the Lance Formation, Fox Hills Formation and Pierre Shale (Strata, 2011a). The ore deposits subject to the proposed activities are found within a 30- to 55-meter [100- to 180-foot] thick (an average of 41.5 m [136 feet]) sequence of lithologies that encompasses both the lower portions of the Lance Formation and upper portions of the Fox Hills Formation (Strata, 2011a). The depth to the top of the mineralized zone at the Ross Project is between 76 and 201 meters [250 and 660 feet] below grade; in general, the depth to the top of the mineralized zone increases in the westward direction (Strata, 2011a). The applicant discusses the stratigraphy of the mineralized zones in detail based on data from historical explorations, current explorations and a study by Buswell for his master's thesis (Buswell, 1982).[6]

Pierre Shale

The applicant reports that most boreholes completed by the applicant or past uranium exploration companies terminate at the top of the Pierre Shale (Strata, 2011a). Consequently, the applicant's site-specific information on the Pierre Shale is based on published sources of information (Strata, 2011a). The sources that the applicant relied on for its description of the Pierre Shale consist largely of geophysical wells from oil and gas wells drilled in the area, published geologic mapping and visual observations in areas east of the Ross Project in which the Pierre Shale outcrops at ground surface (Strata, 2011a).

The applicant estimates that the depth to the top of the Pierre Shale varies between152 and 299 meters [500 and 980 feet] below grade in the Ross Project and an estimated thickness of 670 m [2200 feet] (Strata, 2011a). The applicant states that the Pierre Shale has an absence of water-bearing horizons based on the geophysical logs (from the oil and gas drill holes) and thus considers the Pierre Shale to be a regional groundwater confining unit within the Ross Project because of its estimated low permeability and thickness (Strata, 2011a).

The applicant developed site-specific nomenclature for the stratigraphic sequence of interest (SER Figure 2.3-4). The applicant designates the Pierre Shale as KP, which is similar to the

[6] The application includes Buswell's 1982 thesis as Addendum 2.6-A.

designation for the Cretaceous (K) Pierre (p) Shale as a mapable formation in published literature (see (USGS, 2013) and SER Figure 2.3-3).

The applicant states that the Pierre Shale is conformably overlain by the Fox Hills Formation (Strata, 2011a).

Fox Hills Formation

The applicant states that, regionally, the Fox Hills Formation has been divided into an upper and lower unit in previous studies (Strata, 2011a). The material comprising the lower unit is attributed to deposition in marginal marine, foreshore or shore-face (strandline) environments whereas the material found in the upper unit is attributed to deposition in near-shore estuarine environment (Strata, 2011a). The applicant reports that the Fox Hills Formation is dominated by fine-grained sandstones, with a general fining-upward sequence that is typical of the Powder River Basin (Strata, 2011a). The depositional environments for the Fox Hills Formation represent a transition from marine (underlying Pierre Shale) to terrestrial depositional patterns (overlying Fox Hills Formation)(Strata, 2011a).

In its detailed stratigraphic analysis, the applicant reports that the lower Fox Hills Formation, which is not part of the designated ore zone, consists of two sandstone members separated by shales (mudstones) and siltstones.[7] The lowermost sandstone member, which the applicant designates as the "FS" horizon, includes interbedding of thin shale and siltstone lenses, which are capped by a calcareous-cemented sandstone. This lowermost sandstone member is interpreted to represent the basal unit of the Fox Hills Formation (Strata, 2011a). The base of this lowermost sandstone member has a gradational contact with the underlying lithologies (i.e., the Pierre Shale), a coarsening upwards sequence to a sharp contact with the overlying mudstones/siltstones within the lower Fox Hills Formation. Thickness of the FS horizon is approximately 6.1 to 10.7 meters [20 to 35 feet] (Strata, 2011a).

The applicant describes the other sandstone member of the lower Fox Hills Formation, which the applicant designates as the "BFS" horizon, as thinly bedded sandstones with interbedded shales, siltstones and calcareous-cemented sandstones. The BFS horizon has a sharp lower contact with the lower mudstones/siltstones (Fox Hills Formation), contains an upward fining sequence, and its upper contact with the overlying mudstones is gradational (Strata, 2011a). Thickness of this BFS horizon ranges from 3.0 to 9.1 meters [10 to 30 feet], with an average of 5.0 meters [16.5 feet]. This horizon also has the applicant's designation as the "DM" aquifer, or the underlying aquifer, as it represents the first contiguous water-bearing horizon under the proposed ore body (Strata, 2011a).

Materials in the upper Fox Hills Formation above both sandstone members (the FS and BFS horizons) consist of interbedded black to dark gray shales, siltstones and claystones that contain marine fossils (Strata, 2011a). The applicant designates these horizons as the "BFH" horizon(s). The thickness of the BFH horizon between the BFS horizon (DM aquifer) and the overlying units in the upper Fox Hills Formation, which are included within the ore zone, ranges between 3.0 and 15.2 meters [10 and 50 feet], with an average of 9.8 meters [32 feet]. The applicant assigns the BFH designation to strata below the BFS horizon and reports that the thickness of this portion of the BFH horizon is also between 9.1 to 15.2 meters [30 to 50 feet]

[7] The applicant used the term sand, shales and silts to describe the units; however, staff will use the associated terms with the sedimentary consolidated lithologies.

(Strata, 2011a). The applicant states that the BFH horizon above the BFS horizon is contiguous throughout the Ross Project and designates this BFH horizon as the "underlying confining unit".

The applicant states that the remaining portion of the upper Fox Hills Formation above the BFH horizon consists of primarily two sandstone types (Strata, 2011a). The first type is a thick-bedded, blocky, well- to moderately well-sorted, fine-grained sandstone. The second type consists of thin, interbedded sandstone, siltstone and shale lenses. Sandstone lenses in this second type consist of moderately to poorly sorted, fine- to very fine-grained sandstone with the interbedded black shales and dark gray siltstones that are slightly bioturbated and potentially containing coalified leafy matter and small carbonaceous fragments (Strata, 2011a). Thickness of this portion of the upper Fox Hills Formation is between 15.2 and 19.8 meters [50 and 65 feet] (Strata, 2011a).

The applicant designates the sandstones in the uppermost portion of the upper Fox Hills Formation above the BFH horizon as the "FH" horizon (Strata, 2011a). The FH horizon makes up the lower portion of the ore body or mineralized zone. The applicant identifies mineralization within four intervals of the FH horizon. The ore mineralization is associated with three to four discontinuous interbedded sandstones as described above as the second type. The applicant refers to the mineralized roll fronts with letter designations as "A", "B", "C" or "D", in stratigraphically ascending order.

Lance Formation

The applicant reports that the Ross Project lies entirely within the aerial extent of mapped outcrops of the lower Lance Formation, though the Lance Formation outcrops are poorly exposed at ground surface, (i.e., the Lance Formation is generally mantled by a thin veneer of soil). Consequently, only the lower portions of the Lance Formation occur in the subsurface at the Ross Project (Strata, 2011a). The upper portions of the Lance Formation are mapped at ground surface and found in the subsurface west of the Ross Project.

The lower Lance Formation conformably overlies the Fox Hills Formation (Strata, 2011a). The sediments comprising the Lance Formation were deposited in a fluvial-deltaic environment and reflect the final withdrawal of the Cretaceous Seaway in this area of the Powder River Basin (Strata, 2011a). The applicant describes the lower Lance Formation as being comprised of multiple sandstone bodies bounded by abundant shales and siltstones (Strata, 2011a). The lower Lance Formation is dominated by fluvial-channel, fine-grained to very fine-grained sandstones (one-third of the formation) whereas the remaining stratigraphic thickness is composed of interchannel mudstone and sandstone (Strata, 2011a). The interchannel mudstone and sandstone are finer grained, compared to the channel deposits, and consist of sandy clay that swells when wet, and tuffaceous mudstones. The mudstones contain degraded plant material debris, but coaly shales are absent (Strata, 2011a).

The applicant reports that the lower Lance Formation was divided into two packages by the earlier work of Buswell (1982). The stratigraphically lowermost package is comprised of thickly bedded sandstones with thin, interbedded sandstone, siltstone and shale (Strata, 2011a). The thickly bedded sandstones are fine- to very fine-grained, contain clasts of carbonaceous fragments and coalified woody fragments, have sharp upper and lower contacts, are typically narrow and straight, with a net north-south orientation, and are interpreted as representing complex rejoining channel patterns that resulted from rapid and repeated channel diversions in a coastal plain environment. The interbedded material consists of organic-rich or lignitic shales, siltstones and very fine-grained sandstones, and are interpreted as interchannel deposits. The

second sandstone package in the lower portion of the Lance Formation, which stratigraphically overlies the lowermost package, consists of small, narrow, “shoestring”, east-west oriented fine- to very fine-grained sandstones with sharp lateral boundaries. The sandstones within this package are bounded laterally by abundant gray shales and siltstones (Strata, 2011a).

The applicant designates the basal units of the lower Lance Formation into an “LT” or LTS” horizon. The LT horizon consists of thickly bedded sandstones and the LTS horizon, if present, consists of thin interbedded sandstones, siltstones and shales. The LT horizon contains the uppermost mineralized horizon, which the applicant designates as the “E” roll front, whereas the mineralization is generally lacking in the LTS horizon (Strata, 2011a). The applicant reports the thickness of the LT horizon varies between 9.1 and 12.2 meters [30 and 40 feet] and the thickness of the LTS horizon varies from 0 to 6.1 meters [0 to 20 feet].

The applicant designates the ore zone as the combined LT and LTS horizons of the lower Lance Formation and the FH horizon in the upper Fox Hills Formation (Strata, 2012b). The ore zone is also designated by the applicant as the “OZ” aquifer. Thickness of the OZ aquifer varies between 30.5 and 54.9 meters [100 and 180 feet], with an average of 41.5 meters [136 feet] (Strata, 2011a).

The remainder of the lower Lance Formation overlying the OZ aquifer consists of fine to very fine grained sandstones, siltstones and mudstones that represent interbedded floodplain deposits (Strata, 2011a). These sandstones, siltstones and mudstones extend from ground surface to the top of the ore zone, which the applicant designates as the “LA” through “LS” horizons. Based on descriptions in SER Figure 2.3-4, each individual horizon is based on changes in major lithology presented within a particular horizon. The thickness of each horizon varies between 0 and 18.3 meters [0 and 60 feet]; in general, the horizons comprised of sandstones are thinner than horizons comprised of siltstones and mudstones. The applicant states that not all horizons are observed at all locations throughout the Ross Project area (Strata, 2011a).

Based on Figure 2.6-7 of the Technical Report (Strata, 2011a), the LA through LS horizons are designated in chronological (alphanumeric) order with increasing depth except for the LC horizon. The LC horizon consists of the mudstones immediately overlying the LT horizon (OZ aquifer). The applicant reports that this horizon is contiguous throughout the Ross Project with thicknesses ranging from 6.1 and 24 meters [20 to 80 feet], an average of 13.1 meters [43 feet] (Strata, 2011a). The applicant refers to the LC horizon as the “upper confining unit”, though additional horizons (LN through LS) may exist and contribute to the confinement of the mineralized zone from the designated overlying aquifer.

The applicant designates the overlying aquifer, which the applicant also refers to as the shallow monitoring (SM) aquifer, to the LK, LL and LM horizons (Strata, 2011a). The applicant reports that the SM aquifer is the first laterally contiguous, water-bearing sandstone package above the mineralized zone. The thickness of the SM aquifer varies between 18.3 to 51.8 meters [60 to 170 feet], with an average of 34.1 meters [112 feet] (Strata, 2011a). The depth to the top of the SM aquifer varies from 30.5 to 137 meters [100 to 450 feet]; in general, the depth increases in the westerly direction.

The applicant reports that the horizons above the SM aquifer (i.e., the LA, LB, LD, LE, LF and LG horizons) are fine grained and act to confine the SM aquifer (Strata, 2011a). Thickness of this confining unit above the SM aquifer varies from 6.1 to 36.6 meters [20 to 120 feet], with an average of 18.3 meters [60 feet]. The applicant reports that “sandy units” in the uppermost LA

and LB horizons may be locally saturated and hydraulically connected to the surficial aquifer (hydraulically connected to the surface water bodies), which the applicant designates as the “SA” aquifer.

Formations older than the Pierre Shale

The applicant does not discuss in depth on site-specific lithologies stratigraphically older than (underlying) the Pierre Shale. The applicant’s rationale for not discussing the older lithologies is: (1) site-specific information on those lithologies is limited because most on-site borings terminate at the top of the Pierre Shale; and (2) the Pierre Shale is a regional confining unit that limits potential impacts from the proposed Ross Project to lithologies younger than (above) the Pierre Shale. The exceptions are the Cambrian-age Deadwood and Flathead formations, which the applicant plans to use as the recipient formation for liquid waste disposal through deep well injection (see SER Section 4.2). The applicant reports that the estimated depth for the proposed deep well injections into the Cambrian-age formations is between 2488 and 2610 meters [8163 and 8565 feet] below grade (Strata, 2011a). Staff estimates, based on regional thickness of those Cambrian Age formations and the applicant’s estimated depth to the Cambrian age formations that the depth to bedrock at the Ross Project is approximately 2743 meters [9000 feet]. This estimate is consistent with the regional geologic cross section provided by the applicant (see SER Figure 2.3-2).

Formations younger than the lower Lance Formation

The applicant does not provide detailed descriptions of the upper Lance Formation or younger formations as these formations are not found within the Ross Project. Based on the geologic mapping provided by the applicant (Strata, 2011a), the contact between the Lance and Fort Union formations is approximately 2 miles west of the Ross Project.

The applicant provides a description of recent unconsolidated surficial deposits in the area of the proposed central processing plant (CPP) based on detailed on-site investigations performed by the applicant (Strata, 2011a;2012b). From those investigations, the applicant reports that the unconsolidated surficial deposits in the CPP area consist of fine- to very fine-grained alluvium, colluvium and eolian deposits. The surficial deposits are comprised largely of clays, but also include localized lenses of sand to pebble conglomerates. Thickness of the unconsolidated surficial deposits in the area of the proposed CPP varies from 0.6 to 10.7 meters [2 to 35 feet]. The deposits generally overly a deeply weathered Lance Formation (i.e., the physical properties of the Lance Formation have been altered due to weathering to a substantial thickness (several feet) below the reported “top of the Lance Formation”).

For areas within the Ross Project outside of the CPP, the applicant provides details on the recent unconsolidated sediments from a soil survey conducted throughout the Ross Project as discussed in SER Section 2.3.3.5, and published geologic mapping showing Quaternary Alluvium along the present-day channels of the ephemeral Little Missouri River and Deadman Creek (Strata, 2011a). In Table 2.7-9 of the Technical Report (Strata, 2011a), the applicant describes the alluvium as unconsolidated silt, sand and occasional gravel that underlies flood plains and bordering terraces. The applicant reports that thickness of the alluvium is typically under 7.6 meters [25 feet]; however, the thickness may be up to 15.2 meters [50 feet] in major drainages (Strata, 2011a).

Structural Features

The applicant states that the Black Hills monocline is the major regional geological structural feature, which serves as the boundary between the Black Hills uplift to the east and the Powder River Basin to the west (Strata, 2011a). For the Ross Project, the Black Hills Monocline is located along and oriented roughly parallel to its eastern margin (Strata, 2011a). The applicant reports that the Fox Hills and Pierre Shale outcrops along the Black Hills monocline within ¼-mile east of the Ross Project. The applicant states that bedding along the monocline has nearly vertical dips, which contrasts with the shallow dips of same formations within the Ross Project even within several hundred feet of the monocline (Strata, 2011a).

The applicant provides geologic cross sections, fence diagrams, structural contour maps and isopach contour maps for the various hydrogeologic units to support its conceptual model of the subsurface geology (Strata, 2011a).

Previous Studies

The applicant reports results of prior studies on the subsurface geology within the Ross Project. The prior studies consist of a Master's of Science thesis prepared by Buswell (1982), and assorted documentation associated with a former research and development (R&D) ISR project, hereinafter referred to as the Nubeth R&D site, which was licensed by the NRC between 1978 and 1986 (Strata, 2011a).

The applicant incorporates descriptions of the subsurface geology made by Buswell (1982) into its conceptual model of the geology with one notable exception. The applicant disagrees with Buswell's interpretation of faulting within the area. Buswell had extrapolated a complex pattern of small-scale pre-mineralization faulting (see Addendum 2.6-A of the Technical Report (Strata, 2011a)). Buswell's evidence for faulting consisted of slickenslides in one core, hydrologic barriers noted in pumping tests, and displacement of stratigraphic units ranging between 6.1 and 9.1 meters [20 and 30 feet].

The applicant disagrees with Buswell's interpretation of faulting suggesting that no faults of major displacement exist in the Ross Project (Strata, 2011a). Strata reports that the linear features, as interpreted by Buswell (1982) as faults, are depositional rather than structural features consisting of localized slumps, folds and differential compaction. The applicant discounts Buswell's slickenside observation from one core as conjecture and subjective judgment on the part of Buswell. For the hydrologic barriers noted in the pumping test (see discussion in SER Section 2.4.3.4.3), the applicant refers to the hydrologic report cited by Buswell, which reports that the lateral discontinuity in the stratigraphy was the more probable reason for some observation wells to be hydrogeologically isolated rather than structural faulting, which contrasts with Buswell's faulting interpretation (Strata, 2011a). Finally, the applicant recalculates displacement along the Buswell-proposed faults based on more-accurate, recently acquired reference elevations (Strata, 2011a). The applicant states that, based on the updated evaluation, the apparent displacement of the various bedding is a maximum of 3.0 to 3.7 meters [10 to 12 feet] and is better explained by slumping and differential compaction to the stratigraphy than faulting. The applicant further states that accuracy of Buswell's reference elevations likely contributed to the interpreted fault displacement of bedding of 3.0 to 9.1 meters [10 to 30 feet] (Strata, 2011a).

For the former Nubeth R&D site, the applicant provides a discussion of historical documentation dating back to the initial identification of radiological anomalies in the 1970's, permitting and operations of the Nubeth R&D site between 1978 and 1979, and restoration and

decommissioning activities culminating with approval for license termination in 1986 (Strata, 2011a). The applicant states that the former Nubeth R&D site had limited success in production of yellowcake, but overall demonstrated that commercial ISR operations and restoration could be successful (Strata, 2011a). The limited success in production during its Phase I operations was attributed to injectivity problems (Strata, 2011a). The applicant states that a report prepared for the former licensee concluded that commercial production at the site (Phase II) was viable (Strata, 2011a). The commercial production was not pursued due to declining uranium prices at that time and negative impacts to the nuclear industry due to the 1979 accident at Three Mile Island Nuclear Power Plant (Strata, 2011a). The applicant reports that restoration was approved by the regulatory agencies (Wyoming and NRC), and the site was properly decommissioned for license termination.

The applicant provides an in-depth discussion on the injectivity problems at the former Nubeth R&D site. The applicant attributes the injectivity problems to fines and organic material buildup in the wellfields due to insufficient filtering equipment during the R&D operations (Strata, 2011a). In Section 3.1 of the Technical Report (Strata, 2011a), the applicant states that improvements to the well design, well development and filtration systems will be used at its proposed facility (Strata, 2011a).

<u>Ore zone</u>

The applicant states that the ore deposits (ore mineralization or ore bodies) at the Ross Project consist of epigenetic roll front deposits in sandstone host formations similar to ore deposits observed elsewhere in the Powder River Basin (Strata, 2011a). The applicant states that the ore bodies developed from oxidized uranyl-bearing groundwater moved downdip within the host formation precipitating uranium in coatings on sand grains as the oxidized groundwater encountered reducing conditions of the host formation. Deposition of the uranium occurred at the oxidation/reduction front, i.e., the point at which the reducing conditions downgradient prevailed over the oxidation of the groundwater, but the reducing conditions of the formation upgradient of the roll front had been overcome by the oxidation of groundwater, and the uranium mobilized. The applicant states that the deposition of the uranium was a function of several factors including permeability of the host formation, reducing conditions of the host formation and groundwater flow (Strata, 2011a).

Based on three core samples, the applicant reports that the composition of ore deposit sandstones consists of fined grained, argillaceous sandstone with abundant quartz grains, moderate to common feldspar grains and trace to minor amounts of lithic fragments including metamorphic, carbonate, sandstone and argillaceous rock fragments, detrital and authogenic clay minerals (kaolinite, chlorite or illite), chert, calcite, pyrite, micas, heavy minerals (titanium oxide) and carbonaceous plant fragments (Strata, 2011a). The detrital clay minerals consist of illite and the authogenic clay minerals are primarily kaolinite. The applicant reports that the clay mineralogy for one core sample includes up to 5 percent montmorillinite, a smectite group clay. The applicant reports that the principal uranium minerals are uraninite and coffinite and that vanadium-bearing minerals vanadinite and carnotite are found in association with the uranium (Strata, 2011a). The applicant also reports that, based on the petrographic analysis of core samples, two of three “sandstone” samples contain abundant primary intergranular pore space whereas the third “argillaceous sandstone” sample contains moderate amounts of primary pore space (Strata, 2011a). The reduction in primary pore space of the argillaceous sample is attributed to the existence of detrital and authogenic clay minerals (Strata, 2011a).

The applicant states that ore bodies within the Ross Project have two differing geometries (Strata, 2011a). The applicant attributes the differing geometries of the ore bodies to differences in the original depositional environments of the strata making up the host formations (Strata, 2011a). The roll front deposits in the upper Fox Hills Formation are generally thicker and more massive due to the thicker sandstones that were deposited in a near-shore marine environment. The roll front deposits in the lower Lance Formation are narrow and often stacked due to the narrow fluvial channel sands that were deposited in the on-shore deltaic environment (Strata, 2011a).

The applicant states that the estimated recoverable resources at the Ross Project consist of 5.5 million pounds of uranium.

With the noted exception below, staff finds that the applicant's description of the site-specific geology meets the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the SRP (NRC, 2003), because the application contains a local stratigraphic description based on sampling, geophysical logs, geologic cross-sections, isopach and structural contour mapping and fence diagrams, a geologic and geochemical description of the ore zone and units immediately surrounding the ore zone and a description of the local geologic structures. The information was verified by staff's independent review of published data primarily for the former R&D facility. The mapping was clearly labeled, exhibited locations of all features discussed in the application (well locations, cross-section lines), drawn at appropriate scales and included proper geographic references.

The noted exception is the analysis of the potential for preferred migration paths due to heterogeneities in the ore zone geology. Staff finds that the applicant did provide an adequate description of the heterogeneities in the ore zone. Staff agrees with the applicant's departure from Buswell's interpretation ofthe faults based on the evidence provided in the application. However, staff does not fully agree with the applicant's argument that the heterogeneities in the Ross Project ore zone geology are similar to heterogeneities in other ore zone geologies that have undergone ISR operations. The applicant's argument is exemplified by the introductory sentence in Section 6.1.6.1 of the Technical Report (Strata, 2011a):

> *"Although depositionally and formationally different, roll front deposits in the western interior that have undergone successful recovery and restoration have a number of common attributes, key of which is a permeable host rock, typically consisting of slightly dipping sandstones deposited in fluvial or marginal marine environments."*

As noted by the introductory sentence, the facts are that (1) the host formation at the Ross Project is unique compared to the host formations at other ISR facilities in Wyoming (Upper Cretaceous Lance/Fox Hills Formation versus the Tertiary Wasatch Formation); and (2), the depositional environments are different (marine to marginal marine fluvial environments versus terrestrial fluvial environments). In a broad sense, a sequence of interlayered mudstones, siltsones and sandstones with similar detrital material will have common traits regardless of the geologic time or environments during which the original material was deposited. However, the applicant acknowledges that the lateral discontinuity of the stratigraphy has led to hydraulic isolation of observation wells in the ore zone host formation at the Ross Project. The hydraulic isolation refers to the lack of responses in water levels at several monitoring wells during the Nubeth R&D operations. In addition to hydraulic isolation, staff has inferred that changes in water quality can also be associated with the hydraulically isolated wells (for further discussion,

see SER Sections 2.4.3 and 2.5.3). Therefore, staff will include a license condition, which would limit the minimum density of baseline wells for the ore zone aquifer to one well per 2 acres (see SER Section 5.7.8.4). Staff is reasonably assured that, with that license condition, preferred migration paths and variability in the baseline water quality due to the heterogeneities of the host formation will be identified such that the applicant will have the ability to confine its possession and use of source and byproduct material to locations and purposes identified in the approved application.

2.3.3.4 Historic Borings

The applicant reports the status on the number of historic exploratory and delineation drill holes and wells completed within or near the Ross Project.[8] The status is reported in various sections of the Technical Report, most notably in Section 2.6.1, Section 3.1.1 and Addendum 2.6-B and Addendum 2.6-E (Strata, 2011a). The number of drill holes as presented in the various sections of the application is reported from different perspectives, which is slightly confusing to the casual reader. The number of borings is not consistent because: (1) the number of exploratory borings installed and/or surveyed by the applicant was changing during the preparation of the application and the reference date for one particular section differs from that for another; or (2), the reported numbers are for various subsets that may not be directly comparable (i.e., surveyed versus not surveyed, installed by Nubeth or Strata, or located within the Project area or within ½ mile radius of the Project Boundary). Based on staff's evaluation, the most complete or best estimate of the existing number of exploratory and delineation drill holes at the time of the application submittal is listed in Table 1 of Addendum 2.6-E (Strata, 2011a).

The applicant reports that 2222 exploratory and delineation drill holes were located within a ½-mile of the Ross Project (Strata, 2011a). Of that number, the former owners (Nubeth and its predecessor) completed 1682 drill holes and the applicant completed 540 drill holes (Strata, 2011a). Those numbers noted by the applicant and summarized in this SER were current as of October 2010. While the number of borings completed by the former owners would not have changed since submittal of the Ross Project application, the number of borings completed by Strata is expected to have increased as a result of additional delineation of the ore body being conducted by the applicant since submittal of the application.

In Addendum 2.6-E of the technical report (Strata, 2011a), the applicant states that it is required to properly abandon the exploratory and delineation drill holes completed by Strata using existing abandonment procedures as required by the State of Wyoming. The applicant provides its Standard Operating Procedures for abandoning new exploratory or delineation drill holes (Strata, 2011a). In Addendum 2.6-E (Strata, 2011a), the applicant reports that documentation of abandonment practices for the majority of Nubeth drill holes is not available. In Section 2.6 of the technical report (Strata, 2011a), the applicant reports that the abandonment methods used by the former owners met all State of Wyoming requirements at the time the drill holes were abandoned. The State's abandonment requirements have changed over time; the current state requirements for drill hole and well abandonment are stricter than those applicable prior to 1996. The applicant lists that the existing drill holes were abandoned with cement or plug gel.

In Addendum 2.6-E of the technical report (Strata, 2011a), the applicant states its intent to locate each of the Nubeth drill holes and abandon each drill hole within the Ross Project in accordance with the current State of Wyoming requirements. The applicant states that the

[8] The applicant refers to the historical exploration and delineation borings as boreholes, drillholes or drill holes.

location of existing drill holes can be found in the field using a metal detector because metal plugs are often associated with the drill holes (Strata, 2011a). The applicant reports that 300 Nubeth drill holes have been surveyed within the Ross Project as of June 18, 2010, and reports that, within ½-mile of the Ross Project, 1115 drill holes have been surveyed while 962 drill holes have not been surveyed as of June 18, 2010.[9]

Based on the numbers provided by the applicant in Addendum 2.6-E of the technical report (Strata, 2011a), 65 Nubeth drill holes were abandoned by the applicant (398 minus 333).[10] In Addenda 2.6-E and 2.7-F of the technical report (Strata, 2011a), the applicant states that 55 drill holes were abandoned within an approximately 500-foot radius of well cluster 12-18 prior to the pumping tests conducted in that area. Based on information in Table 1 of Addendum 2.6-B (Strata, 2011a), the plugging procedures for 1616 Nubeth exploratory drill holes are unknown by applicant, 398 drill holes are abandoned with cement and 208 drill holes are abandoned with Plug Gel as of October 2010.[11]

In addition to the drill holes, the applicant reports that Nubeth and its predecessors installed 47 wells, 44 of which have been abandoned by the previous owners (Strata, 2011a). Ownership of the three wells that were not abandoned was changed to Merit Oil (2 wells) and a private landowner (1 well) and eventually to Merit (Strata, 2011a). The wells owned by Merit are currently used for water supplies for the oil reservoir flooding operations (Strata, 2011a).

The staff reviewed the information provided by the applicant and found the information consistent with guidance in NUREG-1569. Section 2.2.3 of NUREG-1569 states:

> "*locations of abandoned wells and drill holes, including …plugging procedure used…for each well or drill hole within the site area and within 0.4 km [.25 mi] of the wellfield boundary."*

Section 2.6.3 of NUREG-1569 states that the staff can find the characterization of the geology acceptable if:

> *"plugging and abandonment records are provided from State, Federal, and local sources, as appropriate, and that the applicant should provide evidence that action has been undertaken to properly plug and abandon all wells that cannot be documented in this manner*."

The staff acknowledges that the applicant has undertaken efforts to provide information on historic abandoned boreholes/wells (drill holes) and recognizes that the applicant commits to the plugging of all abandoned drill holes within the Ross Project. The applicant provides its current SOP for plugging and abandonment; however, the applicant does not provide specific details on the timing for the abandonment activities for the existing drill holes (e.g., all drill holes will be abandoned prior to the pumping test for the first module). Based on the applicant's commitment and the staff's review of the applicant's submitted data, staff finds that the applicant will be able

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[9] It is assumed that the numbers included both drill holes installed by Nubeth and Strata.
[10] In Table 1, 398 drill holes (Strata and Nubeth) were plugged with cement. The narrative lists 333 drill holes completed by Strata were plugged with cement.
[11] The numbers provided by the applicant indicate an error of 1 drill hole, i.e., 66 versus 65 Nubeth drill holes were abandoned. Staff assumes this error is attributed to a clerical error. Also, though a date is not referenced in Addendum 2.6-B, the total number corresponds to the number listed in Table 1 of Addendum 2.6-E for October 2010.

to operate safely within the existing setting provided that the applicant proceeds with its commitments to identify all drill holes and confirm/re-abandon all drill holes from the former owners. The applicant's commitment to abandon the drill holes will be included as a license condition (see SER Section 2.2).

In addition, staff will require abandonment of wells that are screened throughout the entire Lance-Fox Hills Formations and within the footprint of any wellfield production area. The staff is memorializing this commitment in a license condition (see SER Section 2.4.4).

2.3.3.5 Soils

The applicant provides information on soil properties for the entire Ross Project from published sources, by a confirmatory on-site survey of the soil profiles, and through the collection and analyses of chemical and physical properties on selected representative samples (Strata, 2011a). The published sources consist of soils mapping for Crook County, Wyoming, which was conducted by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) between 1960 and 1977. The applicant provides a map of the baseline soils within the Ross Project in the Technical Report Figure 2.6-9 (Strata, 2011a;2012a). The raw data from the on-site survey and sampling efforts are presented in Addenda 3.3-A through 3.3-F of the environmental report (Strata, 2011a). The confirmatory survey and collection of samples were conducted by the applicant in 2009 and 2010. Results of the survey and sample analyses were used to refine the NRCS mapping.

The applicant describes the soils in the Ross Project as typical for semi-arid grasslands and shrublands in the Western United States (Strata, 2011a), and maps all soils within the Ross Project into 15 mappable units (Strata, 2011a;2012a). The parent materials for the soils consist of residuum, colluvium and alluvium. The applicant characterizes the soils as either moderate to deep, clayey or fine-texture soils on nearly level uplands and near drainages, or, shallow, sandy or coarse-texture soils on hills, ridges and breaks. The applicant reports that the suitability of soil as a plant growth medium is largely marginal to unsuitable based on physical factors (e.g., high clay texture and saturation percentages) and chemical factors (selenium, SAR and pH). The applicant reports that no prime farmland was indicated for the mapped soils within the Ross Project and that the slightly coarser texture of the surficial soils would contribute to soils that are slightly more susceptible to wind erosion than from water erosion.[12]

A primary purpose of the applicant's soil survey was to establish the average topsoil salvage depth, a requirement for the Wyoming Permit to Mine Application. The applicant reports the salvage depth varied from 0.09 to 1.5 meters 0.29 to 5.0 feet, with a weighted average of 0.41 meters [1.36 feet].

The applicant also reports results of an on-site survey of wetland soils (see SER Section 2.4.3).

The staff finds that the applicant adequately described the soils in the proposed license area in accordance with the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the SRP (NRC, 2003) because the applicant's soil description is based on widely accepted published data supplemented by a site field survey and sample collection and analyses in accordance with established field survey and sampling protocols. The mapping, descriptions and sample analyses support the applicant's evaluation of environmental effects of construction and operations on erosion.

[12] In Addendum 3.3-E, the applicant notes that various mapped units are prime farmland only if irrigated.

2.3.3.6 Seismology

The applicant reports that a surface expression of capable faults (i.e., active faults that would be able to produce an earthquake than may cause damage to structures) are not mapped within or near the Ross Project (Strata, 2011a). The applicant states that the closest capable faults are located 270 km (168 mi) west-southwest of the Ross Project in central Wyoming.

The applicant reports that earthquakes in Wyoming occur largely associated with magmatism and/or faults within the Yellowstone National Park (Strata, 2011a). The applicant states that only three earthquakes with likely magnitudes greater than 3.0 have been recorded in or around Crook County, Wyoming. The oldest recorded earthquake occurred on February 1897, which severely shook a school in southwest Sundance. The second earthquake was an earthquake with a magnitude of 4.3 that occurred in February 1972 approximately 18 miles east of Gillette near the Crook-Campbell county line. The third one was an earthquake with a magnitude of 3.7 that occurred in November 2004 near Moorcroft.

The applicant states that earthquakes with magnitudes less than 6.5 would cause little damage to specialty built structures, but could cause could cause considerable damage to ordinary buildings and severe damage to poorly built structures (Strata, 2011a). Those earthquakes generally would not break underground pipes but could cause minor cracking in the ground surface (Strata, 2011a). The applicant provides a figure graphically displaying a probability less than 1 out of 1000 for an earthquake with a magnitude greater than or equal to 6.5 to occur at the Ross Project within 50 years based on the web-based USGS Probabilistic Seismic Hazard Analysis (PSHA) model (Strata, 2011a). The applicant includes published mapping of the probabilistic acceleration mapping for the area surrounding the Ross Project (Strata, 2011a). Based on that mapping, the applicant estimates the peak horizontal acceleration at the Ross Project of 7.5 %g for the 2500-year time frame (equivalent to a 2% exceedence probability in 50 years). The International Building Code (IBC) incorporates this time frame for designing structures, and the Wyoming State Geologic Survey suggests that this time frame is used for the design of critical structures in this part of Wyoming (Strata, 2011a). The applicant commits to designing the Central Processing Plant and other Ross ISR Project buildings to the 2500-year probabilistic map (IBC designs).

The staff finds that the applicant has provided information that is consistent with the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the SRP (NRC, 2003) because the information includes a history of the seismic history of the region and an evaluation of the design criteria for short-term seismic stability based on reputable published sources. Staff verified the information from the published sources. The Wyoming Fire Marshal code adopted the International Building Code (IBC) as of February 11, 2008, which bases the design criterion on the 2,500-year probability. The applicant commits to using the design criteria appropriate for the prevailing applicable codes (Strata, 2011a). Use of the IBC criterion is conservative and provides the best assurance that the potential for failure of any constructed pond embankment due to seismic activity is minimized during the proposed life of the facility.

2.3.4 EVALUATION FINDINGS

The staff finds that the Ross Project application provided site characterization of the geography, geology, soils and seismology at the Ross Project in accordance with review procedures in Section 2.6.2 and acceptance criteria in SRP Section 2.6.3 of the SRP (NRC, 2003). The information provided in this section meets the regulatory requirements listed in SER Section

2.3.1 because the applicant has adequately described the geology and seismology by providing (a) a description of the local and regional stratigraphy, (b) geologic, topographic, and isopach maps at acceptable scales showing surface and subsurface features and locations of all wells and site explorations used in defining stratigraphy, (c) a geologic and geochemical description of the mineralized zone and the geologic units adjacent to the mineralized zone, (d) a description of the local and regional geologic structure, (e) a discussion of the seismicity and seismic history of the region, (f) a generalized stratigraphic column that includes the thickness of rock units, a representation of rock units and a definition of mineralized horizon, and (g) a description and map of the soils.

The applicant has provided documentation on all known historic exploratory drill holes. Although the applicant states that the historic drill holes have been abandoned in accordance with past regulatory requirements, the applicant states that the exact abandonment procedures for a significant portion of the historic drill holes are unknown The applicant has re-abandoned several drill holes surrounding one pumping test site and has observed responses to the underlying aquifer during pumping tests at two sites, which show that the observed responses in the underlying aquifer may be attributed to communication through nearby drill holes. Consequently, staff will require that the historic drill holes are shown to have been or will be abandoned in the vicinity of a wellfield prior to the conduct of principal activities at that wellfield. The applicant commits to abandon all historic drill holes that could be a pathway for lixiviant migration to the overlying aquifer. The staff will memorialize that commitment in a license condition as follows:

Facility Specific License Condition 10.12

> Prior to conducting tests for a wellfield data package, the licensee will attempt to locate and abandon all historic drill holes located within the perimeter well ring for the Wellfield. The licensee will document such efforts to identify and properly abandon all drill holes in the wellfield data package.

2.4 HYDROLOGY

2.4.1 REGULATORY REQUIREMENTS

General requirements for contents of an application for a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(h) specifies that an application must clearly demonstrate how requirements and objectives set forth in 10 CFR Part 40 Appendix A are addressed. Technical Criteria 1, 5B, 5F, 5G & 7 of 10 CFR Part 40 Appendix A set forth requirements and objectives for a suitable hydrologic setting for a uranium recovery facility.[13] Furthermore, 10 CFR 40.41(c) requires that a Part 40 licensee has the ability to confine the licensee's possession and use of source and byproduct material to locations and purposes authorized by the license. At an ISR facility, meeting this requirement includes determining that

[13] Criteria in Appendix A are written for conventional mill setting. The conventional mill setting differs from an ISR setting in that (1) at a conventional mill, all activities conducted under the license are performed above ground whereas at ISR settings, the uranium extraction from the ore is performed in situ (or in the subsurface), and (2) at a conventional mill, a solid byproduct material, the mill tailings, is stored above ground in a tailing pile whereas at ISR settings, no mill tailings are generated. Staff is applying these criteria to ISR facilities because 10CFR 40.31(h) specifies that not only the requirements but objectives of the technical criteria in Appendix A are met.

the hydrologic setting is appropriate to confine the regulated material to the designated areas in the subsurface.

Based on guidance in RG 3.46 (NRC, 1982b) and Section 2.7 of the SRP (NRC, 2003), an application should provide a sufficient description of the hydrologic setting and a demonstration of the licensee's thorough understanding of that setting.

Staff is required to determine that the application has provided sufficient data on the hydrologic setting and a clear demonstration of the applicant's thorough understanding of the setting to meet the above regulatory requirements.

2.4.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviews the application for compliance with applicable requirements of 10 CFR 40.31(h), 10 CFR 40.41(c) and 10 CFR Part 40 Appendix A Criteria 1, 5B, 5F, 5G & 7, using review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the Standard Review Plan (NRC, 2003) and guidance in Regulatory Guide 3.46 (NRC, 1982b).

Information in the application, as reviewed and verified by staff, will be deemed acceptable provided staff determines, with reasonable assurance, that a license issued based on the application meets the above regulatory requirements, and, pursuant to 10 CFR 40.32, can conclude that (1) the proposed project is for a purpose authorized by the AEA, (2) the applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner to protect health and minimize danger to life or property; (3) the proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property; and (4), issuance of a license will not be inimical to the common defense and security or to the health and safety of the public.

2.4.3 STAFF REVIEW AND ANALYSIS

Unless otherwise stated, information reported in this SER Section is from Section 2.7 of the technical report (Strata, 2011a).

The following sections present staff's review and analysis of various aspects of the surface water and ground water hydrology at, and in the vicinity of the Ross Project.

2.4.3.1 Regional Surface Water

The applicant states that the entire Ross Project is located within the upper reaches of the Little Missouri River Basin (USGS Hydrologic Unit Code (HUC) 101102). The headwaters for Little Missouri River are located immediately south of the Ross Project, and the river flows through the northeastern corner of Wyoming (including the Ross Project), the southeastern corner of Montana, northwestern corner of South Dakota and through a portion of the southwestern corner of North Dakota prior to its confluence with the Missouri River within North Dakota (SER Figure 2.4-1). The entire area of the Little Missouri River Basin is approximately 9550 square miles and the total river length from its headwaters to its confluence with the Missouri River is 405 miles (Strata, 2011a).

The applicant summarizes benchmark flows at five established USGS Gaging Stations along the Little Missouri River (Strata, 2011a). All five stations are located downstream of the proposed Ross Project, one of which is located in Montana, one station in South Dakota and

three in North Dakota. The mean annual flow at the gaging station immediately downstream of the Ross Project (USGS Gaging Station 06334000 near Alzada, Montana) is 2.18 cubic meters per second (cms) [77 cubic feet per second (cfs)]. The upstream basin area at that stream gaging station is 904 square miles. The range in annual peak flows for the period of record for that USGS station is between 8.47 and an estimated 170 cms [299 and an estimated 6000 cfs] (Strata, 2011a). In general, the peak flows occur between late March to June. The applicant states that the timing of the peak flows is consistent with snow-melt and spring run-off (Strata, 2011a).

The applicant provides a qualitative analysis of the regional surface water quality (Strata, 2011a). The Little Missouri River and its tributaries from the headwater to its confluence with Government Canyon Creek, which is located approximately 40 miles downstream of the Ross Project, have a Wyoming Surface Water Classification of 3B. Surface water with a 3B Classification consists of intermittent or ephemeral streams incapable of supporting fish populations or drinking water supplies. Designated uses include scenic (aesthetic), industrial, agricultural, wildlife, recreational, and other aquatic life. The Little Missouri River downstream of its confluence with Government Canyon Creek to the Wyoming/Montana State Line has a Wyoming Surface Water Classification of 2ABWW. Designated uses of surface water with a 2ABWW Classification include those for the 3B Classification plus fish consumption, non-game fish, game fish, drinking supplies and warm water fishery.

Staff reviewed the information and independently verified that the information as presented by the applicant is accurate. Staff’s review also identified that the Little Missouri River, at the USGS gaging station located immediately downstream of the proposed project area, has been dry over a several-week interval during each of the past several years. Although the applicant did not provide historical water quality data for the USGS stream gaging stations as suggested by RG 3.46 (NRC, 1982b), the qualitative analysis of the regional water quality is sufficient for staff’s finding because of the ephemeral nature of the river.

2.4.3.2 Site Surface Water

The applicant reports that the channel for the Little Missouri River bisects the Ross Project from the southwest (upstream) to the northeast (downstream). At the point at which the river exits the Ross Project, the Little Missouri River Basin comprises an area of approximately 18.2 square miles (Strata, 2011a). The headwaters for the Little Missouri River are located approximately 3 miles south of the project area.

In addition to the main stem of the Little Missouri River, the Ross Project contains watersheds of several tributaries, the most significant of which is Deadman Creek. Confluence of Deadman Creek with the Little Missouri River is located in the west-central portion of the Ross Project immediately upstream of the Oshoto Reservoir.

For discussion purposes and its modeling effort, the applicant assigned names to the watersheds for the other unnamed tributaries in the basin within and upstream of the Ross Project (Strata, 2011a). The names given by the applicant to the tributaries within the Ross Project are Draw13, Draw14, Draw15, Draw18, Draw5, Draw7 and Draw9 (SER Figure 2.4-2). In Table 2.7-3 of the Technical Report (Strata, 2011a), the applicant lists stream gradients (slopes) for all tributaries within the Ross Project. The gradients vary between 0.0086 and 0.0244 feet per foot. The steepest stream gradients were generally associated with tributaries located north of the Little Missouri River in the northern portion of the Ross Project (Strata, 2011a). In Attachment 3.4-A of the ER, the applicant states that the Little Missouri River within

the Ross Project has a relatively shallow gradient for the main channel and that the active channel meanders within an often steep-side, wider flood plain (Strata, 2011a).

The applicant characterizes all streams within the Ross Project as ephemeral whereas the applicant characterizes the Little Missouri River immediately downstream of the Ross Project as an intermittent stream (Strata, 2011a). These classifications by the applicant are based on historic stream flows observed by the local population. Higher flows in all tributaries generally follow a snow-melt or a specific precipitation event (Strata, 2011a). The applicant installed real-time dataloggers to measure surface water elevations (and calculated flows) at three gaging stations (SW-1 through SW-3) established by the applicant within the Ross Project as follows: one gaging station is located on Deadman Creek near its most-upstream point within the Ross Project; one gaging station is located on the Little Missouri River near its most-upstream point within the Ross Project; and one gaging station is located on the Little Missouri River near its most-downstream point within the Ross Project (SER Figure 2.4-3). The applicant acquired and documented stream flows/stages at those stream gaging stations during a portion of the pre-operational study period (primarily the summer of 2010; for a discussion of the data, see below and SER Section 2.5.3.1)

The applicant identified 43 surface water rights listed in the Wyoming State Engineer's Office (WSEO) database within a 2-mile radius of the Ross project. Based on the its field survey, the applicant identified another 17 existing "reservoirs" not listed in the WSEO database but located within the same area (Strata, 2011a). Based on published data (WSEO database) or survey of the current property owners, usage of surface water is primarily for livestock watering and, to a lesser extent, irrigation or industrial usages (the industrial usages include temporary water supplies for oil and gas well construction activities and long-term water supplies for oil reservoir flooding). The applicant states that usage for "nearly" half of the 43 surface water rights has been cancel, and 90 percent of the remaining surface water rights, along with the reservoirs not listed in the WSEO database, are used for livestock watering (Strata, 2011a).

In Addendum 3.4-A of the application (Strata, 2011a), the applicant characterizes the existing reservoirs as either naturally occurring depressions or man-made bermed areas within an existing ephemeral stream channel (SER Figure 2.4-4). The largest impoundment is the Oshoto Reservoir, which is located on the Little Missouri River within the Ross Project.

The applicant states that no long-term monitoring data exist for the streams located within the Ross Project (Strata, 2011a). To estimate benchmark flows and areas of potential inundation, the applicant performed surface water hydrologic modeling of the Little Missouri River Basin upstream of the Ross Project. The modeling software used by the applicant was HEC-HMS (Scharffenberg, 2001). The surface water hydrologic model consisted of dividing the Little Missouri River basin upstream of the Ross Project into 20 watersheds (subbasins). Flows within each subbasin were calculated by the modeling software based on SCS losses and lag-time equations (Strata, 2011a). Flows within the subbasins were routed by the model through channels using the Muskingum method.

The applicant reports results of model-predicted flows following several benchmark precipitation events. The benchmark precipitation events are based on published data (Miller, 2003), and include events with a 24-hour duration occurring every X years (e.g., 24-hour, X-year event) where "X" is either 2, 5, 10, 25 50 or 100. Results of the applicant's surface water modeling for the estimated 24-hour, 100-year precipitation event are summarized in SER Table 2.4-1.

The applicant compared its surface water hydrologic modeling results at the most downstream point of the model along Little Missouri River with the respective flooding events calculated using published, empirically derived equations for streams in Wyoming (Strata, 2011a). The model flows estimated by the applicant were generally 4 to 4.5 times greater than the respective flows calculated by the empirical equations (Strata, 2011a). The applicant attributed differences between the model predicted flows and flows estimated by the empirically derived equations to effects of reservoirs on flows in Wyoming streams on which the empirical equations were based (i.e., the empirically derived equations were based on streams which had reservoirs and thus lower flows).

The applicant estimated the area of inundation for the 100-year event for all streams within the Ross Project (Strata, 2011a). The area of inundation was determined by the applicant using flows estimated from the HEC-HMS model for the 100-year precipitation event, measured geometries of selected stream cross-sectional areas and estimated stream channel characteristics (e.g., slope and roughness coefficient) in the immediate area of the cross sections. The areas of inundation were extrapolated for each stream channel in the Ross Project from the locations of at least two selected cross-section areas. The areas of inundation for the 100-year event as determined by the applicant are shown on SER Figure 2.4-5.

The applicant states that structures (e.g., wellhouses) will be kept out of the flood plain; however, if placed within or near a drainage channel, the applicant will employ proper engineering controls to control flooding and erosion of equipment by high water levels and flows (Strata, 2011a). The proposed Central Processing Plant (CPP) and ancillary structures and equipment will be located in an area that is used currently for dryland hayfields. The applicant states that prior to use for the hayfield, an ephemeral stream bisected the field. The current location of the stream channel had been moved in the recent past to the east side of the field to optimize the area for the hayfield. The applicant states that a diversion channel will be designed and constructed to ensure that the channel remains east of the CPP (see SER Section 3.1.3.8).

The applicant states that in the unlikely event that a recovery, injection or monitoring well is placed within a flood plain, engineered controls and instrumentation will act to prevent leakage to the environment or contamination to the well. The engineered controls and instrumentation include those to be constructed for each well at the well head. The applicant also commits to using erosion control measures such as rip-rap, grading, contouring and water bars, where appropriate, should the equipment be placed in the flood plain.

The applicant collected surface water quality data from three on-site surface water gaging stations (SW-1through SW-3) and 10 reservoirs (R1 through R-8, R10 and R11) that are located within (or immediately adjacent to) the Ross Project. The ten reservoirs consist of depressions or man-made impoundments within the various stream channels. Five reservoirs are located either in the Deadman Creek or Little Missouri River channels, which comprise the topographically lowermost points within the Ross ISR Project. The remaining five reservoirs are found along other tributaries at topographically higher elevations than the nearby elevation of Deadman Creek or Little Missouri River.

The sampling was conducted quarterly though several quarterly samples could not be obtained for many sampling locations. Reasons for not obtaining a surface water sample include (1) no surface water, (2) frozen, (3) lack of landowner’s permission or (4) a reservoir was sampled immediately upstream.

The applicant presents piper diagrams to categorize major-ion chemistry of the various surface waters. The applicant characterizes the water quality of the stream samples as sodium bicarbonate type, the ponded surface water in reservoirs along Deadman Creek and Little Missouri River as sodium bicarbonate type, and the ponded surface water in the topographically higher reservoirs as calcium bicarbonate type (Strata, 2011a). The applicant states that the similarity in chemistry of groundwater in the uppermost aquifer with that of surface water in the Deadman Creek and Littler Missouri River indicates a potential communication between the uppermost aquifer and surface water in the streams (Strata, 2011a). The applicant states that a significant number of wetland areas in small depressions appear to be influenced by groundwater, receiving seepage from the Lance Formation.

Staff reviewed the applicant's descriptions, mapping and analyses of the site-specific surface water regime and finds the applicant adequately characterizes the existing setting consistent with review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP (NRC, 2003) because staff independently reviewed the published data, verified that the applicant's description and model inputs are consistent with the available mapping, and confirmed the accuracy of the applicant's assessment of the potential for flooding and erosion. Staff finds that the applicant provided adequate data to support the fact that all streams are ephemeral. Because the streams are ephemeral, the sampling conducted at the streams was sufficient to characterize the pre-operational quality. The applicant reports that automated samplers will be employed at the surface water sampling locations to collect surface water samples during the operational monitoring program. Such practices as the applicant proposes are consistent with the current state of the art and thus supported by staff.

Staff reviewed the surface water hydraulic evaluation and finds the modeling and model predicted flows are based on sound engineering practices. Given the proximity of the Ross Project to headwaters of the watershed, use of flows resulting from benchmark precipitation events is appropriate. Staff agrees that the applicant's measures for impacts due to erosion and inundation during the design maximum flooding event are appropriate to ensure safe operations to the workers, public in general, equipment and the environment.

2.4.3.3 Regional Hydrogeology

The applicant states that Ross Project is located on the eastern margin of the Powder River Basin along the western margin of the Black Hills Uplift (Strata, 2011a). The applicant states that the geologic ages for water-bearing bedrock formations in eastern Powder River Basin range from Precambrian to Paleocene. In the subsurface, the bedrock formations dip towards the west; though the dips are shallow, the formations that are near ground surface at the basin margins become significantly deep in its center (Strata, 2011a).

In general, under static conditions, the applicant states that the regional groundwater flow is westward in direction with a slight northerly component (Strata, 2011a). Due to the increased depths to many of the older formations, bedrock formations that may be sources of water supplies near the margin of the basin become inaccessible or have poor quality that make them unusable for potable water supplies in the basin interior (Strata, 2011a).

In addition to the bedrock formations, the applicant states that saturated Quaternary-age alluvium (and colluvium) is found in the region primarily along the present-day stream channels (Strata, 2011a). The alluvial aquifers may serve as localized sources of water to a well completed in the alluvium. In addition, the saturated alluvium may enhance recharge to the

underlying bedrock formations in contact with saturated alluvium by providing a steady source (Strata, 2011a).

As discussed in SER Section 2.3.3, the applicant's proposed activities are to be located within and will affect aquifers with the Upper Cretaceous lithologies. Consequently, the applicant focuses its discussions on the regional hydrogeology to the Upper Cretaceous aquifers in the eastern Powder River Basin, specifically, the Upper Cretaceous aquifer that consists of the Lance-Fox Hills formations. The other Upper Cretaceous Formation is the Pierre Shale, which the applicant states acts as a regional confining unit and is largely non-water bearing (Strata, 2011a). The applicant reports that the thickness of the Pierre Shale in the vicinity of the Ross Project is 670 meters [2200 feet], and regionally, the thickness of the Pierre Shale and other underlying shales is up to 1524 meters [5000 feet]. The applicant states that the Pierre Shale outcrops east of the Ross Project and the outcrops represent the eastern limit of the Lower Cretaceous Lance-Fox Hills aquifers (Strata, 2011a). In the subsurface, the Pierre Shale isolates the Upper Cretaceous aquifer from aquifers located in geologic formations below it (e.g., Lower Cretaceous Inyan Kara Group, Mississippian Madison Formation). The applicant reports that the estimated vertical hydraulic conductivity for the Pierre Shale ranges from $5x10^{-4}$ to $9x10^{-9}$ feet per day based on studies in areas outside of the Ross Project (Strata, 2011a).

In response to Staff's RAIs (Strata, 2012b), the applicant states that aquifers exist in the Tertiary Fort Union and Wasatch Formations, primarily with in the center of the Powder River Basin, as those formations have been eroded along the basin margins including at the location of the Ross Project. Although not discussed in depth in the application, hydrogeologists performing research in the area generally consider aquifers in those Tertiary Formations isolated from the Lance-Fox Hills formations even in areas of the Powder River Basin in which both exist (Lindner-Lunsford and J.F. Wilson, 1992; Rankl and Lowry, 1990; Seeland, 1992; Whitcomb and Morris, 1964).

Due to the lack of reliable surface water bodies for dependable water supply sources (i.e., the surface waters are ephemeral), groundwater is the source for most water supplies including large municipalities and industrial users in this area of Wyoming (Strata, 2011a). In Section 7.4.2 of the Technical Report (Strata, 2011a), the applicant summarizes details on four public water systems located within 10 to 22 miles of the Ross Project. The summary includes the public water systems for the towns of Pine Haven, Hulett, and Moorcroft, and the City of Gillette. In Section 4.12 of the Environmental Report (Strata, 2011a), the applicant states that except for Moorcroft, the water supply sources for the public water systems is groundwater from the Mississippian Madison Formation. The applicant reports that the water supply source for the Town of Moorcroft is currently groundwater in the Lance-Fox Hills formations, which are the same geologic formations as the proposed activities at the Ross Project. The applicant states that the Town of Moorcroft is planning to drill a new water supply well in the Madison Formation at a location approximately 10 miles east of the town (21 miles SE of the Ross Project).

The applicant's discussion on other regional users of groundwater (e.g., private water supply, industrial, agricultural or livestock water supply wells) is focused on the regional area within 2 miles of the Ross Project (see discussion of Site Groundwater). In general, water supply wells located west of the Pierre Shale outcrop are likely completed in the Lance-Fox Hills Formation or in the unconsolidated alluvium whereas those wells located east of the Pierre Shale outcrop are completed in formations older than the Pierre Shale.

The applicant states that regional recharge occurs in the outcrops with groundwater moving away from the outcrops into the basin (Strata, 2011a). In Addendum 2.7-H Groundwater Model

(Strata, 2011a), the applicant presents an estimated regional potentiometric surface for a portion of the Lance-Fox Hills aquifer (OZ aquifer). The contours for the regional potentiometric surface indicates a westward component in and around the Ross Project from the outcrop area towards the basin, consistent with the applicant's discussions, and a northerly groundwater flow component depicted in areas north of the Ross Project.

The staff finds that the applicant adequately described the regional hydrogeology in accordance with the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP (NRC, 2003) by describing the setting using established mapping from published sources (e.g. USGS). Staff based this determination on the quality and quantity of the hydrogeologic information provided by the applicant, as independently confirmed and verified by the staff. Staff verified the information on the municipal water supply sources and concludes that the information is accurate but notes that only completion depths are published for several municipal water supply wells and, for the most part, the applicant interpreted the formations for which the wells are completed. Based on the reported depths to the municipal wells and other information (e.g., well-documented thicknesses of the mapped formation and established water quality for the various aquifers), staff finds that the applicant's assessment of the aquifers screened by the municipal water supply wells is reasonable. Staff agrees that the municipal water supply wells are not completed in the Fort Union-Lance aquifer except for the water supply well for the Town of Moorcroft as noted by the applicant.

The applicant includes discussions on several regional aspects of the Lance-Fox Hills aquifer including regional water supply sources and other major water users within 80 km (50 mi) of the Ross Project, to the lateral extent of the aquifer to the eastern outcrops and the depths of the aquifer within the Powder River Basin (Strata, 2011a;2012b). However, the applicant's discussions on the regional hydraulic properties (e.g., transmissivity, regional potentiometric surface and sinks (groundwater discharge areas)) for the Lance-Fox Hills formations were limited to an area within several miles of the Ross Project based largely on the extent of the numeric groundwater flow model developed by the applicant. The term "regional" is not defined in context of hydrogeology in the regulations found in 10 CFR Part 40 or Part 51. Guidance in the SRP (NRC, 2003) states:

> *"The regional map should represent the mineralized zone aquifer and should encompass the likely consequences on any affected highly populated areas."*

and

> *"To construct a regional potentiometric map, a reasonable effort should be made to consider as many existing wells as possible."*

Staff finds that the regional hydrogeologic information provided by the applicant is consistent with the above guidance and provides a basis for staff's determination that the proposed operations can be conducted safely. The impacts of the operations on the regional water resources will be addressed in the Supplemental Environmental Impact Statement (SEIS) being prepared by NRC staff.

During its review, staff's opinion on the regional and site geology and hydrogeology was influenced by information from published sources outside of those noted by the applicant. Specifically, based on Downey (1986), the regional extent of the Lance-Fox Hills aquifer is shown on SER Figure 2.4-6. The applicant's narrative on the extent of the aquifer is consistent with the published data but the applicant did provide graphical mapping of the Lance-Fox-Hills aquifer to its natural boundaries as shown on SER Figure 2.4-6. The regional potentiometric

surface for the Lance-Fox Hills aquifer indicates regional flow in the Lance-Fox Hills aquifer extends beyond the Powder River Basin and Wyoming several hundred miles north to the Yellowstone and Missouri rivers (SER Figure 2.4-6). The potentiometric surface in the applicant's regional model is consistent with the published information though the regional flow is more northward as the western component noted by the applicant is likely due to the proximity to the eastern margin of the Lance-Fox Hills aquifer.

Similarly, based on Downey (1986), the isopleth contour map of the transmissivity within the regional Lance-Fox Hills aquifer is shown on SER Figure 2.4-7. The published data suggest that the regional transmissivity of the Lance-Fox Hills aquifer decreases in the southerly direction. This information combined with the fact that the thickness of the aquifer increases to the south suggests that the hydraulic conductivity of the Lance-Fox Hills aquifer decreases to the south. The transmissivity for the applicant's regional model is consistent with the published data.

2.4.3.4 Site Hydrogeology

As discussed above in the regional hydrogeology, the Lance and Fox Hills formations are generally combined and referred to as a single aquifer because those formations are regionally hydraulically connected and distinct from the overlying aquifers in the Tertiary formations or underlying aquifers in the Lower Cretaceous formations (Downey, 1986). For its conceptual model of the site hydrogeology, the applicant divides the Lance-Fox Hills aquifer into several discrete water-bearing horizons each of which the applicant designates as an aquifer as discussed below. Staff acknowledges that such designation of discrete water-bearing horizons as aquifers is an industry standard practice and consistent with the goal of NRC to minimize potential impacts by limiting the extent of the “ore aquifer” at an ISR facility.

In Section 2.6 of the Technical Report (Strata, 2011a), the applicant states that the ore bodies subject to the proposed actions are found in five mineralized zones within a discrete stratigraphic interval that extends from the upper Fox Hills Formation to the Lower Lance Formation (Strata, 2011a; see SER Section 2.3.3). The applicant designates this stratigraphic interval as the ore zone (OZ) aquifer (see SER Section 2.3.3). The applicant states that the OZ aquifer is amenable to in situ recovery of the uranium based on chemical and physical properties of the OZ aquifer (Strata, 2011a).

The applicant defines the first contiguous water-bearing sandstone in the Lance Formation above the OZ aquifer as the shallow monitoring (SM) aquifer, and designates this aquifer as the first overlying aquifer (Strata, 2011a). The applicant describes the stratigraphic interval between the SM and OZ aquifers, which is predominantly comprised of mudstones, as the designated overlying confining unit. The applicant states that this designation is based on its anticipated low vertical hydraulic conductivities and thicknesses of 9.1 to 24.4 meters [30 to 80 feet].

The applicant defines the first contiguous sandstone in the upper Fox Hills Formation below the OZ aquifer as the deep monitoring (DM) aquifer, and designates the DM aquifer as the first underlying aquifer (Strata, 2011a). The applicant describes the stratigraphic interval between the OZ and DM aquifer, which is predominantly comprised of mudstones, as the designated underlying confining unit. The applicant states that this designation is based on its anticipated low vertical hydraulic conductivities and thicknesses of 3.0 to 15.2 meters [10 to 50 feet].

Finally, the applicant designates the near surface aquifer as the SA aquifer. The SA aquifer consists of saturated unconsolidated alluvium and colluvium, which are largely confined to the

present-day stream channels for the Little Missouri River and Deadman Creek, or shallow sandstones lenses in the Lance Formation which, based on depth of the SA wells, may be at depths up to 32.9 meters [108 feet] below grade (Strata, 2011a). The shallow sandstones in the Lance Formation may be locally unsaturated (Strata, 2011a).

The applicant's conceptual model of the DM, OZ, SM and SA aquifers within the upper Fox Hills and lower Lance formations is based on historical data from the former Nubeth R&D facility, historical and current nearby groundwater use, analysis of the hydrogeologic properties for the various intervals, and a numeric groundwater flow model predictive results. The data used for the conceptual model are summarized below.

2.4.3.4.1 Former Nubeth R&D Facility

In Section 1.2 of the Technical Report (Strata, 2011a), the applicant reports that the former Nubeth R&D facility operated a single 5-spot in situ recovery pattern between August 1978 to April 1979. The 5-spot consisted of typical commercial ISR pattern of four injection wells with a single recovery well in the center in the then designated "B" aquifer".[14] The plant designed production rate was 90 gallons per minute (Strata, 2011a). The authorized initial lixiviant composition was groundwater with sodium carbonate and hydrogen peroxide (Strata, 2011a).

The applicant also reports that a feasibility study conducted at the end of the Nubeth operations estimated that commercial production could produce approximately 363 kilograms [800 pounds] of uranium with a plant throughput of 11300 to 15100 Lpm [3000 to 4000 gpm].[15] However, operations at the plant were discontinued prematurely, because of (1) the injectivity problems that plagued the preliminary phase of operations; and (2) declining prices for uranium (Strata, 2011a). Following operations, the R&D facility underwent groundwater restoration and decontamination, which were ultimately approved by NRC in 1986 following the R&D license termination request (Strata, 2011a).

The applicant states that the overall success of the Nubeth R&D facility was limited due to the injection problems which the applicant attributed to the buildup of fines and organic material in the wellfield (Strata, 2011a). The applicant states that although filtering equipment was used, it was insufficient and led to the injection problems. The recovery well flow rates ranged from 19 to 53 Lpm [5 to 14 gpm]. Only a small amount of uranium was recovered by the Nubeth operations and it was never fully processed to yellowcake (Strata, 2011a). Consequently, approximately 50 percent of the plant's equipment was never used (Strata, 2011a).

In Section 1.2 of the Technical Report (Strata, 2011a), the applicant states that the Nubeth R&D facility demonstrated that the site conditions are amenable to ISR operations using a sodium-bicarbonate-based lixiviant.

In response to staff's request for additional information (Strata, 2012b), the applicant addresses staff's concern regarding the early Nubeth correspondence suggesting that the licensee had requested a license amendment to change the lixiviant from a sodium-carbonate to ammonium-based, in part to address the ongoing injectivity problems. In 1979, NRC staff's evaluation of

[14] The Nubeth designated the "B" aquifer as the ore aquifer and the "A" aquifer as the overlying aquifer. The applicant correlates the Nubeth's "B" aquifer with the applicant's OZ Aquifer and the "A" aquifer with the applicant's SM aquifer.
[15] The applicant notes that the first operations constituted the "Phase I" and the commercial operations constituted "Phase II". The facility discontinued operations after Phase I.

that request was that sodium in the lixiviant may have reacted with clays in the formation causing swelling and plugging leading to the injectivity problems (NRC, 1979). The applicant acknowledges that a consultant for the R&D licensee favored changing the lixiviant to ammonium-based for the second phase of the R&D program. However, that second phase, including using an ammonium-based lixiviant, was never initiated as the program was terminated during the first phase due to economic conditions (Strata, 2012b).

In addition, the applicant references published information that the swelling capacity of montmorillonitic clays depends on the chemistry of the clay, specifically whether the cation adsorbed between the clay mineralogical layers is monovalent (e.g., sodium) or divalent (e.g., calcium, magnesium).[16] In brief, the swelling capacity is a function of its sodium content; montmorillonitic clays with high sodium contents exhibit the largest swelling. The applicant states that the OZ aquifer contains elevated sodium concentrations compared to the calcium and magnesium concentrations and that the clays within the aquifer host formation are naturally elevated in sodium and, at present, are expanded to the maximum swelling capacity (Strata, 2012b). Therefore, the applicant concludes that plugging reported by the Nubeth operations was due to particles clogging the pores (inadequate filtering) rather than swelling of the clays, and, that the proposed project includes improved well design and filtration systems that will result in wellfield production and restoration without serious losses of injectivity (Strata, 2012b).

Staff reviewed the applicant's evaluation of Nubeth's operation and finds the information as presented by the applicant is acceptable because the applicant provided information on the past operations, which is verified by staff, and an analysis of that information meets the appropriate acceptance criteria in the SRP (NRC, 2003) with the following two clarifications.[17] First, as discussed in SER Section 2.3.3, the applicant argues that faults identified by a former investigator, Buswell (1982), are more likely depositional rather than structural features consisting of localized slumps, folds and differential compaction (see SER Section 2.3.3). Staff finds the applicant's conclusion and supporting arguments as a reasonable interpretation. However, staff acknowledges that localized slumps, folds and differential compaction will have the effect of providing preferred migration paths. For example, based on Nubeth quarterly progress reports, the former licensee identifies two "B" aquifer monitoring wells that were hydraulically and chemically isolated from the R&D production unit, which was approximately 23 meters [75 feet] from the wells (Cannaday, 1979). Staff will require in a license condition that the licensee demonstrate the lateral continuity of the OZ aquifer and provide sufficient data to demonstrate chemical variation within a wellfield in each wellfield data package.

Second, based on documents submitted after staff's evaluation in 1979, the injectivity problems that plagued the Nubeth operations were likely attributed to the buildup of "fines" and organic material that plugged the injection wells and not primarily a result of the aquifer plugging due to the reactions of the sodium in the lixiviant and clays in the aquifer, as originally determined by NRC staff as documented in the 1979 evaluation report (NRC, 1979). Staff's determination that the aquifer plugging was not the cause of the injectivity problems is based on the geochemical information supplied by the applicant in response to the RAIs (see above), review of ore

[16] Montmorillonite is another name for bentonite.
[17] The acceptance criteria in the SRP that staff used for the evaluation includes 2.7.3(6) "provided information on past … water use … [that] must be sufficient to evaluate potential risks to ground-water or surface-water users in the vicinity", but also 1.3(2) "include results from research and development operations … as a basis for … assessment of likely consequences of any environmental impact", and 3.1.3 (10) "[r]esults from research and development … are used to support the description of the *in situ* leaching process".

mineralogy and operational history at other ISR facilities since 1979, and review of historic Nubeth documents subsequent to the 1979 evaluation report.

Staff identified that ore bodies at other ISR facilities in northeastern Wyoming/western South Dakota also contain a measurable smetitic clay fraction. Those facilities include: Powertech's Dewey Burdock site in South Dakota; Power Resources, Inc.'s (PRI's) Ruth site in Wyoming; PRI's North Butte site in Wyoming; and, UraniumOne's Willow Creek site in Wyoming. The ISR operations similar to the operations proposed by the applicant have been or will be operated at those locations. Documentation for the Willow Creek site indicates that, in the late 1980s, the licensee had requested to use clay-swelling inhibitors, including aluminum salts, and chlorine gas or hypochlorite to inhibit bacteriological growth, to allow for injectivity improvements at their R&D site (NRC, 1989; Wichers, 1989). Subsequently, the Willow Creek site has had successful uranium recovery operations and restorations on commercial production wellfields. Consequently, staff finds that the industry has developed techniques that minimize the potential impacts on operations from clays inherent in the ore mineralogy.

Several selected Nubeth documents reveal that the injection wells had well construction problems, which may have contributed to the injectivity problems. The documents consist of the following:

- The January 1979 Nubeth Quarterly Report documents observations made while the licensee cleaned out the injection wells by airlifting techniques (Stoick, 1979a). The airlift samples revealed some fresh calcite precipitate and presence of microorganisms.

- The April 1979 Nubeth Quarterly Report and follow-up report document that a "trickle of water" was observed seeping at ground surface along the piping from the plant where it goes underground (Stoick, 1979b). Upon further investigation, the licensee reports that the water seeping at ground surface was injection fluid and that the casing at one injection well, I-1, had irregularities at a depth of 21.3 meters [70 feet] below grade (Stoick, 1979c).

- The July 1979 Nubeth Quarterly Report indicates a leak in the casing of injection well I-2 was discovered (Stoick, 1979d).

Staff agrees with the applicant that the injectivity problems are attributable to the buildup of "scale" at the injection wells but differs with the applicant's interpretation on the source of the scale.

The applicant's interpretation is that filtering at the Nubeth facility was inadequate which led to the injection fluid containing suspended particles which precipitated at the well screen. However, as noted above, the fine material was referred to as calcite by the former licensee. The buildup of calcite is not necessarily attributed to suspended particles but likely attributed to in situ precipitation from solution, a common problem of scaling for water supply wells. To precipitate calcite, the groundwater needs to be saturated with respect to calcite but the historical documents indicate that the licensee was maintaining proper calcium levels so as not to result in saturation conditions. On the other hand, the Nubeth documents state that the pH levels of the fluids in or near the injection wells were above 9.0 su. For example, the former licensee purposely adjusted the pH levels of the lixiviant to be above 9.0 su. In addition, the documents also report that the chemistry of fluids that leaked through the casing and migrated up the concrete annulus exhibited elevated pH levels, a pH of 10.6 su. Such fluids also have

the potential to migrate down the annulus to the well screen. The Nubeth documents also provide evidence that more than one injection well had a loss of integrity. Finally, as discussed in SER Section 2.5.3, there is an apparent correlation with wells with high pH and low hydraulic conductivities.

Therefore, staff finds that the applicant's commitment to incorporate improved well designs, construction techniques, and routine well integrity testing would minimize the number of wells that would have a loss of integrity during operations, and, the applicant's design for the lixiviant's makeup to have pH levels below 9.0 su would minimize the potential for injectivity problems.

2.4.3.4.2 Historical and Current Nearby Groundwater Use

The applicant provides information on the historical and current nearby groundwater uses. The sources for the information consist of review of registered groundwater rights on file (in the database) with the Wyoming State Engineers Office, interviews with landowners and field investigations (Strata, 2011a). The area for this review extends to a 2-mile radius of the Ross Permit Boundary.

The applicant determined that 119 historical groundwater rights and unregistered wells are located within 2-mile radius of the Ross Project (Strata, 2011a). The historical groundwater use dates back to 1918. The applicant provides a historical use summary as follows:

- 1918 to 1977 — Primarily domestic and livestock water supply, few irrigation water supply wells
- 1977 to 1991 — Industrial water supply and monitoring wells (Nubeth, Bentonite Mines)
- 1991 to 2009 — Domestic and livestock water supply wells
- 2009 to present — Monitoring wells (Strata)

Forty-eight of the 119 historical groundwater rights are or have been located within the Ross Project (Strata, 2011a). The applicant states that historical groundwater uses within the Ross Project have not included domestic water supply or irrigation uses; the historical uses were limited to livestock water supply wells, industrial water supply wells and monitoring wells (Strata, 2011a). Other than monitoring wells completed by Strata, current groundwater use within the Ross Project is limited to four livestock water supply wells and three industrial water supply wells (Strata, 2011a).

The total depths for the livestock water supply wells within Ross Project range from 39.3 to 80.8 meters [129 to 265 feet], which is above the proposed production zone (Strata, 2011a). The applicant does not provide a succinct list on the identification of all currently used livestock water supply wells located within the Ross Project. However, from the listing of all wells in the Technical Report Table 2.7-25, staff deduced that the currently used stock wells within the Ross Project have the following identifications:

WSEO Permit No.	Facility Name	Well ID	Depth (meters[feet])
P7323P	Berger #6		45.7[150]
P55052W	Windmill Well #2		39.0[128]
P192896W	Wesley 2010	TWWELL03	80.8[265][a]
P50883W	Morel #4	P50883W	45.7[150]

[a] Technical Report Tables 2.7-25 and 2.7-44 do not include a depth. However, a depth for this well is included in the RAI responses (Strata, 2012b)

The applicant reports the three industrial water supply wells located within the Ross Project as follows:

WSEO Permit No.	Facility Name	Well ID	Depth (meters[feet])
P67746W	789V State		172[566]
P67747W	19XX State	19XX18	163[536]
P50917W	22x-19	22XX-19	229[750]

The applicant reports that the average withdrawal from the industrial wells located within the Ross Project is 114 Lpm [30 gpm] from the OZ aquifer (Strata, 2011a). In Addendum 2.7-H of the technical report (Strata, 2011a), the applicant provides an annual estimate of the withdrawals from these and four other nearby industrial wells since 1980.

The applicant does not provide a succinct listing on current usage for wells located within a 2-mile or 2-kilometer buffer zone surrounding the Ross Project but outside of the Ross Project. Based on a review of well information in the Technical Report Table 2.7-25 (Strata, 2011a), staff estimates that 57 water supply wells currently exist within the 2-mile buffer zone of the Ross Project as follows:

Total Number of groundwater rights: and unregistered wells within 2-miles of the Ross Project	118[18]
Total Number of groundwater rights: Within the Ross Project	-48
Number of Cancelled Groundwater: rights	-13
Total:	57

Based on information in Technical Report Table 2.7-25 (Strata, 2011a), the water supply wells located outside of the Ross Project but within the 2-mile buffer are categorized as follows:

[18] Table 2.7-25 lists only 118 groundwater rights although the narrative indicates 119 groundwater rights

Domestic use[19]	20
Livestock Water Supply	28
Industrial	6
Miscellaneous	2
Irrigation:	1

The applicant provides the estimates of annual withdrawal estimates for four of the six industrial wells located outside of the Ross Project from 1980 to present in the Technical Report Addendum 2.7-H (Strata, 2011a). The annual withdrawals for the four industrial wells varied between 0.0 and 92.4 Lpm [0.0 and 24.4 gpm] (Strata, 2011a). The withdrawals for the four wells are included in the calibration of the applicant's numeric groundwater flow model.

Staff also estimates that 34 domestic, livestock or industrial water supply wells or groundwater use permits exist within 2 kilometers of the Ross Project (SER Table 2.4-2). The applicant states that all operable wells within 2 kilometers of the Ross Project were sampled as part of the preoperational monitoring program (Strata, 2011a).

In Technical Report Addendum 2.7-H (Strata, 2011a), the applicant states that typical depths for most livestock water supply wells located west of the Lance-Fox Hills formations outcrop area suggest that the wells are completed in thin sands within the Lance Formation aquitards.[20] Within the outcrop area in the eastern periphery of the Ross Project, the applicant states that the OZ and SM (production and overlying) aquifers are much shallower than in areas to the west and the several livestock and domestic wells are likely completed in the lateral continuation of the production and overlying (OZ and SM) aquifers (Strata, 2011a). Water supply wells located east of the outcrop area are completed either in formations below the Pierre Shale and hydrogeologically isolated from the Lance-Fox Hills aquifer, or in alluvium (Strata, 2012b).

In Technical Report Addendum 2.7-H (Strata, 2011a), the applicant states that several operating oil fields are located in the greater Oshoto region. The production for those oil fields is the Minnelusa Formation, which is approximately one mile deeper than the Fox Hills Formation. The oil reservoirs are currently undergoing enhanced oil recovery by water flood operations (Strata, 2011a).

In Section 2.2 of the Technical Report (Strata, 2011a), the applicant reports that 192 oil and gas wells are located within 2 miles of the Ross Project; however, only 19 wells are in production and the applicant reports that the majority of oil and gas wells are plugged and abandoned. In Section 2.2.7.2.3 of the Environmental Report (Strata, 2011a), the applicant states that three producing oil wells, two water injection wells [to the oil field], and three water supply wells for the water used in the water flood operations are located within the Ross Project. The three water supply wells for the water flood operations consist of the three industrial wells 789V, 19XX18 and 22X-19.

For calibration of the numeric groundwater flow model as documented in Technical Report Addendum 2.7-H (Strata, 2011a), the applicant includes recent (1980 to 2009) withdrawals from the three onsite and four of the six off-site industrial wells located within the 2-mile buffer of the Ross Project. The wells are completed in the OZ (production) aquifer and possibly the SM aquifer as well. Based on results of the numeric groundwater flow model as documented in

[19] Also includes other uses such as livestock watering and miscellaneous
[20] The applicant does not refer to a specific direction but because the numeric model includes areas only west of the outcrops, the reference is interpreted by staff to be west of the outcrops.

Technical Report Addendum 2.7-H (Strata, 2011a), the applicant reports that the model-predicted drawdown in the OZ (production) aquifer near the on-site industrial water supply wells after 30 years of production is approximately 61 meters [200 feet], and 45.7 meters [150 feet] in the vicinity of well 21-19OZ, the nearest monitoring well cluster.

Staff finds that the information supplied by the applicant is consistent with the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP (NRC, 2003) because it provides completed information on the past and current groundwater uses, which is verified by staff, and an analysis of that information that includes numeric groundwater flow modeling to estimate the currently existing impacts (see below).

2.4.3.4.3 Hydraulic Properties

In Technical Report Addenda 2.7-F through 2.7-J (Strata, 2011a), the applicant estimates hydraulic properties of the production aquifer, the underlying and overlying aquifers, the confining units and/or the Pierre Shale based on responses to in situ pumping tests and sampling of groundwater at various on-site monitoring wells, laboratory permeability testing of core samples, long-term "continuous" monitoring of groundwater elevations at wells installed at the Ross Project, parameter values used in the numeric groundwater flow model developed by the applicant, comparison of the data to historic site information and existing ISR operations and published data.

The on-site monitoring wells consist of six "regional" well clusters. Each cluster consists of wells screened in the four designated aquifers (DM, OZ, SM and SA), three partially penetrating wells in the OZ aquifer in the vicinity of well cluster 12-18, and 78 boreholes/monitoring wells in the SA aquifer (near surface alluvium and/or Lance Formation) in the area of the proposed CPP. (Data from the monitoring wells installed in the area of the proposed CPP are discussed in SER Sections 3.1.3 and 4.2.3). Pumping tests were performed by Strata in 2010 or Nubeth in 1977 or 1978. Groundwater sampling was performed at the regional well clusters quarterly during 2010. The long-term continuous monitoring of groundwater elevations consists of data acquired during 2010 at the monitoring wells at the well clusters. A dedicated pressure transducer and datalogger were installed in all SM, OZ and DM wells in the well clusters which allowed for frequent (continuous) monitoring and recording of water levels through the end of March 2010; however, a pressure transducer and datalogger were installed in only one SA well, 12-18SA, whereas non-continuous, less-frequent manual water level measurements were taken at several SA wells, generally during the quarterly sampling events. In addition to the well clusters, a dedicated pressure transducer and datalogger were installed in one SA well, SA43-18-3, in the CPP area which recorded continuous water level measurements since August 2010. This well is the one SA well in the CPP area screened in the alluvium.

The 2010 Strata pumping tests consisted of pumping groundwater from the OZ aquifer well at a well cluster, and monitoring water level responses at all wells in the well cluster during the pumping and recovery periods. The pumping tests for five of the six clusters consist of a 24-hour constant rate test with pumping at a constant rate under 56.8 Lpm [15 gpm]. The distance to the observation wells for these tests ranged from 13.4 to 28 meters [44 to 92 feet]. For the sixth well cluster, well Cluster 12-18, the applicant performed two pumping tests. The first pumping test consists of a 3-day constant rate test, which included monitoring water levels at four wells in the cluster plus three additional partially penetrating wells in the production aquifer. The three additional wells were located approximately the same distance of 21 meters [70 feet], but in different compass directions, from the pumping well (12-18oz). The second test consists of a 1-day constant rate pumping test at which the pumping well was one of the partial

penetration production zone observation wells used for the first test.   Results of the pumping tests are presented below in discussions of the aquifers.

The applicant presents results of pumping tests performed by Nubeth in 1977 and 1978 (Strata, 2011a). The applicant states that the Nubeth pumping tests demonstrate no hydraulic communication between the [OZ aquifer] and the overlying SM aquifer and the early tests did not stress the SM aquifer to yield aquifer properties; however, based on lithologic similarities, the applicant expects the hydraulic properties for the SM aquifer to be comparable to those for the OZ aquifer (Strata, 2011a). In Section 2.6.2.1 of the Technical Report (Strata, 2011a), the applicant states that Buswell's (1982) conclusion of the presence of faults based on hydrologic barriers noted in the 1978 pumping test differs from the conclusion of the author who prepared the original report on the 1978 pumping test[21]. The applicant states that the original report's author ascribed the observed hydrologic barriers to changes in "permeability and lateral discontinuity in the stratigraphy" (Strata, 2011a). The applicant concludes that depositional irregularities and differential compaction led to minor localized slumps, folds and differential compaction features consistent with Buswell's interpretation. In Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant summarizes the hydraulic parameters (transmissivity, hydraulic conductivity and storativity) determined from the Nubeth pumping tests (see discussion below under the OZ aquifer)

The applicant includes a qualitative analysis of the hydraulic parameters for the SM and DM aquifer based water level responses following sampling and the long-term monitoring of groundwater elevations at the regional monitoring wells during 2010 (Strata, 2011a) (see discussions below under the SM and DM aquifers).

In Addendum 2.7-F and Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant summarizes the laboratory analyses of core samples collected from on-site drill holes in 1977 (by Nubeth) and 2009/2010 (by the applicant). The core samples consist of 54 samples from seven drill holes from depths ranging from 116 to 180 meters [380 to 590 feet] below grade in the Lance-Fox Hills formations. The applicant grouped the samples by sample lithologic type and reported the porosity, horizontal and vertical permeabilities, and the ratio of vertical: horizontal permeabilities (see discussion below under the OZ aquifer).

The applicant did not discuss but rather summarized the porosity data of the core samples in Technical Report Addendum 2.7-F. Appendix 9 (Strata, 2011a). The porosity of the core sandstone samples were high, varying from 38.6 to 46.6 percent, with an average of 39 percent. The porosity for one cemented sandstone sample is 14 percent (Strata, 2011a). The applicant used the average porosity of 29 percent in calculating the specific storage to be used in the numeric model for the shale confining units in Technical Report Addendum 2.7-H (Strata, 2011a). The applicant used a porosity value of 0.30 to determine groundwater seepage velocities in numeric model predictive simulation in Technical Report Addendum 2.7-H and a value of 0.34 for pore volume estimates in Section 6.0 of the Technical Report (Strata, 2011a).

[21] The applicant states that P.A. Manera was the author of the 1978 pumping test report. The applicant includes references to two unpublished reports attributed to Manera, one in 1977 and one in 1978. Staff did not have access to the 1978 report whereas the 1977 report was included in the NRC license application: Stoick, A. F., 1977. "Application for a New Source Material License, Sundance R&D Project, Wyoming", Nuclear Dynamics, Inc., ADAMS Legacy Accession no. 9811120004, November 1977. The 1977 report did not include discussions on hydraulic barriers.

The applicant based the hydraulic parameters for the Pierre shale on published data. Based on the applicant's analyses, the hydraulic properties for the Lance-Fox Hills aquifer are summarized in SER Table 2.4-3. The following is a discussion of hydrogeologic properties determined by the applicant for the various aquifers:

Pierre Shale

The applicant reports that the Pierre Shale is approximately 670 meters [2200 feet] thick at the Ross Project, is relatively uniform and void of any water-bearing strata (Strata, 2011a). The applicant estimates the depth to the top of the Pierre Shale varies from 152 to 299 meters [500 to 980 feet] below grade in the Ross Project (Strata, 2011a). Site-specific hydraulic conductivity tests have not been performed on the Pierre Shale; however, the applicant includes published vertical hydraulic conductivity estimates of $5x10^{-4}$ to $2.6x10^{-10}$ feet per day for the Pierre Shale based on studies in South Dakota and Kansas. Because the Pierre Shale is a regional confining unit, the applicant concludes that similar values are applicable to the Pierre Shale in the Ross Project. No wells exist in the Pierre Shale in the Ross Project area.

Fox Hills and Lower Lance Formations

The applicant divides the upper Fox Hills and lower Lance formations into four aquifers, which the applicant designated as the DM, OZ, SM and SA aquifers (Strata, 2011a). The DM aquifer is the designated underlying aquifer, which the applicant states is the first water-bearing horizon in the lower Fox Hills Formation below the production zone. The OZ aquifer is the production zone aquifer within both the upper Fox Hills and lower Lance formations. The SM aquifer is the designated overlying aquifer, which the applicant states is the first water-bearing horizon in the lower Lance Formation above the production zone. The SA aquifer is the surficial (near-surface) aquifer composed of intermittent saturated sandstone lenses in the upper Lance Formation and alluvium in the stream channels. For a completed description of the aquifers and intervening confining units, see SER Section 2.3.3.

The hydrogeologic properties assigned by the applicant to the aquifers and intervening confining units are as follows:

DM Aquifer

The DM aquifer is a confined aquifer with the potentiometric heads 97.5 to 131 meters [320 to 430 feet] above the top of the aquifer (Strata, 2011a). Based on the July 2010 groundwater elevation data (Strata, 2011a), flow in the DM horizon is generally downdip, northeast to southwest in the northern areas of the Ross Project but shifts to the more-northerly component in the southern areas. A distinct trough exist in the south-central portion of the Ross Project which the applicant attributes to the long-term withdrawal of groundwater by the three industrial water supply wells (Strata, 2011a). The applicant estimates a static hydraulic gradient in the DM aquifer at approximately 15.2 meters [50 feet] per mile (0.009 feet per foot). The potentiometric head in the DM aquifer relative to the potentiometric head in the overlying production aquifer (OZ aquifer) is variable (i.e., the head in the DM aquifer is both above and below the head in the

OZ aquifer at different locations within the Ross Project). The applicant attributes the variation to the long-term pumping of the industrial wells.

The applicant states that the sources of water for the DM aquifer consist of recharge along outcrops of the Fox Hills Formation, in particular where Little Missouri River crosses the outcrop (Strata, 2011a). Based on the long-term monitoring of groundwater elevations at wells screened in the DM aquifer (Strata, 2011a), the applicant reports minor (0.03 meters [0.1 feet]) perturbations due to variations in barometric pressures. The applicant reports that a 0.9-meter [3-foot] or so blip in groundwater elevations was observed at several DM wells but the cause of the blips is unknown; the applicant states it is unlikely that the blips are due to the operation of the oil field water supply wells. The applicant did not discuss long-term trends to the groundwater elevations at the DM wells due, in part, to the long recovery times for the groundwater to return to static levels at all DM wells following each quarterly sampling event for the pre-operational baseline monitoring. The applicant notes that the water levels take 45 to 60 days to recover following a sampling event (Strata, 2011a). The applicant describes groundwater flow in the DM aquifer as “sluggish” (Strata, 2011a). The applicant did not provide estimates of the hydraulic properties for the DM aquifer.

Based on the Technical Report Addendum 2.7-H (Strata, 2011a), the DM aquifer was not included in the numeric groundwater flow model developed by the applicant.

During the pumping tests by the applicant in 2010, two DM wells (34-18DM and 14-18DM) exhibited a slight (0.06 to 0.08 meters [0.20 to 0.25 feet]) response to pumping at the nearby OZ well. The applicant attributed the response to leakage through nearby abandoned drill holes rather than leakage through the overlying confining unit.

Lower Confining Unit

The applicant states that no data exist for the hydraulic properties of the lower confining unit but the applicant anticipates a vertical hydraulic conductivity for the lower confining unit similar to that for the Pierre Shale (i.e., $5x10^{-4}$ to $2.6x10^{-10}$ feet per day).

The applicant did not include the lower confining unit in the numeric groundwater flow model.

OZ Aquifer

The OZ aquifer comprises the 30.5- to 45.7-meter [100- to 150-foot] interval of the upper Fox Hills Formation and the 9.1- to 12.2-meter [30- to 40-foot] interval of the lower Lance Formation (Strata, 2011a). The OZ aquifer is a confined aquifer with the potentiometric heads 45.7 to 122 meters [150 to 400 feet] above the top of the aquifer (at the well clusters, the groundwater elevations are 60.1 to 91.4 meters [200 to 300 feet] above the top of the screened horizon (Technical Report Addendum 2.7-F (Strata, 2011a))) (SER Figure 2.4-9). The potentiometric head in the OZ aquifer has been affected by pumping of the industrial wells during the past 30 years (Strata, 2011a). The applicant states

that the groundwater levels at well cluster 34-7 is least impacted by the pumping due to its location being farthest from the industrial wells whereas at well cluster 21-19, the levels are lowered by an estimated 45.7 meters [150 feet]. In the Technical Report Addendum 2.7-H (Strata, 2011a), the applicant reports that model predicted drawdown at the industrial wells due to the past long-term pumping is approximately61 meters [200 feet]. Drawdown in the OZ aquifer attributed to pumping of the industrial wells modified the vertical gradient between the OZ and DM aquifers (Strata, 2011a).

The applicant provides two isopleth contour maps for the OZ aquifer. On Technical Report Figure 2.7-22, the contours indicate a depression centered in the vicinity of well cluster 21-19. On Technical Report Addendum Figure 2.7-22 (Strata, 2011a), the contours indicate a single depression centered immediately south of well cluster 21-19. On Technical Report Addendum 2.7-H Figure 4.7-5 (Strata, 2011a), the contours indicate four depressions centered at the industrial wells (three wells in the Ross Project and one well located west of the Ross Project) (SER Figure 2.4-10). At distances from the industrial wells, the contours on both figures have similar orientations.

The applicant estimates a hydraulic gradient for the OZ aquifer of 15.2 meters [50 feet] per mile to the southwest based on the potentiometric surface near the well cluster least affected by the recent pumpage of the industrial wells (i.e., 34-7). The applicant reports that the OZ aquifer potentiometric surface contour map indicates flow from the Fox Hills Formation outcrop toward the depression in the vicinity of well cluster 21-19 (Strata, 2011a).

Based on the long-term monitoring of groundwater elevations at wells screened in the OZ aquifer (Strata, 2011a), the applicant reports less than 0.15-meter [0.5-foot] perturbations due to variations in barometric pressures. The applicant notes that groundwater elevations for most monitoring wells screened in the OZ aquifer exhibit an abrupt rise and decline during two periods in 2010, during the June/July and then September/October timeframe (Strata, 2011a). The applicant attributes these abrupt rises and declines in groundwater elevations to cessation/re-initiation of pumping at the industrial wells. At the well cluster located farthest from the industrial wells (i.e., 34-7), the long-term trend noted in the groundwater elevations is steady increase of 0.6 meters [2 feet] during 2010 (to October).

In response to the Environmental Review RAIs (Strata, 2012a), the applicant provided electronic data for quarterly groundwater elevation measurements at the well clusters throughout 2011. A general increase in groundwater elevations was noted for most OZ wells during 2011 (SER Figure 2.4-11). The greatest increase of approximately 7.6 meters [25 feet] was observed at the OZ well in well cluster 21-19, which is located closest to the on-site industrial water supply wells. Similar, albeit less significant increases over the same period were noted in groundwater elevations at wells screened in the DM and SM aquifers.

The applicant provides information and analysis of the hydraulic properties from the historic (1977 and 1978) and recent (2010) pumping tests and core data:

1977 and 1978 Pumping Test Analyses

In Technical Report Addendum 2.7-F (Strata, 2011a), the applicant reports results of two pumping tests conducted by Nubeth in support of the R&D site. The applicant reports that Nubeth had conducted two pumping tests, one in 1977 and the other in 1978. The 1977 pumping test consisted of a 72-hour test at a location slightly north of the present-day well cluster 21-19. The 1977 pumping test consisted of measuring water levels at 12 monitoring wells, four wells screened in each of the aquifers that the applicant has designated as the OZ, SM and SA aquifers. Based on its analysis of the data, the applicant reports that the transmissivity values ranged from 11 to 25 square feet per day. Using an aquifer thickness of 100 feet, the applicant estimates the ore zone horizontal conductivity at 0.11 to 0.25 feet per day. The applicant reports storativity values from the historic pumping tests that ranged from 8.6×10^{-5} to 2.5×10^{-4}. The applicant reports no effects were noted in the monitoring wells completed in the SM or SA interval.

The 1978 pumping test consisted of a modified 5-spot unit with one pumping well and six observation wells completed in the OZ aquifer in the vicinity of the 1977 pumping test (Strata, 2011a). The applicant reports that results of the 1978 pumping test yielded transmissivities between 12.8 and 29.1 square feet per day, and average hydraulic conductivity value of 0.22 feet per day, and storativities between 4.5×10^{-5} and 8.3×10^{-5}.

2010 Pumping Tests

The applicant performed pumping tests at each of the six well clusters during 2010 (Strata, 2011a). For five of the six clusters, the pumping test consists of pumping of between 8.7 and 56.4 Lpm [2.3 and 14.9 gpm] at the well in each cluster that was screened in the OZ aquifer for 24 hours, and monitoring groundwater elevations at that well and the other wells in that cluster that are screened in the DM, SM and SA aquifers. For the sixth cluster (12-18), the applicant performed two slightly different tests. The first test at the sixth cluster was similar to those conducted at the five other clusters except the pumping period was extended to 3 days and monitoring was conducted at three additional observation wells screened in a portion of the OZ aquifer. The second test was similar to the first except one of the partially penetrating observation wells in the OZ aquifer was used as the pumping well. Duration of the second pumping test was 24 hours. Prior to the testing at well cluster 12-18, the applicant undertook abandoning 55 drill holes within the area of concern of the pumping tests.

Based on information in the Technical Report Addendum 2.7-F (Strata, 2011a), the following is a summary of the observations during the tests:

Well Cluster	Pumping Rate (gpm)	Drawdown (feet) OZ	DM	SM	SA	Comments
34-7	14.9	28	0	0	0	24 feet within first 10 minutes
42-19	2.3	48	0.05	0	0	DM attributed to background
34-18	5.3	64.3	0.25	0	0	DM attributed to abandoned drill holes
14-18	5.3	117.2	0.2	0	0	DM attributed to abandoned drill holes
21-19	5.3	42.9	0	0	0	
2-18(1)	5.3	22	0	0	0	Drawdown listed on second line
		5.6 to 7.15				were observed at observation wells
2-18(2)	5.66	48.21	0	0	0	Drawdown listed on second line
		5.05 to 6.18				were observed at observation wells

The applicant's analyses of the pumping tests data yield a range of transmissivities for the OZ aquifer between 3.8 and 367.6 square feet per day, with an average of 88 square feet per day, range of horizontal hydraulic conductivities for the OZ aquifer between 0.13 and 7.62 feet per day, with an average of 3.26 feet per day, and a range of storativities between $4.0x10^{-6}$ and $1.5x10^{-4}$, with an average of $6.7x10^{-5}$. The applicant analyses of the multi-well pumping test include an evaluation of the vertical and horizontal anisotropy of the OZ aquifer. The applicant estimates that the vertical: horizontal hydraulic conductivity ratio 1.0, indicating no vertical anisotropy. The applicant estimates that the OZ aquifer has a horizontal anisotropy ratio of 2.6:1 for the major: minor axes; the major axis has an azimuth orientation of 22 degrees.

The applicant concludes that results of the 2010 pumping tests are similar to those of the 1977/1978 tests in that no responses were recorded by the SA or SM wells, and responses at DM wells were attributed to leakage through drill holes or natural fluctuations (Strata, 2011a). The applicant states that the calculated hydraulic conductivities fall in the range of published data for fine-grained sand, very fine-grained sand and silt, that the applicant used the state-of-the-art equipment and most-advanced software available to conduct and analyze the pumping tests and that the values determined by the applicant should be considered precise and objective.

In Technical Report Addendum 2.7-F (Strata, 2011a), the applicant calculates the specific capacities for the pumping wells based on the pumping test data. The calculated specific capacities range from 0.05 to 0.53 gallons per minute per foot of drawdown. The applicant notes that in addition to aquifer properties, the specific capacity of a well is also a function of the well's efficiency. The applicant states that well efficiency is believed to be a factor for one of two wells with the lowest calculated specific capacity (i.e., at the 14-18 cluster).

The applicant states that hydraulic conductivity calculations were based on the well's screened length. Although the OZ wells at the various well

clusters are essentially completed throughout the entire OZ thickness, the applicant states that interbedded impermeable shales are located within the screened interval and thus the screen length may not represent the exact ore zone thickness. The applicant notes that it calculated the hydraulic conductivities at the well cluster 12-18 using the thickness of the aquifer and not the screen length.

Core Samples

In Technical Report Addendum 2.7-F (Strata, 2011a), the applicant provides data and its analysis on the hydraulic properties for core samples collected by Nubeth in 1977 and Strata in 2009 and 2010. The core samples were collected at various depths in the Lance and Fox Hills formations at seven locations. The applicant groups the samples into lithologic types resulting in 24 sandstone, 5 siltstone, 11 shale, 7 shale/sandstone mix, 5 sandstone/siltstone mix and 1 cemented sandstone samples.

The laboratory-measured horizontal hydraulic conductivity for the sandstone samples (from the OZ aquifer) ranges from 2.4 to 11.9 feet per day, with an average of 5.1 feet per day. The applicant states that these values are comparable to the results of the pumping tests. The ratio of vertical: horizontal hydraulic conductivity for the sandstone core samples varied between 0.09 and 0.99, which an average of 0.68.

The horizontal hydraulic conductivity of the siltstone, sandstone/siltstone mix and cemented sandstone samples varies between 0.003 and 2.1 feet per day, with an average of 0.33, 1.17 and 0.003, respectively.[22]

The horizontal hydraulic conductivity of the shale samples varied between 0.003 and 0.163 feet per day, with an average of 0.074 feet per day. The ratio of vertical: horizontal hydraulic conductivity for the shale core samples varied between 0.001 and 0.286, with an average of 0.04.[23]

In Technical Report Addendum 2.7-H (Strata, 2011a), the applicant reports that the horizontal hydraulic conductivities used in the numeric groundwater flow model for the layer simulating the OZ aquifer varied between 0.01 and 3.0 feet per day with the predominant value used in the model outside of the Ross Project area equaling 0.19 feet per day. The vertical hydraulic conductivities used in the model for that layer varied between 0.08 and 2.10 feet per day with the predominant value used outside of the Ross Project area equaling 0.12 feet per day.

In Section 6.1 of the Technical Report (Strata, 2011a), the applicant states that the geologic and hydrogeologic properties, including porosity, hydraulic conductivity, transmissivity and storativity, determined for the ore zone at the

[22] Because there was only one cemented sandstone sample, the listed average is for that sample.
[23] Two samples had vertical conductivities that were less than the measurable minimum level of 0.01 millidarcy and assigned a value of 0.0 feet per day. One sample had an abnormally high vertical conductivity of 0.009 feet per day compared the values from other samples.

Ross Project compares favorably with those at ISR operations in Wyoming and Nebraska.

Upper Confining Unit

The applicant states that the thickness of the upper confining unit is between 6.1 and 24.4 meters [20 and 80 feet] within the Ross Project (Strata, 2011a). The applicant states that no hydraulic data exist for the upper confining unit; however, in the Technical Report Addendum 2.7-F (Strata, 2011a), the applicant suggests that the vertical hydraulic conductivities of the shale core samples (see discussion on core samples in "OZ aquifer" above) provide a measure on the degree of groundwater confinement provided by the confining units. For the numeric groundwater flow model in Technical Report Addendum 2.7-H (Strata, 2011a), the applicant uses a vertical hydraulic conductivity of 6.5×10^{-6} feet per day for the layer simulating the upper confining unit.

SM Aquifer

In Technical Report Addendum 2.7-F (Strata, 2011a), the applicant reports that the distance from the base of the SM aquifer to the top of the OZ aquifer varies from 22.3 meters [73 feet] at well cluster 34-7 to 54.9 meters [180 feet] at well cluster 42-19. These distances are thicker than the reported range of the upper confining unit (see discussion in SER Section 2.3.3.3). The applicant attributes the greater thicknesses to the additional stratigraphic units not included in the designated upper confining unit (Strata, 2012b).

The SM aquifer is under confining conditions with potentiometric heads varying from 36.5 meters [120 feet] above the top of the SM aquifer at well cluster 42-19 to 76.2 meters [250 feet] above the top of the SM aquifer at well cluster 12-18 (Strata, 2011a). In contrast to the DM aquifer, the potentiometric heads in the SM aquifer are always higher (8.2 to 45.4 meters [27 to 149 feet] higher) than the potentiometric heads in the OZ aquifer (Strata, 2011a).

The applicant's contour map for the SM aquifer indicates a trough in the SM aquifer potentiometric surface extending from the southwestern corner to the northwestern corner of the Ross Project (Strata, 2011a). Within the trough are two depressions, one is located in the vicinity of the industrial wells and the other in the northwestern corner of the Ross Project north of the stream channel for the Little Missouri River. The potentiometric surface is not as expected for a confined aquifer with flows from the outcrop to the basin center (Strata, 2011a). The applicant attributes the unexpected configuration of the potentiometric surface to drawdown from pumping of the industrial wells (applicant's estimate of 3.0 meters [10 feet] of drawdown at well cluster 21-19), and the discontinuous nature of the lithologies in the subsurface leading to difficulties in correlating a specific horizon across the Ross Project (Strata, 2011a). The applicant states that the SM aquifer is the first sandstone above the OZ aquifer but acknowledges that the first sandstone may not be the same across the entire project area. The applicant states that the contour map of the SM aquifer potentiometric surface may include some speculation (Strata, 2011a).

The fluctuations in potentiometric head for the SM aquifer during 2010 were less than 1 foot, which is less than fluctuations in the potentiometric surface for the DM and OZ aquifers. The notable exception is at well cluster 12-18 at which the fluctuations in the potentiometric head was in excess of 0.6 meters [2 feet] (Strata, 2011a).

Based on documentation for the former Nubeth R&D facility, the applicant states that no communication exists between SM aquifer and aquifers within the Fox Hills Formation (Strata, 2011a). The applicant reports that the lack of response at wells screened in the SM aquifer to the 2010 pumping tests (see OZ Aquifer discussions above) indicates a lack of communication.

Although no specific hydrogeologic data exists for the SM aquifer, the applicant estimates that the hydraulic properties for SM aquifer would be similar to those for the OZ aquifer (Strata, 2011a). In Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant estimates the transmissivity and hydraulic conductivity of the SM aquifer based on recovery of water levels after a sampling event. The estimated transmissivities for the SM aquifer range from less than 0.15 square feet per day (wells 42-19SM and 34-18SM), and between 6.8 and 33.44 square feet per day at the other four SM wells. The applicant estimates the corresponding hydraulic conductivities for the SM aquifer range from less than 0.005 feet per day (wells 42-19SM and 34-18SM), and between 0.36 and 0.8 feet per day at the other four SM wells.

In Technical Report Addendum 2.7-H (Strata, 2011a), the applicant reports that horizontal hydraulic conductivities used in the numeric groundwater flow model for the layer simulating the SM aquifer varied between 0.003 and 3.0 feet per day with the predominant value outside of the Ross Project area of 0.32 feet per day. The vertical hydraulic conductivities used in the model for that layer varied between 0.002 and 2.10 feet per day with the predominant value outside of the Ross Project area of 0.21 feet per day.

SA Aquifer

The applicant defines the SA aquifer as the surficial, water table or uppermost aquifer at the Ross Project (Strata, 2011a). The SA aquifer is comprised of the shallow-most water-bearing intervals in upper Lance Formation and, in some areas of the project area, alluvium of the Little Missouri River and Deadman Creek flood plains. The applicant installed wells in the SA aquifer (Lance Formation) at the six well clusters. The depth to the bottom of the SA wells varies between 9.1 and 32.9 meters [30 and 108 feet] and the depth to the top of the SA wells varies between 6.1 and 29.9 meters [20 and 98 feet] below grade. The distance between the bottom of the SA aquifer wells and top of the respective SM aquifer wells varies between 46.3 and 72.8 meters [152 and 239 feet] for the six well clusters (Strata, 2011a).

Except in the area of the proposed CPP, the applicant did not install wells in the alluvium (Strata, 2011a). (See SER Section 3.1.3 for discussion of the CPP investigation.)

Based on information on Table 2 in Addendum 2.7-F of the Technical Report (Strata, 2011a), the depth to groundwater varies between 2.8 meters [9.2 feet] and greater than 32.9 meters [108 feet] below grade.[24] The depth to groundwater is below the bottom of two SA wells located in the southern areas (wells 42-19SA and 34-18SA). The applicant constructs a potentiometric surface for the SA aquifer and states that groundwater flow in the SA aquifer follows the topography, moving from highlands to the lowlands (Strata, 2011a). The applicant estimates the hydraulic gradient for the SA aquifer is 10.7 meters [35 feet] per mile converging on the Oshoto Reservoir. The applicant states that changes in groundwater elevations at monitoring sites in lowland areas correlate with changes in surface water elevations within the Oshoto Reservoir and that groundwater in the SA aquifer leaves the project area in the northeasterly direction as alluvial underflow (Strata, 2011a).

The applicant states the groundwater levels fluctuated between 0.3 and 1.5 meters [1 and 5 feet] in the SA aquifer (Strata, 2011a). The applicant states that the higher fluctuation is a seasonal increase common in shallow, water table aquifers and indicates recharge from snow melt and spring precipitation (Strata, 2011a).

In Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant includes data from selected wells in the SA aquifer (as well as seepage areas along a stream outside of the Ross Project) for model calibration purposes only.

Staff finds that the hydraulic property information presented and analyzed by the applicant is acceptable, with the clarifications noted below, because the applicant described the regional and local hydraulic gradient and hydrostratigraphy, demonstrated that subsurface water level measurements were collected by acceptable methods, presented regional and local mapping, provided a narrative on the mineralized zone, summarized past, present and future water users including available locations, depths and screened intervals for regional water users, and described and estimated values for hydraulic parameters of the aquifer(s) based on appropriate testing.

Staff's clarifications of the findings consist of (1) estimates of the hydraulic conductivity of the OZ aquifer, (2) heterogeneity and anisotropy of the OZ aquifer, (3) definition of the DM aquifer as an aquifer, and (4) contouring of the potentiometric surface in the SA aquifer as follows:

Hydraulic Conductivity of the OZ Aquifer

Staff acknowledges that the applicant used appropriate testing techniques and analyses to determine the hydraulic properties. For the hydraulic conductivity of the ore aquifer, the applicant based its estimates on direct measurements from permeability testing on undisturbed core samples or calculations from the pumping tests. Each method has its limitations, which staff acknowledges the applicant properly states in the application and/or in responses to RAIs (Strata, 2011a;2012b). For the core samples, the limitation is the small size of the sample. For the pumping test, the limitations are (1) determining the appropriate

[24] Staff corrected the depth to water by the difference between the top of casing elevation and ground surface elevation listed in Technical Report Table 2.7-20 (Strata, 2011a)

value for aquifer thickness, and (2) a bias due to using drawdowns at the pumping well, which are affected by well efficiency.

On Table 6.1-7 of the Technical Report (Strata, 2011a), the applicant presents a list of geologic and hydrogeologic properties for the Ross Project along with those at analog ISR facilities. For the hydraulic conductivity at the Ross Project, the applicant lists values of 4.5 to 7.6 feet per day for the hydraulic conductivity and references the source of that information as Addendum 2.7-F of the Technical Report (Strata, 2011a). Staff's review of the reference indicates the applicant selected data only from the observation wells in which the hydraulic conductivity calculations were based on the respective screen thickness of the well and not the entire ore zone. On the other hand, the hydraulic conductivity for the analogs were based on the entire thickness of the ore aquifer. If the applicant had used the entire thickness, then the representative hydraulic conductivities would have been in the range of 0.15 to 2.8 feet per day. Those values are comparable to the range of the analogs, albeit on the lower end of the range, and staff has determined that the comparison to the analogs is still valid.

The applicant used a finite difference numeric groundwater flow model (e.g., MODFLOW) to predict drawdowns and flare factors. Due to its construction (largely a limitation on the dimensions of single cell) finite difference models may not accurately predict drawdown at a specific well. Furthermore, models do not incorporate well efficiencies in their model-predicted potentiometric head. Therefore, if a concern, as noted in the application is dropping of water levels below the top of an aquifer, then the analysis should also include a factor for well efficiencies. In the application and responses to RAIs (Strata, 2011a;2012b), the applicant commits to providing detailed hydrogeologic evaluations in the wellfield packages. Staff expects that the detailed hydrogeologic evaluations will include such factors. Staff will include a license condition that the initial wellfield package will be submitted for NRC review and verification to ensure that the detailed hydrogeologic evaluation is appropriate.

<u>Heterogeneity and Anisotropy of the OZ Aquifer</u>

In the application (Strata, 2011a), the applicant evaluates both quantitatively and qualitatively the heterogeneity and anisotropy of the OZ aquifer. The applicant provides a qualitative analysis of the heterogeneity of the aquifer throughout the application by stating that the "stratigraphy is complicated and vertically heterogeneous" (pages 2-95 and 2-149), uranium host sandstones are "highly heterogeneous sandstones" (page 3-3), and that tests performed by the applicant show that the "ore zone sands have greater horizontal permeability than vertical permeability" (page 3-3). The applicant correctly performed tests that were distributed throughout the Ross Project, provided ranges to the calculated hydraulic properties and appropriately averaged the data for use in the regional numeric groundwater flow model. In addition, the applicant provided a quantitative analysis of the horizontal and vertical anisotropy at one location in Addendum 2.7-H of the application (Strata, 2011a). Staff finds the evaluations adequate because the application provides descriptions of the existing data and a reasonable evaluation of that data.

Despite the description and qualitative analysis of the heterogeneities of the ore zone aquifer, the analytical models used by the applicant to estimate the hydraulic properties generally include the assumptions of a homogeneous, isotropic and infinite aquifer. The ore zone aquifer (or the Lance/Fox Hills aquifer) is not infinite. The applicant properly identifies the boundary of the aquifer primarily to the east and for an analysis of a long-term trend, the applicant properly relies on results of the numeric groundwater flow model, which can model aquifers that are not infinite. For the short-term test used by the applicant to estimate the hydraulic properties, staff finds that the assumption of an infinite aquifer is valid.

Hydrogeologists generally differentiate between homogeneous and isotropic as applied to an aquifer as follows: homogeneity refers to variability in the hydraulic properties at various points within the aquifer whereas isotropy refers to variability in hydraulic properties in all directions at a single point. The applicant acknowledges that the ore zone aquifer likely has vertical anisotropy due to changes in heterogeneities in the formation strata. The question to staff is the horizontal heterogeneity of the ore zone aquifer.

The applicant performed tests at locations distributed through the project and obtained an average value. The results from the various pumping tests were more or less uniform and use of an average value is acceptable. However, staff observed a slight decreasing trend in hydraulic conductivity within the Ross Project from north to south. This trend is similar to trends in the regional transmissivity of the Lance-Fox Hills through eastern Montana and Wyoming as seen in published data (see discussion on Regional Hydrogeology above). However, this trend in heterogeneity of the ore zone aquifer would not have an appreciable impact on proposed operations.

On the other hand, heterogeneities on a more local scale pose a safety significant issue because of the potential for preferred flow paths. The applicant acknowledges the horizontal heterogeneities by stating that "*minor localized slumps, folds and differential compaction features are common*" and quotes from a former investigator that "*changing permeability and lateral discontinuity in the stratigraphy was the more probable reason for some observation wells to be hydrologically isolated*" (Strata, 2011a). In Section 2.6 of the Technical Report (Strata, 2011a), the applicant states that the *"geometry at the proposed project area is complex due to the variability of the depositional environment of the host sandstones and hence controls on groundwater movement".* And finally, the applicant states that the *"epigenetic roll fronts deposited in the Oshoto area demonstrate patterns similar to those across the Powder River Basin".*

While the sequence of interlayered mudstones and sandstones is similar to host formations at other NRC-licensed facilities, the host formation at the Ross Project has a unique geologic age compared to the host formations at other ISR operations. Staff must have reasonable assurance that heterogeneities in the unique host formation at the proposed project do not impact the applicant's ability to control the migration of source and byproduct material subsurface. The applicant's references to lateral discontinuities in the ore zone stratigraphy ultimately refer to observations during the former Nubeth R&D facility. In its November 1978 Quarterly Report (Stoick, 1979a), the former licensee

documents that groundwater levels at two monitoring wells, wells M2 and M3, were hydraulically isolated from the R&D injection and production well operations. Both wells are located 30.5 meters [100 feet] north of the nearest injection wells. The former licensee notes that certain parameters, specifically carbonate and chloride, were "abnormal" from the beginning (Stoick, 1979a). Starting in the following quarterly report, the former licensee draws a line on the map for the wellfield between monitoring wells M2 and M3 and the injection wells (Stoick, 1979a). The line is labeled 'Hydrologic Barrier in "B" Zone', which, as discussed in SER Section 2.3.3, is the ore zone.

This report from the former R&D operations is within the same host formation as the proposed Ross operations and suggests to staff that the local-scale heterogeneities may affect groundwater flow within the ore zone aquifer. Therefore, staff will include a license condition that requires the licensee to have a minimum density of one well per two acres for the baseline data rather than the minimum density of one well per three to four acres as proposed by the applicant (see SER Section 3.1.4). Staff is reasonably assured that the suggested density of wells will identify any preferred migration paths and or variations in quality within the ore zone aquifer. The variation in quality is discussed in SER Section 2.5.

<u>DM aquifer</u>

In the Technical Report (Strata, 2011a), the applicant describes flow through the DM aquifer as "sluggish" based on responses during the sampling events but does not provide any quantitative analysis of the DM aquifer properties. Because of the anticipated low yields, staff questions whether or not the DM aquifer meets the definition of an aquifer.

The definition of an aquifer is found in the Introduction to Appendix A of 10 CFR Part 40 as follows:

> *Aquifer means a geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs.*

That definition is similar to the definition of an aquifer found in 40 CFR Part 144. The regulations do not define the term "significant amount." Guidance available for staff to use to define "significant amount" is as follows:

First, the definition of "limited use groundwater" in 40 CFR Part 192.11(e) includes the following:

> *Limited use groundwater means groundwater that is not a current or potential source of drinking water … or (3) the quantity of water reasonably available for sustained continuous use is less than 150 gallons per day. The parameters for determining the quantity of water reasonably available shall be determined by the Secretary [of Energy] with the concurrence of the Commission.*

A yield of 150 gallons per day (gpd) is equivalent to domestic water usage for two persons based on an industry standard water use of 75 gpd/capita. This yield would likely be the minimum needed for a domestic water supply from an aquifer and, thus, in staff's opinion, a minimal value for "significant amount." The quantity of water available for sustained continuous use of the DM wells has not been determined by the applicant (nor is it a requirement for an application). Staff's review of the field sampling sheets presented in Addendum 2.7-J of the Technical Report (Strata, 2011a) finds that, during the initial sampling events, the DM wells were purged dry following removal of approximately one well volume of water. For a typical DM well, one well volume is approximately 350 gallons. Thus, to meet the 150 gallons per day requirement, the well will need to be able to be pumped dry once every 2.3 days. However, the time for water levels to fully recover following a sampling event at the DM wells is generally 45 to 60 days (Strata, 2011a). Consequently, a well is only partially recovered after 2.3 days, which complicates the sustainable well yield calculations.

In Addendum 2.7-H of the Technical report (Strata, 2011a), the applicant reports that the DM wells are typically pumped dry at a pumping rate of less than 0.5 gpm. If so, then the maximum recharge to the well from the aquifer must be significantly less than 0.5 gpm. A sustainable 150 gallon per day yield equates to 0.1 gpm. Therefore, although the data are not conclusive, sustainable yields for the DM wells are marginal at best to meet the "limited use groundwater" definition. Staff could not verify the 0.5 gpm pumping rate as the field sampling records provided by the applicant are incomplete.

Second, additional guidance for the definition of "significant amount" is found in Chapter 4 of US Geological Survey (USGS) Techniques in Water-Resources Investigations (USGS, 2006). The USGS guidance recommends not sampling low-yielding wells for water quality purposes, especially those wells that exhibit slow recovery or that are pumped dry. Furthermore, the USGS guidance has a rule-of-thumb that states "do not sample wells at which, after purging, recovery of water levels to 90 percent exceeds 24 hours." Based on staff's review, recovery of water levels in the DM wells after sampling barely meets the above USGS rule of thumb. Again, staff finds the data for the DM wells are marginal at best in meeting the sampling guidance of the USGS.

Finally, the U.S. Environmental Protection Agency (EPA) has provided guidance on the definition of an Underground Source of Drinking Water (USDW) in the document "Technical Program Overview: Underground Injection Control Regulations" (EPA, 2002). Under the program definitions section, the guidance states that for a significant amount of water

> *For the purpose of defining a USDW, the Office of Ground Water and Drinking Water uses 1 gallon per minute as the threshold value for determining if an aquifer produces a significant amount of water.*

Based on that guidance, the DM aquifer does not meet the definition of a USDW.

Staff finds the classification of the DM aquifer is marginal but accepts the applicant's proposed monitoring this aquifer as the underlying aquifer because

the monitoring will provide an added level of safety as the next underlying USDW is located below the Pierre Shale and, given the thickness and low permeability of the Pierre Shale, monitoring of that USDW would not be required. During staff's review, several inconsistencies were noted in the field sampling documentation, primarily significant data were missing, and the applicant's SOP for well sampling did not specifically address sampling procedures for low-yielding wells. As a result, staff will include license conditions such that the applicant develops procedures to properly document future sampling events including low yielding wells (See SER Section 2.5.4).

<u>Contouring of the SA Aquifer Potentiometric Surface</u>

The applicant provides contradictory information on whether the Oshoto Reservoir is losing or gaining stream (i.e., groundwater flow is recharged by or seeps into the surface water body). The applicant states that changes in surface water elevations in the streams correlate with changes in groundwater elevations in the SA aquifer (though the applicant only has one SA well in the alluvium), which suggests that the Oshoto Reservoir and the uppermost aquifer are hydraulic connected. This conclusion is also supported by the chemistry of the water.

Much of the applicant's data suggest that the Oshoto Reservoir is a gaining stream. The applicant states that the contours of the potentiometric surface for the SA aquifer converge on the Little Missouri River (which includes the Oshoto Reservoir) and Deadman Creek. The potentiometric contour maps for the SA aquifer prepared by the applicant in the application (Figure 2.7-25; Strata, 2011a) and responses to RAIs (Figure TR RAI 10-1; Strata, 2012b) support the conclusion that the Oshoto Reservoir is gaining stream, particularly for the Little Missouri River. In the application and responses to RAIs (Strata, 2011a;2012b), the applicant states that wetland areas in the upland areas likely contribute to groundwater (losing stream), whereas surface water in wetland areas in the low lands proximal to main drainage channels for the Little Missouri River or Deadman Creek is likely supplemented by seepage of groundwater from the SA aquifer (gaining stream) and that the only potential springs are associated with the field delineated wetlands or with the "Little Missouri River in the vicinity of the Oshoto Reservoir" (Strata, 2011a). This analysis would indicate that the Oshoto Reservoir is a gaining stream.

On the other hand, the applicant specifies that groundwater in the SA aquifer leaves the project area to the northeast as alluvial underflow but the applicant does not directly discuss groundwater discharge to the Oshoto Reservoir. The 4130 ft-MSL isopleth contour on the potentiometric surface contour maps is located upstream of the Oshoto Reservoir, whereas the hydrograph for the Oshoto Reservoir on Figure 5.2 in the responses to RAIs (Strata, 2012b) indicate the lowest surface water elevation in the Oshoto Reservoir is 4131 ft-MSL. This information indicates that the entire Oshoto Reservoir is a losing stream.

Staff is reasonably assured that the above discrepancy will be resolved as the applicant acquires additional site-specific data for wellfield data packages. Staff's interpretation is that potentiometric contour of 4130 ft-MSL is likely located at the most downstream side of the Oshoto Reservoir and thus would be

consistent with the applicant's description of the Oshoto Reservoir as likely gaining stream. Staff will include a license condition to ensure that monitoring of the Oshoto Reservoir will be included for wellfields located immediately upgradient of the Oshoto Reservoir.

2.4.3.4.4 Numeric Groundwater Flow Model

In Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant presents documentation and results from a numeric groundwater flow model prepared by the applicant. The model is a finite difference numeric model (i.e., MODFLOW) that is designed to simulate groundwater flow in the lower Lance and upper Fox Hills formations from ground surface to the bottom of the OZ aquifer. The modeled area consists of 14375 acres centered about the Ross Project.[25] Sources of water for the model include general head boundaries along the model perimeter and recharge.[26] The sinks in the model common to all simulations were drain boundary conditions, general head boundary conditions and evaporation. Sinks in the model that were simulation dependent are constant flux boundary condition (aka wells).

The applicant performs several simulations that consist of the following:

Calibration	(1980) Estimate water levels prior to the use of the regional industrial water supply wells
Verification	(1980 to 2010) Estimate changes in water levels due to historic pumping at the industrial wells
Predictive	Estimate water levels during and at the end of ISR operations at the Ross Project within and without the onsite Industrial water supply wells in operation. The ISR operations consist of both normal (balanced) operation and out-of-balance simulating excursion and corrective actions for an excursion.
Flare Predictive	Confirm that appropriate flare factors were estimated for the operations

The applicant uses hydraulic properties in the model consistent with those estimated above from the hydraulic testing (i.e., pumping tests and core samples). The applicant calibrates the model by varying the hydraulic properties and/or selected parameters in the boundary conditions and performs sensitivity analyses on key parameters. The calibration simulation is under steady-state conditions whereas the other simulations are under transient conditions. For the flare predictive simulation, the applicant refines the grid to the area immediately surrounding the modeled wellfield, modifies the layering and hydraulic conductivities within the model, and due to limitations of the software, uses constant head boundary conditions along the refined model boundary.

[25] The total area includes a small area of inactive cells located along its eastern edge, which would reduce the active model area to a value slightly less than the total area.
[26] The legend on Figure 4.1-1 of Addendum 2.7-H (Strata, 2011a) lists the boundaries along the perimeter as constant head boundaries; however staff verified through the model electronic files that the boundaries were general head boundaries (except as noted for the flare analysis).

Based on the model results in Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant concludes the following:

As expected, the current potentiometric surfaces, which include troughs and depressions, are attributed to drawdown from operation of the area industrial wells during the past 30 years. The applicant quantifies an existing drawdown of 61 meters [200 feet] in the vicinity of the industrial wells and 4 feet at the monitoring well located farthest from the industrial wells

Concurrent operations of the industrial wells and ISR wellfields may result in significant drawdown at the industrial wells. Drawdown due to operation of the industrial wells decreases substantially at a distance of 0.25 mile from the well. The applicant determines that concurrent operations are possible for the industrial wells and ISR wellfields outside of 0.4 kilometer [0.25 mile] of the industrial wells.

Recovery of the water levels in the aquifers due to the ISR operations to within 3.0 meters [10 feet] will occur within 5 to 10 years after operations have ceased.

Horizontal excursion control and monitoring is adequate for perimeter wells located 183 meters [600 feet] from the wellfields.

Staff finds that the applicant's numeric groundwater modeling efforts is appropriate for the data quality objectives of the application. Given the geologic setting where the boundary of the Lance-Fox Hills aquifer is immediately east of the Ross Project, the numeric model permits the incorporation of the limitations due the boundary. In addition, staff finds that the numeric model provides a reasonable estimate of current drawdown from the combined effects of the nearby industrial water supply wells as well as predicted mutual interference should concurrent operations of the industrial water supply wells and ISR wellfields at the Ross Project occur in the future. Staff will include a license condition that limits the ISR wellfield operations to ensure staff with reasonable assurance that those operations can be conducted safely should operations at the industrial water supply wells continue (see SER Section 5.7.8.4).

2.4.4 EVALUATION FINDINGS

The staff completed its review of the hydrologic site characterization for the Ross Project. The review included an evaluation using the review procedures in SRP Section 2.7.2 and the acceptance criteria outlined in SRP Section 2.7.3. The applicant has acceptably described the surface water hydrology by providing the following:

- the location of the drainages in and around the license area;
- peak flood estimates for appropriate recurrence intervals for all drainages;
- a flood potential analysis for the facilities; and
- acceptable erosion protection against the effects of flooding from nearby streams.

The applicant has acceptably described the groundwater hydrology by providing the following:

- a description of the regional hydrogeology; and
- a description of the overlying aquifer, extraction zone, and underlying aquifer hydrogeology using potentiometric surfaces maps with acceptable contour intervals based on an appropriate number of monitoring wells.

Based on a detailed review of the characterization of the surface and groundwater hydrology at the Ross Project, the staff concludes that the information provided by the applicant is acceptable, except for the following items, which can be addressed through license conditions:

Staff will include a license condition that would require that all historical drill holes be properly abandoned before operations so that they will not act as a conduit for fluid flow from the production aquifer during operations. (see LC 10.12 in SER Section 2.3.4)

Staff will include a license condition requiring submittal of the initial wellfield package to NRC staff for review and verification prior to operations in the wellfield. The initial wellfield package will provide an evaluation of the heterogeneities and confirm the hydraulic isolation of the OZ aquifer (see LC 10.13 in SER Section 5.7.8.4).

Staff will include a license condition requiring that an inward gradient be maintained during the life of a wellfield. This condition will ensure the primary control over fluid migration from a wellfield (see LC 10.7 in SER Section 3.1.4).

Staff will issue a license condition requiring a minimum density of one baseline well for two acres of production area. The minimum density will confirm hydraulic communication and ensure representative samples are collected for a well field (see LC 11.3 in SER Section 5.7.8.4).

Staff will issue a license condition requiring the inclusion of wells in the SA aquifer in the excursion monitoring program should a wellfield be located in an area where the uppermost aquifer is in shallow alluvium. The shallow alluvium aquifer could provide a pathway to the nearby streams should the uppermost aquifer be impacted by the operations (see LC 11.5 in SER section 5.7.8.4).

Staff will issue a license condition requiring development of a Standard Operating Procedure for sampling low yielding wells that will ensure representative samples are collected (see LC 12.11 in SER Section 3.1.4).

In summary, the applicant provided a description of the site-specific hydrogeologic units, included pumping test data that were acquired using acceptable methodologies, and performed data analyses using appropriate analytical models to estimate site-specific hydraulic properties of the subsurface strata. Although the data submitted and analyses performed by the applicant in the application are consistent with guidance in the SRP, the analyses included a degree of uncertainty due to the use of numeric groundwater flow models for the complexities of the subsurface setting. Based upon the review conducted by the staff, discussed above, and information that will be provided by the applicant in accordance with the above license conditions, staff finds that the applicant will be able to control the migration of production fluids in the subsurface and thus meets the applicable acceptance criteria for this section and thus meets requirements of 10 CFR 40.31(b) and will meet requirements of 10 CFR 40.41(c), if issued a license.

2.5 BACKGROUND SURFACE WATER AND GROUNDWATER QUALITY

2.5.1 REGULATORY REQUIREMENTS

General requirements for contents to applications of specific licenses issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(h) specifies that an application must clearly demonstrate how requirements and objectives set forth in 10 CFR Part 40 Appendix A are addressed. Technical Criterion 7 in 10 CFR Part 40 Appendix A set forth requirements and objectives for obtaining complete baseline data on a milling site and its environs under a preoperational monitoring program.[27]

Based on guidance in Section 1.0 of RG 3.46 (NRC, 1982b), Sections 2.9 and 2.10 of RG 4.14 (NRC, 1980a) and Section 2.7 and 2.9 of the Standard Review Plan (NRC, 2003a), an application should provide sufficient characterization of the pre-operational environmental quality. Regulatory Guide 4.14 (NRC, 1980a)provides guidance on conducting radiological effluent monitoring programs at uranium recovery facilities including the preoperational baseline monitoring programs at various environmental media. Regulatory Guide 3.46 (NRC, 1982b) provides guidance on information to be included in an application to document the background quality, both radiological and non-radiological data, for various environmental media. Section 2.7 of the SRP (NRC, 2003) provides guidance on the assessment of the groundwater quality within and adjacent properties and Section 2.9 of the SRP (NRC, 2003) provides guidance on areas of review, review procedures and acceptance criteria for establishing a pre-operational monitoring program.

For this section, staff reviews the background preoperational non-radiological and radiological quality data for the surface water and groundwater environments. Criteria 7 and 7A in Appendix A of 10 CFR Part 40 describe requirements for two monitoring programs; the first program (Criterion 7) is the operational monitoring program and the second program (Criterion 7A) is the groundwater detection monitoring program. In this section of the SER, staff reviews the background (pre-operational) data for the operational monitoring program and not the groundwater detection monitoring program(s). A groundwater detection monitoring program requires a robust analysis of the background data in order to establish Commission-approved background concentrations at the point of compliance in accordance with Criterion 5B(5) in Appendix A of 10 CFR Part 40. Groundwater detection programs are required for each wellfield and for surface impoundments that contain byproduct material. Staff will require licensees to submit background data for each wellfield or surface impoundment immediately prior to being operational (for staff's review, see SER Section 5.7.8.3).

As listed in Criterion 7, the purpose of the operational monitoring program reviewed in this SER section is to:

- Measure or evaluate compliance with applicable standards.
- Evaluate performance of control systems and procedures.

[27] Criteria in Appendix A are written for conventional mill setting. The conventional mill setting differs from an ISR setting in that (1) at a conventional mill, all activities conducted under the license are performed above ground whereas at ISR settings, the uranium extraction from the ore is performed in situ (or in the subsurface), and (2) at a conventional mill, a solid byproduct material, the mill tailings, is stored above ground in a tailing pile whereas at ISR settings, no mill tailings are generated. Staff is applying these criteria to ISR facilities because 10CFR 40.31(h) specifies that not only the requirements but objectives of the technical criteria in Appendix A are met.

- Evaluate environmental impacts caused by the operation.
- Detect potential long-term effects.

The preoperational monitoring program must collect sufficient data to establish existing conditions as the basis for detection, measurements and evaluations performed under the operational monitoring program. Staff is required to determine that the application has provided sufficient data on the groundwater and surface water quality under a preoperational program that meets the above regulatory requirements.

2.5.2 Regulatory Acceptance Criteria

Staff reviews the application for compliance with applicable requirements of 10 CFR 40.31(h) and 10 CFR Part 40 Appendix A Criteria 7, using review procedures in Section 2.7.2 and acceptance criteria in Sections 2.7.3 of the SRP (NRC, 2003), and guidance in Regulatory Guide 3.46 (NRC, 1982b) and Regulatory Guide 4.14 (NRC, 1980a).

Information in the application, as reviewed and verified by staff, will be deemed acceptable provided staff determines, with reasonable assurance, that a license issued based on the application meets the above regulatory requirements, and, pursuant to 10 CFR 40.32, can conclude that (1) the proposed project is for a purpose authorized by the AEA, (2) the applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner to protect health and minimize danger to life or property; (3) the proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property; and (4), issuance of a license will not be inimical to the common defense and security or to the health and safety of the public.

2.5.3 Staff Review and Analysis

Unless otherwise stated, information reported in this SER Section is from Sections 2.7 and 2.9 of the Technical Report (Strata, 2011a).

The following sections present staff's review and analysis of the surface water and groundwater at, and in the vicinity of, the Ross Project.

2.5.3.1 Surface Water

Streams

The applicant states that surface water drainages within the Ross Project are ephemeral in nature with streams being dry during a significant portion of the year (Strata, 2011a). To support this assertion, the applicant installed continuous monitoring gaging stations at three locations within the Ross Project, two gaging stations are located on the Little Missouri River (1 upstream and 1 downstream) and one gaging station is located on Deadman Creek (upstream). Deadman Creek is a tributary of the Little Missouri River and their confluence is located within the center of the Ross Project. The locations of the surface water sampling/gaging stations are shown on SER Figure 2.5-1.

The gaging stations were monitored for a 3-month period during 2010 (June 15th to September 25th). The two upstream gaging stations measured flow at times only immediately after snow melt or a significant precipitation event (Strata, 2011a). The downstream gaging station

recorded flows over a slightly extended period of time compared to the upstream gaging stations, but also recorded a month-long period of no flow during the 3-month monitoring. The applicant attributed the extended flows in the downstream gaging station to attenuation of flows by the Oshoto Reservoir, which is located immediately upstream of that gaging station (Strata, 2011a). The applicant provided a graphical display of water elevations in Oshoto Reservoir and flows in the downstream gaging station to support their conclusion (Strata, 2011a). The ephemeral nature of the streams is consistent with USGS topographic mapping and Wyoming surface water classifications.

Staff finds that the applicant has demonstrated that the surface water bodies, the Little Missouri River, Deadman Creek and the other tributaries, in and around the Ross Project are ephemeral. Guidance in the SRP (NRC, 2003) indicates that applicants should acquire surface water quality in perennial streams. Guidance in RG 4.14 (NRC, 1980a) states that if streams are dry part of the year, samples should be collected during times when the streams are flowing. The applicant collected grab samples at the three stream gaging stations on March 9 and April 13, 2010, which the applicant refers to as the 2010 first and second quarter sampling, respectively. Subsequently, the applicant set up automatic sampling devices at the stream gaging stations, which were not used for sample collection during the remaining portion of 2010.

The applicant states it collected surface water samples in accordance with its Standard Operating Procedure 8 (SOP 8), a copy of which is presented in the Technical Report Addendum 2.9-A (Strata, 2011a). The applicant, through an independent laboratory, analyzed the surface water samples for parameters listed on SER Table 2.5-1. Except for manganese, the trace metal constituents were analyzed as the “dissolved” species (i.e., the sample aliquots were field filtered). Manganese and iron were analyzed as both dissolved and “total” species (i.e., the sample aliquots for total species were not field filtered). The radiological parameters (except gross alpha and gross beta) were analyzed for both “dissolved” and “suspended” species. Not all parameters were analyzed for all sampling events. The applicant presents field data sheets and laboratory reports for the surface water sampling events in Technical Report Addendum 2.7-E (Strata, 2011a), and lists the laboratory results in tabular form in Technical Report Addendum 2.7-D (Strata, 2011a). The range in parameter concentrations for the preoperational surface water monitoring program is summarized for the surface water sampling stations in SER Table 2.5-2.

The applicant evaluates the surface water quality in the streams by providing:

- A summary of the range of concentrations parameter-by-parameter, surface-water-sampling-location-by-surface-water-sampling-location basis.
- A Piper diagram on the average concentrations of major ion chemistries.
- A discussion on the overall trends.

The applicant concludes that the surface water quality of the streams is consistent both spatially and temporally, the TDS concentrations are low to moderate, and the water type is sodium bicarbonate, which the applicant notes is unusual for Wyoming where most streams originating in lowlands are dominated by sodium sulfate type, whereas streams originating in mountainous areas are the calcium carbonate type (Strata, 2011a). The applicant reports that the concentrations of metals and radionuclides in the surface water at the three gaging stations were near or below the minimum laboratory detection limits, with the exception of uranium. The applicant notes that the uranium concentrations were highest during the 2010 second quarter at which time flow in the streams was the lowest. The applicant states that the water quality of the

streams is similar to the ground water quality of the surficial aquifer (SA aquifer) indicating potential communication between the SA aquifer and surface water in the streams (Strata, 2011a).

Reservoirs

The applicant collected surface water samples from 10 on-site reservoirs (Strata, 2011a) (SER Figure 2.5-1). The samples were collected quarterly from the 2009 third quarter to 2010 fourth quarter depending upon whether or not the applicant had the land-owner's permission or whether or not the reservoir was dry or frozen at the time of sample collection (Strata, 2011a). Samples were not collected at one reservoir, designated as R-9, because the applicant reports that the reservoir was located directly downstream of another reservoir which was sampled. A sample was collected once at reservoir R-7, which the applicant subsequently did not sample because its location was immediately outside of the Ross Project (Strata, 2011a).

The applicant reports that the samples were collected with a telescoping dipper, the sample aliquots for dissolved constituents were filtered in the field, and control of the samples was transferred to the outside laboratory for chemical analyses (Strata, 2011a). The applicant presents the field data sheets and laboratory reports in Technical Report Addendum 2.7-E, and lists the laboratory results in tabular form in Technical Report Addendum 2.7-D (Strata, 2011a). The parameters analyzed for the reservoir samples are listed on SER Table 2.5-1. The range in parameter concentrations for the preoperational reservoir monitoring program is summarized in SER Table 2.5-3.

The applicant evaluates the surface water quality in the reservoirs by providing:

- A summary of the range of concentrations parameter-by-parameter, reservoir-sampling-location-by-reservoir-sampling-location basis.
- A Piper diagram on the average concentrations of major ion chemistries.
- A discussion of the overall trends.

The applicant states that the water quality in the sampled reservoirs varied significantly depending upon location (Strata, 2011a). Reservoirs in the channels of the main streams (Little Missouri River and Deadman Creek) exhibited higher salinity, hardness and total dissolved solids (TDS) compared to reservoirs located in the upland tributaries. The water quality of reservoirs in the main channels was similar to the quality at the stream gaging stations, a sodium-bicarbonate-type water, whereas the water quality in the upland reservoirs was calcium-carbonate-type water (Strata, 2011a).

The applicant reports that the concentrations of total metals and radionuclides were low to undetectable for all reservoirs (Strata, 2011a). The highest concentrations of uranium were measured in water in the reservoirs along the main streams; the uranium levels in the reservoirs were similar to those measured in the stream gaging stations. Radium-226 was at detectable levels in water at six reservoirs for one or more sampling events (Strata, 2011a).

2.5.3.2 GROUNDWATER

The applicant's preoperational monitoring plan for the groundwater resource consists of an evaluation of historical data from the Nubeth R&D facility, sampling of existing nearby water supply wells and sampling of the recently installed wells within the Ross Project (Strata, 2011a).

2.5.3.2.1 Evaluation of Historical Data from the Nubeth R&D Facility

The applicant presents a summary of the groundwater quality prior to ("baseline") and following restoration at nine (9) wells associated with the Nubeth R&D facility (Strata, 2011a). The baseline groundwater quality was either sodium sulfate or sodium bicarbonate type. The applicant reports the concentrations of three radiological parameters, gross alpha, radium-226 and uranium, in the groundwater at the nine wells and notes that with the exception of two wells, the gross alpha concentrations exceeded the State of Wyoming I through III class of use standards (Strata, 2011a). The applicant reports the quality of the last sampling following restoration at the Nubeth R&D facility and states that due to elevated gross alpha concentrations, the restored groundwater remained suitable for industrial use only.

In Section 1.2 of the Technical Report (Strata, 2011a), the applicant reports that the final approval for decommissioning the Nubeth R&D facility was granted by the regulatory agencies (Wyoming DEQ and NRC) between 1983 and 1986. The applicant concludes that the Nubeth R&D facility demonstrated a successful reclamation, groundwater restoration and facility decommissioning. The applicant presented the final restoration approval from WDEQ and NRC, and the final site decommissioning report from NRC in the Technical Report Addendum 1.2-A (Strata, 2011a).

2.5.3.2.2 Sampling of Existing Nearby Water-Supply Wells

The applicant identifies 29 existing water-supply wells within 2 miles of the Ross Project that were sampled as part of its preoperational monitoring program (Strata, 2011a). The wells include 2 industrial wells, 15 livestock water-supply wells and 12 domestic water-supply wells (SER Figure 2.5-2). The wells were sampled on a quarterly basis starting with the 2009 third quarter. Some wells were not sampled all quarters for various reasons (e.g., no landowner permission, not functioning, winterized, dry, frozen, no access or well constructed recently). In Technical Report Section 2.9 (Strata, 2011a), the applicant states that 15 of the 29 water-supply wells sampled are located within 2 km of the Ross Project including the three water-supply wells located within the Ross Project and wells at the nearest residences (Strata, 2011a).

In Technical Report Section 2.9 (Strata, 2011a), the applicant states that the samples were collected in accordance with its SOP 9. The applicant provides a copy of its SOP 9 in Technical Report Addendum 2.9-A (Strata, 2011a).

The applicant analyzed the nearby private water supply well samples for parameters listed on SER Table 2.5-1 by an independent laboratory (Strata, 2011a). Except for manganese, the trace metal constituents were analyzed as the "dissolved" species (i.e., the sample aliquots were field filtered). Manganese and iron were analyzed also as the "total" species (i.e., the sample aliquots were not field filtered). The radiological parameters (except Gross alpha and gross beta) were analyzed for both "dissolved" and "suspended" species. Not all parameters, in particular the radiological parameters, were analyzed during all sampling events. The applicant presents the field data sheets and laboratory reports in Technical Report Addendum 2.7-J and lists the laboratory results in tabular form in Technical Report Addendum 2.7-I (Strata, 2011a).

The applicant discusses the quality of the existing water supply wells by segregating the wells into their respective use category, i.e., industrial, livestock water supply or domestic water supply (Strata, 2011a). The applicant evaluates the groundwater quality by providing:

- a summary of the range of concentrations parameter-by-parameter, well-by-well.
- a Piper diagram on the average concentrations of major ion chemistries for each location.
- a discussion of the overall trends.
- comparison of the quality at each well to established regulatory standards.

2.5.3.2.3 Industrial Wells

The range in parameter concentrations for the preoperational monitoring of nearby industrial water supply wells is summarized in SER Table 2.5-4. The applicant sampled the two industrial wells (19XX18 and 22X19) located within the Ross Project and used as water sources for the water used to flood the existing oil fields (Strata, 2011a).[28] The applicant reports that water from the industrial wells is dominated by sodium and sulfate ions, has moderate TDS concentrations, and has detectable radiological constituents. The applicant reports that the highest levels detected in the monitoring program were measured in ground water from well 19XX18 (Strata, 2011a).

The applicant states that water from the industrial wells is consistent with water quality at the monitoring wells screened in the OZ aquifer (see below). This consistency is not unexpected because the industrial wells are screened in the OZ aquifer, though at least one industrial well is also screened in the DM aquifer (Strata, 2011a).

2.5.3.2.4 Livestock Water Supply Wells

The applicant reports on sampling of 15 livestock water supply wells within and nearby the Ross Project as part of the preoperational monitoring program (Strata, 2011a).[29] Of the 15 wells sampled, the dominant cation in the water at 10 wells is sodium, at one well is calcium, and at the remaining four wells is a mixture of sodium, calcium and magnesium. The dominant anion at most wells is bicarbonate whereas sulfate becomes a significant percentage at four wells and is the dominant anion at one well. The applicant characterizes the variation in quality similar to that of the SA aquifer wells (see below) and attributes the variability to the wide range of depths for the livestock water supply wells (i.e., from 12.2 to 91.4 meters [40 to 300 feet] below grade).

The livestock water supply wells exhibit high selenium, uranium and several radiological parameters in approximately half of the wells sampled; the uranium and selenium concentrations at two wells were higher than at wells in the production aquifer at the Ross Project (Strata, 2011a).

The gross alpha levels for approximately one-half of the wells did not meet the suitability criteria for a Wyoming Class I, II or III and the National Primary Drinking Water Regulations MCL for uranium and/or gross alpha (Strata, 2011a). One well met the Class I suitability criteria. The applicant states that remaining wells appear to meet the Class II or Class III suitability criteria. All but one well exceeded the recommended levels for TDS, sulfate and/or manganese as listed in the National Secondary Drinking Water Regulations (Strata, 2011a).

[28] The applicant reports that a third well, 789V, is also used for industrial water supply within the Ross Project but water from this well is comingled with that from 19XX18 prior to the sampling port. Therefore, the sample is representative of 19XX18 and 789V.

[29] The 15 livestock wells have been modified to 6 livestock wells for the range in parameter concentrations reported in this SER because (1) the current usage includes domestic use as reported by the applicant in the RAI responses (Strata, 2011a) or (2) the well is located outside of 2 kilometers.

The range in parameter concentrations for the preoperational monitoring of two livestock water supply wells within the Ross Property is summarized in SER Table 2.5-4 and for four livestock water supply wells within 2 kilometers of the Ross Property is summarized in SER Table 2.5-5.

2.5.3.2.5 Domestic Water Supply Wells

The applicant reports on sampling of 12 nearby domestic water supply wells as part of the preoperational monitoring program (Strata, 2011a).[30] Based on Figure 2.7-33 of the Technical Report (Strata, 2011a), six domestic wells are located within 2 kilometers of the Ross Project boundary. The applicant reports the closest domestic well to the Ross Project is designated as DWWELL01, which is located within 0.12 miles of the Ross Project.

Of the 12 wells, the dominant cation in the water at 10 domestic wells is sodium, while four wells had a significant percentage of calcium plus magnesium (Strata, 2011a). The dominant anion was divided between bicarbonate and sulfate at the domestic wells. TDS concentration ranged between 500 and 2000 mg/L. Several wells had measurable concentrations of uranium and radiological parameters (radium-226, radium-228 and gross alpha).

The applicant states that the quality at a majority of domestic water supply wells had TDS and sulfate levels that exceed the suitability criteria for a Wyoming Class I or II and gross alpha levels at four wells that exceed the Wyoming standard of 15 pCi/L (Strata, 2011a). The quality at five domestic wells exceeds National Primary Drinking Water Regulations MCL for arsenic, uranium and/or gross alpha (Strata, 2011a).

The applicant states that it was generally not possible to assign a completion interval for each of the domestic wells to a specific level in the geologic formations based on limited construction information (Strata, 2011a).

The range in parameter concentrations for the preoperational monitoring of the eight domestic water supply wells located within 2 kilometers of the Ross Property is summarized in SER Table 2.5-6.

2.5.3.2.6 Sampling at Recently Installed Ross Project Monitoring Wells

For the preoperational monitoring program, the applicant completed 6 well clusters (12-18, 14-18, 21-19, 34-7, 34-18 and 42-19) within the Ross Project and three shallow piezometers in the area of the proposed CPP (Strata, 2011a) (SER Figure 2.5-3). Each well cluster consists of four wells screened in the DM, OZ, SM and SA aquifers, (Strata, 2011a). The well clusters were completed between December 2009 and January 2010. The piezometers were completed in May 2010.

Dedicated sampling equipment and pressure transducers for long-term water level monitoring were installed in all DM, OZ and SM wells (Strata, 2011a). The SA wells were sampled using a non-dedicated pump, which was decontaminated between use at the various wells (Strata, 2011a). The preoperational monitoring was initiated during the first quarter of 2010 and continued for all remaining quarters of 2010.

[30] The 12 domestic wells have been modified to 8 domestic wells for the range in parameter concentrations reported in this SER because (1) the current usage includes domestic use as reported by the applicant in the RAI responses (Strata, 2011a) or (2) the well is located outside of 2 kilometers.

The applicant reports that a well was purged during which field parameters were monitored to determine if stabilization was achieved (Strata, 2011a). Should levels of the field parameters stabilize to within set criteria, then sample collection would proceed. If three well volumes were purged, then a sample would be collected irrespective of stabilization of the field parameters (Strata, 2011a). For the background radiological sampling program as listed in Technical Report Section 2.9 (Strata, 2011a), the applicant states that the samples were collected in accordance with its SOP 9. The samples were collected during the same sample collection events for the radiological and non-radiological programs. The applicant provides a copy of its SOP 9 in Technical Report Addendum 2.9-A (Strata, 2011a).

The applicant analyzed the onsite groundwater samples for parameters listed on SER Table 2.5-1 by an independent laboratory (Strata, 2011a). Except for manganese, the trace metal constituents were analyzed as the "dissolved" species (i.e., the sample aliquots were field filtered). Manganese and iron were analyzed as dissolved and "total" species (i.e., the sample aliquots were not field filtered). The radiological parameters (except Gross alpha and gross beta) were analyzed for both "dissolved" and "suspended" species. Not all parameters, in particular the radiological parameters, were analyzed during all sampling events. The applicant presented the field data sheets and laboratory reports in Technical Report Addendum 2.7-J and lists the laboratory results in tabular form in Technical Report Addendum 2.7-I (Strata, 2011a). The range in parameter concentrations for the preoperational onsite groundwater monitoring program is summarized in SER Table 2.5-7.

The applicant characterizes the quality in the four designated aquifers (DM, OZ, SM and SA) as distinct (Strata, 2011a). The DM aquifer is characterized as having elevated chloride concentrations, the OZ aquifer is characterized as having increased radionuclide levels, and the SM and SA aquifer has similar quality although several distinguishing characteristics were noted at several locations by the applicant (Strata, 2011a). The dominant cation in the three lower aquifers (DM, OZ and SM) is sodium whereas, in the shallow SA aquifer, the cation activities include increasing calcium and magnesium levels though sodium remains the most dominant cation. Bicarbonate is the most dominant anion in all four aquifers though chloride is present as a dominant anion in the lowermost DM aquifer and sulfate is present in the intermediate OZ and SM aquifers (Strata, 2011a).

The applicant presents piper diagrams of the major ionic activity based on the average for each aquifer, and then for each aquifer, the average ionic activity for each well (Strata, 2011a). The applicant provides a list of exceedences of Wyoming Class of Use Standards, National Primary Drinking Water Maximum Contaminant Levels (MCLs) and National Secondary Drinking Water Secondary Maximum Contaminant Levels (SMCLs). The applicant states that the probable State of Wyoming classifications for wells in the SA, SM, OZ and DM aquifer are Class II or III (suitable for irrigation or livestock), Class III (suitable for livestock), Class IV (suitable for industry), and Class III (suitable for livestock), respectively. The parameters with one or more levels that exceeded the respective MCL or SMCLs at one or more wells in the four aquifers are as follows:

Aquifer	Exceedence of MCL	Exceedence of SMCL
SA	None	TDS, sulfate & manganese
SM	Arsenic	TDS, sulfate, aluminum & fluoride
OZ	Uranium, radium, gross alpha	TDS, sulfate, aluminum & manganese
DM	arsenic, gross alpha	TDS, chloride, aluminum & manganese

Staff reviewed the information provided by the applicant and finds it is acceptable because the applicant's procedures and methodologies for sample collection and analysis is consistent with industry standards. The information provides a complete, comprehensive evaluation of the pre-operational background for the site surface water and groundwater, and nearby water users. One item that staff determined needs to be better quantified is the sampling protocol for low yielding wells (see discussion on DM aquifer in SER Section 2.3.3). The applicant's sampling protocol is consistent with standards (ASTM, 1992; USGS, 2006; Yeskis and Zavala, 2002); however, staff had difficulty verifying the sampling methods based on the data within the report, specifically, the flow rate for the low yielding wells. Therefore, staff will include a license condition for developing a SOP for sampling the low-yielding wells (see SER Section 2.4.4).

Staff finds that a trend in several low-yielding wells that may not be representative of the aquifer. The trends consist of a decrease in pH and turbidity in the first two sampling events followed by stable levels in the third and fourth sampling event for monitoring wells 14-18DM, 12-18DM, 34-18DM, 21-19DM and 42-19SM. All of the wells are low-yielding wells. Based on a review of the field data sheets in Addendum 2.7-J (Strata, 2011a), the first sampling events may have purged the wells dry for the first sampling event(s), which differs from the sampling procedures for the latter sampling events. Criterion 7 of 10 CFR Part 40 Appendix A requires that representative samples be collected prior to any major site construction. Following discussions on the first draft license on December 20, 2012, the applicant submitted revised summary tables and narrative of groundwater quality data collected from the on-site wells during 2011, the data for which the applicant submitted electronically in response to staff's environmental RAIs (Strata, 2012a;2013a). Staff finds the revised tables based on the additional sampling by the applicant during 2011 are representative of the aquifer.

2.5.4 EVALUATION FINDINGS

The staff finds that the applicant acceptably described the preoperational surface water quality by providing appropriate chemical and radiochemical analyses of water samples from drainages in and near the mineralized zones. The surface water sampling represented the annual storm water runoff from the snowmelt. The surface water quality is representative of un-impacted melt water with limited interaction with the sediments/soils during runoff. The streams on the Ross Project are ephemeral but in several areas, due to shallow groundwater, the surface water quality of the streams and isolated reservoirs are influenced by the discharge of groundwater during times of low flow or lack of precipitation. .

It is difficult to obtain a representative background surface water quality due to the ephemeral nature of the streams at the Ross Project. Based on the information provided in the application and a review of published literature of the surface water drainage in the watersheds, the staff finds that the preoperational surface water quality within the license area is represented by the data submitted by the applicant because the procedures used by the applicant are consistent with guidance in the SRP. Staff expects that the background surface water quality in the future will be similar to what was reported by the applicant.

The applicant described the preoperational groundwater quality for the horizons within the Lance-Fox Hills formations including the SA, SM, OZ and DM aquifers by collecting four quarters of data from several locations. The staff concludes that the sample results are representative of area-wide pre-operational groundwater quality of the license area because the sampling meets the acceptance criteria in SRP Section 2.7.3.

Staff finds that the applicant's approach to preoperational monitoring at the nearby water supply wells is consistent with guidance in RG 4.14 and meets the acceptance criteria in Section 2.7.3 of the SRP (NRC, 2003). The preoperational monitoring of the nearby water supply wells is consistent with monitoring conducted at other facilities that have been shown to provide adequate monitoring to ensure safe operations that are protective of nearby potential receptors.

Based upon the review conducted by the staff as indicated above and supplemented by the noted license condition to establish a SOP for low-yielding wells (see LC 12.11 in Section 3.1.4), the information provided in the application meets the applicable acceptance criteria for this section and requirements of 10 CFR Part 40 Appendix A, Criterion 7.

2.6 BACKGROUND RADIOLOGICAL CHARACTERISTICS

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

2.6.1 REGULATORY REQUIREMENTS

The staff determines if the application has demonstrated that the background radiological characteristics or the preoperational environmental monitoring program complies with 10 CFR Part 40, Appendix A, Criterion 7.

A preoperational monitoring program must be conducted at least one-full year prior to any major site construction, and establishing background concentrations in environmental media is needed to determine operational and post operational compliance with the following regulations:

- Criteria 6(6) of Appendix A to 10 CFR Part 40 requires that soil concentrations not exceed background concentrations by more than 5 pCi/g of radium-226, averaged over the first 15 cm below the surface.
- Criterion 8 of Appendix A to 10 CFR Part 40 requires control of emissions to reduce population exposures to the maximum extent and to avoid site contamination.

2.6.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviews the application for compliance with the one-year sampling requirement of 10 CFR Part 40, Appendix A, Criterion 7 using the acceptance criteria in Standard Review Plan (SRP) Section 2.9.3 (NRC, 2003). The baseline radiological characterization is acceptable if:

- The sampling frequency, sampling methods, and sampling location and density are in accordance with pre-operational monitoring guidance provided in Section 1.1 of Regulatory Guide 4.14 (NRC, 1980a).
- The monitoring program includes air (particulate and radon), water (ground and surface), vegetation, food, fish, soil, sediment, direct radiation, and radon flux.
- Air monitoring stations are located in a manner consistent with the principal wind directions reviewed in Section 2.5 of NUREG-1569 (NRC, 2003).

- Soil sampling is conducted at both a 5 cm (2 in) depth, as described in Regulatory Guide 4.14, Section 1.1.4 (NRC, 1980a), and 15 cm [6 in] for background decommissioning data.

The staff recognizes that the applicant might not collect some samples due to weather conditions, availability, applicability, or access to an area. The staff discusses these situations in the next section.

2.6.3 STAFF REVIEW AND ANALYSIS

The following sections present the staff's review and analysis of various aspects of the background radiological characteristics of the Ross ISR Project. Review areas addressed in this section include air particulate and radon sampling, radon flux monitoring, vegetation, food, and fish sampling, direct radiation measurements, soil sampling, sediment sampling, groundwater sampling, and surface water sampling. The applicant began baseline monitoring in January 2010 and concluded in December 2010 (Strata, 2011a;b;c).

2.6.3.1 Air (Particulate and Radon) Sampling

Regulatory Guide 4.14 (NRC, 1980a) recommends pre-operational air particulate and radon sampling at three locations at or near the site boundaries, one location at or near the nearest residence, and one control location remote from the site. Factors to consider in determining sampling locations include: (a) average meteorological conditions (wind speed, wind direction, atmospheric stability), (b) prevailing wind direction, (c) site boundaries nearest to mill, (d) direction of nearest habitable structure, and (e) location of estimated maximum concentrations of radioactive materials.

In Sections 2.9.2.4 and 2.9.2.5, and Addendum 2.9-D of the technical report (Strata, 2011a;b), the applicant describes the methodology and locations of the air particulate and radon samplers used to collect quarterly samples. The applicant began collecting air particulate samples in January 2010 and analyzed composite air particulate samples quarterly for natural uranium, Ra-226, Pb-210, and Th-230. The applicant selected air particulate sampling locations using criteria from Regulatory Guide 4.14 and meteorological data from nearby weather stations. Because the applicant began collecting meteorological data at the same time the baseline-monitoring program began, on-site meteorological data was not yet available. The applicant selected air sampling locations based on meteorological data from the NWS station located in Gillette, WY (GAP) and the 1977 Nubeth application. The NWS station, approximately 50 miles from the site, recorded prevailing winds from the northwest, southwest, and south, whereas the 1977 Nubeth application for source material license SUA-1331 described predominately-westerly winds at the site. Based on this information, the applicant placed the meteorological monitoring station just outside of the northwest boundary of the proposed licensed area in order for the meteorological station to be upwind on unobstructed terrain. The applicant also selected this location for the background air sampling location, which is location MET in SER Figure 2.2-1 (Strata, 2011a).

In addition to the background air sampling station, the applicant placed sampling stations following guidance in Regulatory Guide 4.14, Section 1.1.1 (Strata, 2011a). These four additional sampling locations included site boundary locations nearest to the Ross ISR Project based on wind direction (South and Southwest) and in the direction of the nearest habitable structures that were downwind of proposed operations (East and Main Office). SER Figure 2.2-1 illustrates the sampling locations. The maximally exposed individual determined by

MILDOS modeling (Section 7.3 in the technical report) using the historical meteorological data from the Nubeth license application was the Strata office at Oshoto, which is located approximately 0.4 km (0.25 mi) northeast of the proposed licensed area. MILDOS modeling using the GAP meteorological data determined that the highest predicted impact from milling operations was the Wesley residence, located approximately 0.4 km (0.25 mi) north of the proposed licensed area. On-site meteorological data collected during the first half of 2010 confirmed the predominant southerly wind direction observed in the GAP data. Based on these results, the applicant installed a sixth air particulate sampler near the Wesley residence in November 2010. The applicant states that the final MILDOS results in TR Section 7.3 show that the maximally exposed offsite individual would reside at the Wesley residence (Strata, 2011a).

The applicant states that the on-site data reveal the southerly winds as the dominant component (see SER Figures 2.2-12 and 2.2-13), therefore the Southwest site appears most representative of background conditions (Strata, 2011a). The applicant states that Inter-Mountain Laboratories of Sheridan, WY, maintained the air particulate sampling stations and collected air particulate samples using F&J Specialty Products Models DF-40L-BL-AC and LV-1D samplers. The applicant operated the air samplers at flow rates sufficient to obtain minimum detectable activities (MDA). Weekly filters were collected from each air-sampler on a weekly basis and composited each quarter. A contract laboratory conducted the sample analysis. SER Table 2.6-1 presents the results of these air samples (Strata, 2011a;b).

The applicant observes that, as illustrated in Table 2.6-1, most of the results, with exception of Pb-210, are at or below lower limits of detection (Strata, 2011a;b). The applicant states that Pb-210 concentrations are consistently higher in comparison to other radionuclides in all samples and attributes the higher concentrations to Pb-210 production from radon. The applicant states that Pb-210, a longer lived radon progeny, is more available and mobile in the atmosphere than the other particulate radionuclides which result from re-suspension of soil particles. Although the 2010 fourth quarter Pb-210 and Th-230 sample concentrations are greater than samples collected during the first three quarters, the applicant initially concluded that there is no proof of seasonal variation without further statistical analysis (Strata, 2011b).

The NRC staff disagreed that the higher concentrations in the fourth quarter were not indications of seasonal variations, which have been observed at other ISR sites (NRC, 2011). Atmospheric dispersion processes affect transport and deposition of radon and its progeny as discussed in SER Section 2.2. These processes are limited by radioactive decay and dry and wet deposition. Radon, a gas, decays to several solid particles that tend to be electrically charged and can deposit on surfaces or attach to dust particles (Mohamed et al., 2008). Atmospheric transport and deposition of these radioactive materials will result in terrestrial variations in natural background radioactivity (Arnold et al., 2009).

Following discussions on the first draft license on December 20, 2012, the applicant submitted data collected during 2011 and a revised evaluation of seasonal trends (Strata, 2013a). The staff finds that the additional data and evaluations are representative of the baseline conditions; however, staff includes a license condition, presented in SER Section 5.7.7.4, requiring the applicant to establish a program to identify the principal radionuclides in the effluent from the ISR process.

The applicant placed the radon detectors at each of the air particulate monitoring stations and other locations depicted by a bold asterisk (*) in SER Figure 2.2-1 (Strata, 2011a). The applicant states that a total of 17 radon sampling locations were used as part of the baseline monitoring program. As stated above, radon detectors were placed at each air particulate

sampling station. The applicant also placed radon detectors at the four residences nearest to the Ross ISR Project site, the potential locations for the CPP and evaporation ponds, the former Nubeth R&D site, and over two of the ore bodies identified for potential extraction. The applicant states that it selected these locations because they have the greatest potential for radiological impact from the extraction and milling process. Strata began sampling at locations 16 and 17 (SER Figure 2.2-1) during the middle of 2010, therefore sampling results for these locations are limited (Strata, 2011a).

The applicant collected radon samples between January and December 2010 using Landauer Radtrak® alpha-track detectors (Strata, 2011a). The applicant mounted the detectors approximately one meter (3.3 ft) off the ground from either steel posts driven in the ground specifically for sampling or on fence posts at locations where fencing was already present. The applicant exchanged detectors quarterly and returned the detectors to Landauer for analysis. The applicant states the detector sensitivity is typically in the range of 20 to 40 pCi/l/day, which would yield a minimum detectable concentration (MDC) of approximately 0.22 to 0.44 pCi/L radon in air for a quarterly (90 day) exposure period (Strata, 2011a). Table 2.6-2 presents the radon concentrations (Strata, 2011b). Table 2.6-3 presents the radon exposures (Strata, 2011b).

The applicant states that radon concentrations are indicative of expected regional background for radon in the range of 0.5 – 2.0 pCi/l and that lower radon concentrations are evident during the fourth quarter of the study (10/22/10 – 1/12/11) (Strata, 2011a;b). The applicant states that a more rigorous statistical analysis of reported uncertainty values would need to be performed to confirm any trends, but that greater air pressure, cloud and snow cover and/or soil moisture during the fourth quarter could have resulted in lower radon concentrations. The applicant also states that greater variability of results occur across the Ross ISR Project during the first quarter and notes that the standard deviation of the mean values are considerably higher than in the second, third, and fourth quarters (Strata, 2011b).

The staff concludes that the instrumentation and number of samplers used to collect radon and air particulate samples followed the guidance in Regulatory Guide 4.14 (NRC, 1980a) for establishing baseline conditions. The applicant’s information provides a complete summary of the rationale for sampler placement, which indicates that it collected samples on a continuous basis for at least 12 months to establish background radon and radioactive air particulate conditions. The applicant, thereby, demonstrates air monitoring compliance with regulatory requirements in 10 CFR Part 40, Appendix A, Criterion 7.

2.6.3.2 Radon Flux Monitoring

The applicant did not collect any radon flux monitoring data because the applicant stated in Section 2.9.1 of the technical report (TR) that there would be no tailings impoundments and that radon flux measurements are not applicable to ISR facilities (Strata, 2011a). The applicant states in TR Sections 4.2.1 and 4.2.3 that liquid AEA-regulated wastes meeting the definition of byproduct material will be managed through discharge to the lined retention ponds. Liquid waste from the ponds will be disposed through surface discharge, recycling for use as plant make-up water, or disposed in the Class I deep disposal wells[31]. The applicant states in TR Section 4.3.1.1 that solid byproduct material will be stored inside the CPP until it is packaged

[31] The applicant has a permit for the deep disposal wells but not for the surface water discharge. Based on 40 CFR Part 440, the applicant may not be able to obtain a discharge permit for a portion of its wastewater (see discussions in SER Section 4.2.3.1.6)

and shipped to an NRC or Agreement State licensed disposal facility. Upon site decommissioning, a contract shipping company will transport pond sludge, pond liners, and impacted soils to a disposal facility licensed by NRC or an Agreement State (Strata, 2011a).

Based on the applicant's proposed operations and cleanup activities, NRC staff agrees that radon flux monitoring is not necessary for preoperational monitoring because radon flux measurements are only needed if the applicant needs to demonstrate compliance with 40 CFR 192.02. Radon flux measurements evaluate radon emitted per unit area per time, such as radon emitted from a tailings impoundment. According to 40 CFR 192.02, radon flux from the tailings impoundment cannot exceed 20 pCi/m^2/s. Therefore, the staff concludes that the applicant is not required to collect radon flux measurements to comply with 10 CFR Part 40, Appendix A, Criterion 7.

2.6.3.3 Vegetation, Food, and Fish Sampling

Regulatory Guide 4.14 recommends the following: (a) vegetation samples from three locations near the site in three different sectors having the highest predicted airborne radionuclide concentration due to milling operations; (b) three food sample locations that include crops, livestock, etc., within 3 km (2 mi) of the site; and (c) samples of fish in each body of water. In Section 2.9.2.9 of the technical report (Strata, 2011a), the applicant states that vegetation and crop sampling was completed with cooperation of landowners within and surrounding the Ross ISR Project. The applicant conducted baseline vegetation and crop sampling June through September during the 2010 growing season. The applicant describes wildlife, game, and fish sampling in Sections 2.9.2.10, 2.9.2.11, and 2.9.2.12 of the technical report, respectively (Strata, 2011a).

The applicant states it completed a field reconnaissance to assess species' presence and abundance and to select general areas for plant sampling because grazing animals within and surrounding the proposed project area feed on a diet of grasses and shrubs (Strata, 2011a). Based on this reconnaissance, Strata collected 11 vegetation samples that the applicant considered best represented the diets of grazing animals on or near the proposed licensed area and in areas likely to be affected by the milling process. The applicant collected samples downwind, at the proposed CPP and evaporation pond sites, and along the major ore bodies. The applicant states that the wellfields have the greatest potential for leaks that may result in uptake by vegetation from contaminated soil, whereas air deposition would more likely contaminate vegetation outside the proposed licensed area (Strata, 2011a). SER Figure 2.6-1 illustrates the sample locations.

The applicant collected 8 kg of each sample to meet the minimum detection limits (MDL) requirements of the analytical laboratory to meet the NRC standards (Strata, 2011a). The applicant states that it was not practical to collect samples of each type of vegetation present at each sampling location because of the large sample size needed to meet the MDL. Thus, the applicant collected composite samples of typical food products for grazing animals at each location. The applicant collected wetland vegetation samples near the confluence of Oshoto Reservoir and the Little Missouri River. The applicant collected food crop samples that included hay and produce from personal gardens. The applicant collected three samples of hay from local landowners at harvest in late July to early August 2010. The applicant collected a single sample of beets, zucchini, and potatoes from the Strong Residence bordering the Ross ISR Project area in September 2010. Strata collected vegetation from grazing areas three times during the growing season in July, August, and September 2010. The applicant collected samples of each type of vegetation at least two weeks apart (Strata, 2011a).

The applicant analyzed the samples for total uranium, Th-230, Ra-226, Pb-210, and Po-210 and reports results in Tables 2.9-18 through 2.9-22 in the technical report (Strata, 2011a). The applicant observes some variability across the sampling results, which Strata attributes to variability in the species-specific uptake characteristics for certain radionuclides. Strata states that Pb-210 concentrations were consistently higher than other radionuclides as would be expected due to the greater bioconcentration in plants characteristic of this element (Strata, 2011a). NRC staff finds the vegetation sampling program consistent with recommendations in Regulatory Guide 4.14 because the applicant collected vegetation samples from three locations near the proposed plant site in three different sectors having the highest predicted airborne radionuclide concentration due to milling operations, and therefore meets SRP Section 2.9.3 acceptance Criterion (1).

The applicant collected several animal tissue samples from locally raised beef cattle in July 2010, and a sample of deer meat in October 2010, in cooperation with the local landowners (Strata, 2011a). Local ranchers raise cattle on and near the proposed licensed area and the applicant collected meat samples from a cattle population that spends the largest portion of its life within 3 km of the proposed licensed area prior to slaughter. The applicant states that baseline wildlife surveys identify deer and antelope as the only wildlife hunted for human consumption and collected one deer sample that the applicant obtained from a local landowner. The landowner donated the deer sample as a frozen meat sample following processing during the 2010 hunting season (Strata, 2011a).

The applicant analyzed the samples for total uranium, Th-230, Ra-226, Pb-210, and Po-210 and reports results in Tables 2.9-23 and 2.9-24 in the technical report (Strata, 2011a). The applicant states that beef results are near or below detectable limits for analyzed radionuclides. The applicant states that the results for the deer tissue sample were consistent with concentrations measured in the beef sample, with the exception of Pb-210 and states that it is difficult to attribute the Pb-210 origins to any particular site because of the migratory nature of deer (Strata, 2011a).

Although the applicant collected beef samples from animals with access to grazing fodder within 3 km, the applicant did not initially collect three cattle samples as recommended in Regulatory Guide 4.14. The staff initially found that the applicant did not supply sufficient justification for not collecting three samples as recommended by the regulatory guide and thus, could not conclude that the applicant provided complete baseline data for the site and its environs, as required by 10 CFR Part 40, Appendix A, Criterion 7. Following discussions on the first draft license on December 20, 2012, the applicant submitted the radiological data on a venison sample collected during 2011 (Strata, 2013a). Staff finds the additional data complete baseline data for the site and its environs, as required by 10 CFR Part 40, Appendix A, Criterion 7.

The applicant stated that Oshoto Reservoir is the only water impoundment within the Ross ISR Project area capable of supporting edible fish and that all other water impoundments within the proposed licensed area are located in ephemeral drainages and unable to sustain edible fish populations (Strata, 2011a). Strata collected 99 fish from Oshoto Reservoir to form a composite sample of edible tissue from the site. The applicant stated that it learned from interviews with landowners that residents do not typically consume fish from the reservoir and thus, fish from the reservoir is not a pathway to the human food chain. The applicant sampled fish to meet the intent of Regulatory Guide 4.14 recommendations. However, the applicant sampled only once to comply with Wyoming Game and Fish Department's (WGFD) requirement to prevent potential detriment to the reservoir ecosystem (Strata, 2011a).

The applicant analyzed the samples for total uranium, Th-230, Ra-226, Pb-210, and Po-210 and reported results in Table 2.9-26 in the technical report (Strata, 2011a). The applicant states that fish samples show a higher uptake of both Pb-210 and Ra-226 in comparison to other animals analyzed as part of the baseline-monitoring program. The applicant states that higher Pb-210 concentrations are not unexpected because lead tends to bioaccumulate in ecosystems and that higher concentrations of Ra-226 indicate a slightly nutrient poor environment where uptake of radium is common in place of other chemically similar elements, such as calcium. The NRC staff finds that the applicant collected fish samples from any bodies of water that may be subject to seepage or surface drainage from potentially contaminated areas as recommended by Regulatory Guide 4.14 and provided sufficient justification for not collecting additional fish samples as recommended in the regulatory guide and therefore, meets SRP Section 2.9.3 acceptance Criterion (1).

2.6.3.4 Direct Radiation

Regulatory Guide 4.14 recommends 80 direct radiation measurements at 150-meter (m) intervals up to a distance of 1500 m in eight directions from the center of the milling area. In addition, the regulatory guide states that the applicant should make direct radiation measurements at the same locations used for the collection of particulate air samples once prior to site construction. The applicant proposes (Strata, 2011a) an alternate methodology to characterize background gamma radiation at the Ross ISR Project because Regulatory Guide 4.14 recommends a sampling design for a conventional mill rather than an ISR facility. Conventional mill operations are centralized between the mill complex and tailings disposal impoundments, whereas ISR operations are dispersed in the licensed area with multiple wellfields and header houses at each wellfield (NRC, 2011).

This alternate methodology the applicant presents consisted of two components. The first component consisted of placing thermoluminescent dosimetry (TLD) in the same locations as the radon samplers as described above and in SER Figure 2.2-1 (Strata, 2011a;b). The applicant describes the TLD program as the long term gamma radiation monitoring program in Section 2.9.2.8 of the application and used Landauer environmental low level TLDs. The applicant initially installed 15 TLDs and added two additional TLDs in May, 2010, on the northern boundary of the proposed project area. The applicant chose these locations to represent a possible CPP site. The applicant placed TLDs on posts approximately 1 m (3 ft) above the ground surface and exchanged TLDs on a quarterly basis. The applicant returned TLDs to Landauer for analysis (Strata, 2011a;b).

The applicant states that results were indicative of regional background for cosmic and terrestrial exposure rates in the range of approximately 9 to 14 μR/hr with a mean of about 12 μR/hr (Strata, 2011a;b). The applicant states that no radiation exposure readings appeared to be consistently high or low at any location, but observes that lower exposure rates are indicated during the fourth quarter of the study. The applicant observes that the lowest averaged exposure rate (10.8 μR/hr) for the 17 locations was lower than the average values for the other three quarters. The applicant states it would need to analyze the uncertainty parameters (i.e., standard deviations) more rigorously to confirm these conclusions (Strata, 2011b).

The second component characterized the licensed area by measuring gamma exposure rates with Ludlum 44-10 2-inch sodium iodide (NaI) gamma radiation detectors coupled to Ludlum 2350-1 rate meters mounted to off-highway vehicles (OHVs) by a contractor, Tetra Tech, Inc.

(Strata, 2011a;b). The applicant paired the NaI detectors with global positioning system (GPS) receivers. The contractor recorded simultaneous GPS and exposure rate data for 80,833 gamma exposure data points throughout the proposed licensed area using an onboard personal computer. The applicant collected soil samples at ten locations within the proposed licensed area as shown in Figure 2.9-28 of the technical report. The applicant selected the soil sampling from the gamma radiation survey results and included samples over the measured exposure rate range. The applicant used the results to assess potential relationships between radiation levels and radium concentrations in soil (Strata, 2011a;b).

NaI detectors are energy dependent, thus these detectors respond differently to radionuclides with higher or lower gamma energies compared to its calibration radionuclide. True gamma exposure rates are best measured with an energy independent system such as a high-pressure ionization chamber (HPIC). NaI detectors are more durable so they are a better choice under the field conditions experienced by the applicant. To address this issue, the applicant cross-calibrated the NaI detectors with Bicron® micro-rem meter previously calibrated to a high-pressure ionization chamber. The applicant used these data to statistically convert raw NaI scan data to estimates of true gamma exposure rates. The applicant states that cross-calibration would allow a comparison of preoperational data with data obtained later without relying on identical detectors (Strata, 2011a;b). The staff finds the applicant's rationale for cross-calibration reasonable and prudent because it is unlikely the applicant will use the same instruments when the site is decommissioned.

Strata states that the technologies the applicant used for the baseline radiological investigation are consistent with ISR license application guidelines described in Regulatory Guide 3.46 (NRC, 1982b), NUREG-1569 (NRC, 2003), and NUREG-1575, Revision 1, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000). The applicant collected a composite soil sample of nine sub-samples collected to a depth of 15 cm (6 in). The applicant measured gamma survey exposure rates as μR/hr and recorded dose rate measurements as mrem/hr. The applicant had soil samples analyzed for Ra-226 by ALS Laboratory in Fort Collins, CO. Table 2.6-4 presents the analytical results for the soil samples and the corresponding gamma radiation exposure rates. The applicant presents dose rate estimates for the proposed licensed area Figure 2.9-30 in the technical report (Strata, 2011a).

The applicant states that measured gamma radiation exposure rates at the Ross ISR Project range from 5.3 to 25.3 μR/hr, with a standard deviation of 1.54 μR/hr (Strata, 2011a). Strata states that the lowest gamma exposure rates (5 μR/hr to 6 μR/hr) were measured along D-Road, running north-south on the western property boundary and that higher exposure rates (14-16 μR/hr) were measured on CR 193 (see Figure 2.2-1). The applicant suggests that different material used on other roads in the area may be the source of the difference in exposure rates measured. The applicant observes the highest gamma exposure rates in a small area in the southern section of the Ross ISR Project (Strata, 2011a).

The applicant states that Ra-226 concentrations in soils were at or near typical natural background concentrations of 1-2 pCi/g, with the exception of ROSS-CORR5 (Strata, 2011a). Strata states that sample ROSS-CORR5 is located in the southern portion of the proposed licensed area, which also corresponds to a higher gamma radiation exposure rate in comparison to other sampling sites. The applicant states that results for the gamma exposure rate and dose rate correlation analysis indicate there was low radiation variability observed throughout the Ross ISR Project. The applicant states that linear regression of the data resulted in a coefficient of determination of 0.93 and attributes the difference between measured exposure and dose rates to the over response of NaI detectors to the lower energy photon

fields. The applicant uses the regression analysis to calculate radiation dose rates throughout the proposed licensed area (Strata, 2011a).

Although the applicant did not collect direct radiation measurements in accordance with Regulatory Guide 4.14, the staff finds that the methodology used followed site characterization methodology recommended in NUREG-1575 (NRC, 2000). The staff finds the use of TLDs is consistent with Regulatory Guide 4.14 because the applicant measured the exposure dose with passive integrating devices as recommended in the regulatory guide. The staff finds the applicant provided sufficient justification for altering the placement of the TLDs in baseline-monitoring program and thus, meets the SRP Section 2.9.3 acceptance criterion (1). The staff determined that the applicant collected a sufficient number of gamma survey measurements to characterize the licensed area and thereby demonstrates compliance with establishing baseline direct radiation readings of the proposed licensed area as required by 10 CFR Part 40, Appendix A, Criterion 7.

2.6.3.5 Soil Sampling

Regulatory Guide 4.14 recommends collecting up to 40 surface soil samples at 300 m intervals to a distance of 1500 m in eight meteorological sectors, five or more surface soil samples at air particulate stations, and at least five subsurface soil samples in four meteorological sectors.

The applicant describes the baseline soil sampling in Section 2.9.2.6 of the technical report and collected soil samples between June and August 2010 (Strata, 2011a). The applicant collected surface soil samples to a depth of the 0-5 cm and 0-15 cm intervals to meet both Regulatory Guide 4.14 recommendations (e.g., 0-5 cm) and reclamation standards in 10 CFR 40, Appendix A, Criterion 6, which require samples to a depth of 15 cm. Strata collected three samples at each sampling site at 0-30, 30-60 and 60-100 cm depth intervals. The applicant states that it selected soil sampling locations with a bias toward areas of the site most likely to be impacted by the ISR process. The applicant states that the only potential releases from uranium recovery activities would be liquids from leaks and spills and radon gas and selected locations that would likely be impacted (Strata, 2011a).

The applicant states that sample sites included the three residences nearest the proposed licensed area, the Strata field office, the former R&D site, the air sampling stations, the potential location of the CPP, the potential locations of the disposal ponds, and locations along the major ore bodies where production and recovery wells will be located (Strata, 2011a). The applicant states that the major ore bodies are important because many wells will be drilled into these areas that will be connected by piping to the CPP. The applicant states that pipe leaks could occur that could affect soil concentrations (Strata, 2011a).

The applicant collected surface soil samples from 39 locations within and surrounding the Ross ISR Project area and collected 18 subsurface samples at six of these sites (Strata, 2011a). The applicant collected subsurface soil samples over the intervals of 0-30, 30-60 and 60-100 cm. The applicant stated that subsurface soil sample locations also included a surface soil sample from the 0-15 cm interval. The applicant analyzed all surface soil samples analyzed for Ra-226 and gross alpha. The applicant analyzed soil samples from the five air monitoring stations, approximately 10 percent of the remaining surface soil samples, and 24 percent of the soil profiles were analyzed for U-natural, Th-230 and Pb-210. The applicant states that analytical results reported in Table 2.9-11 of the technical report are consistent with surface and near surface soil radiological background concentrations of 1-2 pCi/g for total uranium, Ra-226 and gross alpha. The applicant states that four surface soil results (0-15 cm depth) are in excess of

the clean-up criteria for residual radioactivity as specified in 10 CFR 40, Appendix A, Criteria 6(6) (e.g., 5 pCi/g Ra-226 in first 15 cm; 15 pCi/g in 15 cm horizons below). The applicant states that these results are not unusual for naturally occurring elevated levels of uranium and radium in mineralized areas (NCRP, 1988; Strata, 2011a).

NRC staff finds that the number of samples collected and the surface soil sampling methodology are consistent with Regulatory Guide 4.14. The NRC staff finds that the applicant's rationale for selecting soil sampling locations, rather than a radial pattern from the center of the plant, was an acceptable alternative because it sampled baseline conditions at locations that the direct gamma survey predicted would be affected by operations. Based on the information presented in the application, the NRC staff finds that the baseline subsurface soils sampling was collected and analyzed consistent with Regulatory Guide 4.14.

2.6.3.6 Sediment Sampling

Regulatory Guide 4.14 recommends sediment sampling at two locations in each surface water location (e.g., streams, rivers, drainages) and one in each water impoundment. The applicant collected sediment samples in August of 2010 at the Oshoto Reservoir and the three surface water monitoring stations, SW-1 (Little Missouri River downstream), SW-2 (Little Missouri River upstream), and SW-3 (Deadman Creek), as illustrated in SER Figure 2.5-1 (Strata, 2011a). As discussed in SER Section 2.5.3.1, the applicant states that with the exception of Oshoto Reservoir, streams within the Ross Project are ephemeral that are dry during a significant portion of the year; therefore, the applicant only sampled sediments during late summer. The applicant states it collected sediment samples in accordance with its Standard Operating Procedure 5 (SOP 5), a copy of which is presented in the Technical Report Addendum 2.9-A. The applicant analyzed samples for Pb-210, Ra-226, Th-230, and U, as recommended by Regulatory Guide 4.14, as well as gross alpha. The applicant presents analytical results in Technical Report Table 2.9-6. The applicant finds that sediment radionuclide concentrations are near or below detection limits, and concludes that sediment sample SW-1 reported erroneously high concentrations of Pb-210 and Th-230 compared to the other sediment samples. The applicant bases its conclusion that these concentrations are erroneous because the gross alpha result of the same sample was only slightly elevated relative to other results and states that the high concentrations are probably a result of an analytical error (Strata, 2011a). In response to RAIs (Strata, 2012b) and to confirm that the Pb-210 and Th-230 concentrations in sediment sample SW-1 was attributed to analytical error, the applicant collected additional baseline sediment samples at all locations on May 4, 2011 and presents these results in Table TR RAI 14-1. The results in Table TR RAI 14-1 show that Pb-210 and Th-230 concentrations in the second sediment sample collected at surface water monitoring site SW-1 is consistent with the other analytes as expected of U progeny (Strata, 2012b).

Based on the information presented in the application, the staff concludes the collection of sediments in the proposed licensed area is not consistent with Regulatory Guide 4.14. The staff finds that although the applicant collected sediment samples at two locations in the Little Missouri River, as recommended in Regulatory Guide 4.14, Strata only collected a single sample in Deadman Creek. Following discussions on the first draft license on December 20, 2012, the applicant submitted revised summary tables and narrative on the rationale for the sediment sampling (Strata, 2012a;2013a). Initially, the applicant did not describe the justification for not obtaining a composite sampling along the transect of these streams as recommended by the regulatory guide. The applicant's justification was that the stream was ephemeral and dry at the time of sampling and the sample was collected at the deepest portion of the channel at which sedimentation would have occurred during times that the stream was

flowing. Staff finds that the applicant's justification is reasonable and that the sample does provide representative background data for the existing conditions. Therefore, staff finds that the baseline data for the site and its environs is completed, as required by 10 CFR Part 40, Appendix A, Criterion 7.

2.6.3.7 Groundwater Sampling

Regulatory Guide 4.14 recommends that the applicant collect samples quarterly from at least three sampling wells located down gradient from the proposed tailings area, at least three locations near other sides of the tailings area, and one well located up gradient from the tailings area to serve as a background sample. The applicant should analyze samples for dissolved U-natural, Th-230, Ra-226, Po-210, and Pb-210. The applicant should collect additional groundwater samples quarterly from each well within 2 km (1.2 mi) of the proposed tailings area that is or could be used for drinking water, watering of livestock, or crop irrigation and analyzed for dissolved and suspended U-natural, Th-230, Ra-226, Po-210, and Pb-210. The applicant does not plan to have tailings impoundments on site and thus, does not include analysis of radionuclides other than those constituents suggested in Table 2.7.3-1 in NUREG-1569.

Staff agrees that the applicant is not required to follow Regulatory Guide 4.14 groundwater monitoring guidance for tailings impoundments because Strata will not use tailings impoundments; however, the applicant plans two retention ponds for use prior to deep well injection and thus, must establish baseline groundwater conditions at the retention ponds site, as discussed in SER Sections 4.2.3.1.9.1. As described in detail in SER Sections 4.2.3.1.9.1 and 2.5.3.2.6, the applicant installed a regional monitoring well network to characterize the upgradient and downgradient flow from the proposed locations of the CPP, retention ponds, and wellfields within each aquifer following the guidance in Regulatory Guide 4.14 (Strata, 2011a).

The applicant describes the baseline groundwater radiological sampling program in application Section 2.9.2.1 and states that the regional monitoring wells were sampled quarterly in calendar year 2010 (Strata, 2011a). In addition to the regional monitoring wells, the applicant collected samples from 29 existing water-supply wells within 2 miles of the Ross Project, which consisted of 2 industrial wells, 15 livestock water-supply wells, and 12 domestic water-supply wells. These wells were sampled on a quarterly basis starting with the 2009 third quarter. The applicant did not sample some wells each quarter as discussed in SER Section 2.5.3.2.2, because some privately owned wells were unavailable for sampling due to winterization or temporarily not functioning. In Technical Report Section 2.9 (Strata, 2011a), the applicant states that the samples were collected in accordance with its SOP 9. The applicant provides a copy of its SOP 9 in Technical Report Addendum 2.9-A (Strata, 2011a).

The applicant states that wells used for potable water, livestock and crop irrigation were analyzed for suspended and dissolved U-natural, Ra-226, Th-230, Pb-210, and Po-210, in addition to gross alpha and gross beta measurements for the first three quarters in 2010 (Strata, 2011a). The applicant states that it ceased sampling for the analytes recommended in Regulatory Guide 4.14 because the results for Th-230, Pb-210, and Po-210 during the first three quarters were not atypical for a mineralized area and the applicant wanted to expedite the analysis time. The applicant states that it decided to follow the SRP Section 3.7.3 acceptance Criterion (4), which recommends analysis of uranium, Ra-226, gross alpha (excluding, radon, radium, and uranium), and gross beta. The applicant presents the analysis data in Technical Report Section 2.9, Figures 2.9-1 through 2.9-16 (Strata, 2011a).

The applicant states that the groundwater radionuclide monitoring results indicate extensive variability that is common in a mineralized system (Strata, 2011a). The applicant notes that 13 wells exceeded the EPA's gross alpha MCL (15 pCi/L) at least once, seven wells exceeded the EPA's uranium MCL (30 µg/L) and two wells exceeded the EPA's Ra-226 MCL (5 pCi/L) (Strata, 2011a). The staff finds that these higher concentrations are expected in aquifers near ore zones.

The staff finds that the groundwater samples were collected at locations and analyzed for constituents consistent with recommendations in the SRP, which the NRC staff concludes meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7. The staff finds that the applicant provided sufficient information that showed the applicant followed the sample methodology recommendations in the SRP (NRC, 2003), which the staff finds are acceptable methods and approaches to determine baseline conditions as required by 10 CFR Part 40, Appendix A, Criterion 7.

2.6.3.8 Surface Water Sampling

Regulatory Guide 4.14 recommends surface water sampling for several types of areas. The locations can include large permanent onsite water impoundments, such as a pond or lake, offsite impoundments that could be subject to direct surface drainage from potentially contaminated areas, surface waters or drainage systems crossing the proposed licensed area boundary, and surface waters that could be subject to drainage from potentially contaminated areas. These surface water samples are to be collected as a grab sample on a monthly or quarterly basis for water impoundments and drainage systems, respectively. Regulatory Guide 4.14 recommends analyzing surface water samples separately for suspended and dissolved natural uranium, Ra-226, Th-230, Pb-210, and Po-210 at specific intervals.

In Section 2.7.1 of the technical report, the applicant states that the surface water channels within the Ross Project are ephemeral streams that are dry most of the year (Strata, 2011a). On Table 2.9-2 of the technical report (Strata, 2011a), the applicant lists 26 surface water sampling locations in its summary of the major elements of the radiological baseline characterization program. However, in the narrative of the application, the applicant reports sampling at three sampling stations along the surface water channels passing through the proposed licensed area boundary, two stations (SW-1 and SW-2) located on the Little Missouri River and one station (SW-3) on Deadman Creek, a tributary to Little Missouri River, and at 11 of 12 reservoirs (impoundments) located within or just outside the proposed licensed area. Oshoto Reservoir is the largest and an in-channel impoundment on the Little Missouri River located near the center of the proposed licensed area. According to the applicant in technical report Section 2.7.3.3.5.4, the reservoir was built by compacting an earth filled embankment across the channel and has the potential to affect stream flow characteristics downstream of the reservoir, which may affect water table elevations in its proximity (Strata, 2011a).

As discussed in SER Section 2.5.3.1 staff finds that the applicant has demonstrated that the Little Missouri River, Deadman Creek, and the other tributaries, in and around the Ross Project are ephemeral. Following Regulatory Guide 4.14 guidance, the applicant collected samples when the streams were flowing on March 9 and April 13, 2010, which the applicant refers to as the 2010 first and second quarter sampling, respectively (Strata, 2011a). The applicant collected no samples from streams after May 2010, when flow rates at all three locations were less than 0.014 m^3/s (0.5 cfs). The applicant collected quarterly surface water samples from nine on-site reservoirs from the 2009 third quarter to 2010 fourth quarter, when conditions allowed. The applicant collected samples from the Oshoto Reservoir each quarter; however,

`the applicant was unable to collect samples from several smaller frozen reservoirs during the winter quarter, January through March 2010. The applicant states it collected surface water samples in accordance with its Standard Operating Procedure 8 (SOP 8), a copy of which Strata presents in the Technical Report Addendum 2.9-A (Strata, 2011a).

The applicant analyzed the samples for total and suspended U and Ra-226, as well as gross alpha and beta on a quarterly basis following the guidance in SRP (Strata, 2011a). Biannually, the applicant analyzed samples for total and suspended Pb-210 and Th-230. The applicant presents results in Technical Report Figures 2.9-17 through 23 and concludes that results suggest spatial variability in levels for gross alpha, Ra 226 and uranium between sampling locations but did not observe seasonal variations in the radiological levels at a specific location (Strata, 2011a).

Staff finds that the applicant provided adequate pre-operational radiological baseline data because the sampling frequency, methods and locations are consistent with guidance in RG 4.14 and the data provides representative quality of surface water bodies throughout the proposed license area. Staff acknowledges that the pre-operational monitoring was a departure from the recommended monitoring in RG 4.14, because of the nature of the ephemeral streams and existing weather conditions (site characterizations), and finds that departure acceptable.

Staff finds that the existing levels of radiological constituents are generally low (at or just above the lower limit of detection) in the surface water except for dissolved uranium levels at surface water sampling locations at reservoirs R-6, R-8 and R-10. The dissolved uranium levels at those three sampling locations are at or just below the established EPA MCL for uranium. However, the EPA MCL is used as a reference as surface water in those reservoirs is not used nor anticipated to be used, or has a Wyoming surface water classification for use as a potable water supply.

The staff disagrees with the applicant's conclusion that no seasonal (temporal) variability exists in the data. However, regulatory guide 4.14 does not require analysis of seasonal variability in the dataset but only requires that quarterly sampling be performed. Staff finds that the sampling was performed as required by guidance, given the on-site restraints, and that the data presents a representative background of existing impacts prior to operations.

2.6.4 EVALUATION FINDINGS

Staff reviewed the background radiological characteristics of the Ross ISR Project in accordance with SRP Section 2.9.3. The applicant has provided adequate justification for not conducting radon flux monitoring and analysis for radioisotopes in ground and surface water during preoperational monitoring, as recommend in Regulatory Guide 4.14 by following the guidance in the SRP and meeting SRP Section 2.7.3 acceptance Criterion (4). The applicant has established background radiological characteristics by providing monitoring programs that include sampling frequency and methods, sampling locations, and types of analyses. The applicant collected beef samples from animals with access to grazing fodder within 3 km as recommended in Regulatory Guide 4.14, the applicant collected three food samples (venison and cattle) samples as recommended. Additionally, the applicant collected samples at two locations in Deadman Creek as recommended by the regulatory guide or provided sufficient justification for not collecting samples at upstream and downstream locations in Deadman Creek or for not collecting composite samples along the transect of the streams as recommended by the regulatory guide. Staff finds that the applicant collected representative data prior to major site construction. Therefore, based upon the review conducted by the staff

as indicated in SER Section 2.6.3, the information provided in the application is consistent with the applicable acceptance criteria of SRP Section 2.9.3 and the requirements of 10 CFR 40, Appendix A, Criterion 7.

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Table 2.4-1: Estimated Surface Water Peak Flows at Selected Stream Location in the Ross Project during the 24-hour, 100-Year Event

Location[a]	**24-hour, 100-Year Peak Flow (cfs)**
Southern Tributary of Little Missouri River Upstream of Ross Project (Basin B5 upstream of J3)	1020
Little Missouri River Upstream of Ross Project (J3)	2128
Confluence of Deadman Creek with Little Missouri River (J4)	5583
Tributary in Larson Flat Downstream of CPP Area (J6) [b]	681
Little Missouri River Downstream of the Ross Project (J10)	5975

(a) Identifier listed in parentheses is shown on SER Figure 2.4-2
(b) Peak Flow used in design of diversion upstream of CPP Area
cfs = cubic feet per second
CPP = Central Processing Area
Source: Modified after Table 2.7-5 in the technical report (Strata, 2011a)

Table 2.4-2: Summary of Nearby Private Domestic, Livestock and Industrial Water Supply Wells

Location		Facility Name	Permit #	Use	Total Depth (feet)
Within Ross Project					
	Sampled				
		19XX-18	P67747W	Ind	536
		22X-19	P50917W	Ind	750
		Morel#4	P50883W	Stk	150
		Wesley2010 (TWWELL03)	P192896W	Stk	
	Not Sampled				
		Berger #6	P7323P	Stk	
		Windmill Well #2	P55052W	Stk	
Within 2 kilometers of Ross Project					
	Sampled				
		CSWELL01	P132537W	Dom	330
		CSWELL03	P619W	Dom	120
		DWWELL01		Dom	
		HBWELL03	P7324P	Stk	160
		HBWELL04	P7326P	Stk	100
		HBWELL05	P7430P	Dom	150
		P21128P	P21128P	Stk	140
		P22582P	P22582P	Stk	150
		P42868W	P42868W	Dom	243
		SBWELL02		Dom	
		TW01	P74302W	Dom	200
		TW02	P103666W	Dom	160
	Not Sampled				
		KOKESH#1	P23418P	Stk	150
		WOODS WM. #3	P23422P	Stk	150
		EVERETT NO 1	P146029W	Stk	260
		SOPHIA #1A	P72178W	Ind	1011
		ENL SOPHIA 1A	P72542W	Ind	1011
		KOTTRABA #6	P21129P	Stk	200
		REYNOLDS #2	P99263W	Dom	100
		REYNOLDS #1	P22584P	Dom	386
		REYNOLDS #2	P22585P	Stk	286
		KIEHL WATER WELL #2	P72048W	Ind	720
		KIEHL WATER WELL #1	P70181W	Ind	662
		ENL KIEHL WATER WELL #1	P75737W	Mis	662
		KIEHL WATER WELL #1	P65808W	Ind	
		KIEHL WATER WELL #1	P72004W	Stk	662
		MINNIE BURGER #2	P7331W	Stk	125
		BERGER #8	P7325P	Dom	100

Source: Table 2.7-25, Table 2.7-44; Figure 2.7-26 & Figure 2.7-33
(Strata, 2011a)
Table TR RAI 11-1 (Strata, 2012b)
Not sampled may indicate inoperable well -
Dom = domestic water supply
Stk = livestock water supply
Ind = Industrial water supply

Table 2.4-3: Summary of Hydrogeologic Properties for the Lance-Fox Hills Aquifer

Source of Information	Lithology	Property	Units	Values		
				Minimum	Maximum	Median/ Mean
Pumping Tests	OZ Aquifer	Trasmissivity	ft^2/day	3.8	367.6	89.6
		Hydraulic Conductivity	ft/day	0.13	14.6	5
		Storativity	()	4.00E-06	1.40E-04	5.75E-05
Core Samples	Shale	Horizontal Hydraulic Conductivity	ft/day	0.007	0.163	0.074
	Siltstone	Horizontal Hydraulic Conductivity	ft/day	0.1	0.7	0.33
	Sandstone	Horizontal Hydraulic Conductivity	ft/day	2.4	11.9	5.1
	Shale	Vertical Hydraulic Conductivity	ft/day	0	0.01	0.003
	Siltstone	Vertical Hydraulic Conductivity	ft/day	0.03	0.46	0.16
	Sandstone	Vertical Hydraulic Conductivity	ft/day	0.4	6	3.5

Source: (Strata, 2011a)

Table 2.5-1: Parameters Analyzed for the Preoperational Monitoring Program

Group	Parameter	Units	Surface Water	Reservoirs	GroundWater			
					Onsite Wells	Nearby Water Supply Wells		
						Industrial	Livestock	Domestic
FIELD	Field Conductivity	µmhos/cm	**X**	**X**	**X**	**X**	**X**	**X**
	Field pH	s.u.	**X**	**X**	**X**	**X**	**X**	**X**
	Field turbidity	NTUs	**X**	**X**	**X**	**X**	**X**	**X**
	Depth to Water	ft			**X**		**X**	**X**
	Temperature	Deg C	**X**	**X**	**X**	**X**	**X**	**X**
	ORP	millivolts			**X**			
	Dissolved oxygen	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Dissolved oxygen, pct	% mg/L					**X**	
GENERAL	Alkalinity (as CaCO3)	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Ammonia	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Fluoride	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Laboratory conductivity	µmhos/cm	**X**	**X**	**X**	**X**	**X**	**X**
	Laboratory pH	s.u.	**X**	**X**	**X**	**X**	**X**	**X**
	Laboratory turbidity	NTUs	**X**	**X**				
	Laboratory dissolved oxygen	mg/L	**X**	**X**				
	Nitrate/Nitrite	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Total Dissolved Solids	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Total suspended solids	mg/L	**X**	**X**				
	Oil and Grease	mg/L					**X**	**X**
	Total Petroleum Hydrocarbons	mg/L					**X**	**X**
MAJOR IONS	Calcium	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Magnesium	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Potassium	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Sodium	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Bicarbonate	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Carbonate	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Chloride	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Sulfate	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
METALS	Aluminum, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Arsenic, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Barium, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Boron, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Cadmium, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Chromium, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Copper, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Iron, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Iron, total	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Lead, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Manganese, total	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Mercury	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Molybdenum, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Nickel, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Selenium, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Silver, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Uranium, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Uranium, suspended	mg/L		**X**	**X**	**X**	**X**	**X**
	Vanadium, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
	Zinc, dissolved	mg/L	**X**	**X**	**X**	**X**	**X**	**X**
RADIOLOGICAL	Lead 210, dissolved	pCi/L		**X**	**X**	**X**	**X**	**X**
	Lead 210, suspended	pCi/L		**X**	**X**	**X**	**X**	**X**
	Polonium 210, dissolved	pCi/L		**X**	**X**	**X**	**X**	**X**
	Polonium 210, suspended	pCi/L		**X**	**X**	**X**	**X**	**X**
	Ra-226, dissolved	pCi/L	**X**	**X**	**X**	**X**	**X**	**X**
	Ra-226, suspended	pCi/L	**X**	**X**	**X**	**X**	**X**	**X**
	Ra-228, Dissolved	pCi/L	**X**	**X**	**X**	**X**	**X**	**X**
	Radon-222	pCi/L			**X**	**X**	**X**	**X**
	Th-230, dissolved	pCi/L		**X**	**X**	**X**	**X**	**X**
	Th-230, suspended	pCi/L		**X**	**X**	**X**	**X**	**X**
	Gross Alpha	pCi/L		**X**	**X**	**X**	**X**	**X**
	Gross Beta	pCi/L		**X**	**X**	**X**	**X**	**X**
QA/QC	Anion Sum	meq/L		**X**			**X**	**X**
	Cation Sum	meq/L		**X**			**X**	**X**
	Total Anion/Cation Balance	%		**X**			**X**	**X**
	Total Dissolved Solids (calc)	mg/L		**X**			**X**	**X**

Source: Tables 2.7-12, 2.7-29, 2.7-45, 2.7-46 & 2.7-49 (Strata, 2011a)
X means included in that monitoring program

Table 2.5-2 Range in Parameter Concentrations for the Preoperational Monitoring of the On-Site Surface Water

Parameter	Units	SW-1	SW-2	SW-3
Field conductivity	µmhos/cm	933 - 1200	422 - 1348	909 - 1209
Field pH	s.u.	8.06 - 8.39	7.62 - 8.35	8.5 - 8.86
Field turbidity	NTUs	9.1 - 14.14	3.86 - 11.68	14.9 - 16.29
Temperature	Deg C	1.8 - 9.8	3.2 - 7.8	2.4 - 10
Dissolved oxygen	mg/L	6.92 - 7.28	7.59 - 10.46	7.89 - 8.77
Alkalinity (as CaCO3)	mg/L	331 - 497	118 - 600	357 - 586
Ammonia	mg/L	<0.1	<0.1	<0.1
Fluoride	mg/L	0.2	<0.1 - 0.3	0.1 - 0.3
Laboratory conductivity	µmhos/cm	795 - 1110	283 - 1250	794 - 1120
Laboratory pH	s.u.	8.2 - 8.7	8.1 - 8.6	8.3 - 8.8
Laboratory turbidity	NTUs	7.7 - 12.7	2.3 - 8.9	12.8 - 14.4
Laboratory dissolved oxygen	mg/L	8	10	9
Nitrate/nitrite	mg/L	<0.1	<0.1	<0.1
Total dissolved solids	mg/L	580 - 790	220 - 940	580 - 800
Total suspended solids	mg/L	<5 - 7	6 - 7	14
Calcium	mg/L	17 - 37	14 - 58	24 - 32
Magnesium	mg/L	12 - 24	6 - 29	25 - 35
Potassium	mg/L	11	6 - 7	10 - 11
Sodium	mg/L	154 - 204	37 - 216	129 - 196
Bicarbonate	mg/L	404 - 542	144 - 655	435 - 619
Carbonate	mg/L	<5 - 32	<5 - 38	<5 - 47
Chloride	mg/L	7 - 8	3 - 10	4 - 7
Sulfate	mg/L	98 - 147	26 - 168	92 - 102
Aluminum, dissolved	mg/L	<0.1 - 0.2	<0.1 - 0.2	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.5	<0.5	<0.5
Boron, dissolved	mg/L	<0.1 - 0.1	<0.1	<0.1 - 0.1
Cadmium, dissolved	mg/L	<0.002	<0.002	<0.002
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	0.08 - 0.33	0.14 - 0.26	0.07 - 0.34
Iron, total	mg/L	0.37 - 0.95	0.32 - 0.64	0.58 - 0.87
Lead, dissolved	mg/L	<0.02	<0.02	<0.02
Manganese, total	mg/L	0.05 - 0.17	0.05 - 0.11	0.17 - 0.21
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005
Silver, dissolved	mg/L	NM	NM	NM
Uranium, dissolved	mg/L	0.008 - 0.011	0.003 - 0.02	0.009 - 0.014
Vanadium, dissolved	mg/L	<0.02	<0.02	<0.02
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01
Ra-226, dissolved	pCi/L	<0.2	<0.2	<0.2
Ra-228, dissolved	pCi/L	<1	<1 - 1.3	<1
Gross Alpha	pCi/L	7.3 - 8.8	4 - 7.9	6 - 7.3
Gross Beta	pCi/L	8.6 - 9.7	6 - 7.4	9.8 - 11.2

Source: Table 2.7-12 (Strata, 2011a)

Table 2.5-3: Range in Parameter Concentrations for the Preoperational Monitoring of Surface Water in the Onsite or Nearby Reservoirs

Parameter	Units	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-10	R-11
		TWRES01	HBRES04	CSRES03	CSRES04	CSRES02	P17592S	TSRES01	P15508S	P15507S	TWRES02
Field Conductivity	µmhos/cm	147.3 - 247	654 - 1265	307 - 985	153.7	127.5 - 359	2890	2720	2700	1413 - 3640	281 - 1801
Field pH	s.u.	8.99 - 10.64	8.1 - 9.46	9 - 10.19	9.85	7.36 - 10.24	9.29	8.87	9.68	9.2 - 10.2	9.03 - 10.46
Field turbidity	NTUs	6.05 - 64.4	4.32 - 26	4.8 - 101		49.6 - 620	23.4	63	86.9	31.4 - 596	3.22 - 26.5
Temperature	Deg C	9.2 - 20.5	1.7 - 23.9	8.2 - 26.6	24.2	7.5 - 30.4	19.2	5.5	18.4	10.7 - 25.2	15.5 - 21.8
Dissolved oxygen	mg/L	3.91 - 7.21	5.34 - 9.42	4.32 - 7.66		0.46 - 8	4.88	6.78	9.87	10.14 - 11.32	4.37 - 10.73
Alkalinity (as CaCO3)	mg/L	55 - 116	301 - 507	117 - 346	72	47 - 147	1090	1080	1220	639 - 1700	107 - 732
Ammonia	mg/L	<0.1	<0.1 - 0.3	<0.1 - 0.6	<0.1	<0.1 - 5.6	0.1	<0.1	<0.1	0.1 - 0.2	<0.1 - 0.1
Fluoride	mg/L	<0.1 - 0.2	0.2	<0.1 - 0.2	<0.1	<0.1	0.5	0.3	0.5	0.3 - 0.7	<0.1 - 1.7
Laboratory conductivity	µmhos/cm	129 - 231	713 - 1090	296 - 1000	143	108 - 327	2270	2000	2130	1220 - 2910	273 - 1870
Laboratory pH	s.u.	8 - 9.2	8.3 - 9.2	8.5 - 10	9.5	7.5 - 8.1	9	8.6	9.4	8.9 - 9.9	8.6 - 10
Laboratory turbidity	NTUs	4.8 - 62	3.1 - 19.1	2.4 - 101	6.2	7.6 - 490	18.7	58.4	69.4	27.3 - 392	2.2 - 24.8
Laboratory Dissolved Oxygen	mg/L	9 - 13	5 - 13	10	10	<1 - 10		12			
Nitrate/Nitrite	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Dissolved Solids	mg/L	100 - 170	460 - 730	200 - 760	100	110 - 500	1710	1360	1560	970 - 2320	210 - 1190
Total Suspended Solids	mg/L	6 - 74	<5 - 24	6 - 134	<5	58 - 252	8	62	86	37 - 530	<5 - 8
Calcium	mg/L	11 - 21	15 - 29	25 - 54	16	11 - 34	18	41	13	10 - 43	5 - 38
Magnesium	mg/L	3 - 5	17 - 25	8 - 26	4	2 - 7	33	60	36	42 - 46	5 - 18
Potassium	mg/L	9 - 14	10 - 14	8 - 29	7	9 - 23	18	24	16	11 - 31	5
Sodium	mg/L	7 - 15	123 - 226	22 - 119	4	<1 - 5	515	440	494	212 - 739	24 - 427
Bicarbonate	mg/L	49 - 137	292 - 539	56 - 398	64	58 - 179	1080	1190	1030	635 - 1130	51 - 363
Carbonate	mg/L	<5 - 9	<5 - 88	5 - 43	11	<5	123	66	226	71 - 548	7 - 261
Chloride	mg/L	<1 - 4	7 - 9	3 - 9	<1	3 - 20	20	10	8	7 - 21	2 - 3
Sulfate	mg/L	4 - 8	66 - 97	32 - 169	3	<1 - 3	224	136	90	54 - 163	27 - 235
Aluminum, dissolved	mg/L	<0.1 - 0.2	<0.1	<0.1	<0.1	0.2 - 1.4	<0.1	<0.1	<0.1	<0.1	<0.1 - 1.5
Arsenic, dissolved	mg/L	<0.005 - 0.006	<0.005 - 0.01	<0.005 - 0.022	0.009	<0.005 - 0.028	0.013	0.005	0.015	0.006 - 0.052	<0.005 - 0.007
Barium, dissolved	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron, dissolved	mg/L	<0.1	<0.1 - 0.1	<0.1	<0.1	<0.1	0.2	0.3	0.2	0.1 - 0.4	<0.1 - 0.6
Cadmium, dissolved	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Source: Table 2.7-14 (Strata, 2011a)

Table 2.5-3 (continued): Range in Parameter Concentrations for the Preoperational Monitoring of Surface Water in the Onsite or Nearby Reservoirs

Parameter	Units	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-10	R-11
		TWRES01	HBRES04	CSRES03	CSRES04	CSRES02	P17592S	TSRES01	P15508S	P15507S	TWRES02
Iron, dissolved	mg/L	<0.05 - 0.35	<0.05 - 0.06	<0.05	0.1	0.2 - 8.32	0.18	0.07	0.08	0.06 - 0.13	<0.05 - 0.8
Iron, total	mg/L	0.43 - 2.62	0.07 - 0.25	0.08 - 1.32	0.46	1.68 - 19.7	0.77	1.95	1.3	1.06 - 6.28	0.06 - 1.29
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, total	mg/L	0.02 - 0.12	0.03 - 0.16	<0.02 - 1.12	0.04	0.14 - 1.24	0.08	0.25	0.09	0.11 - 0.34	0.03
Mercury	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02 - 0.06	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005 - 0.005	<0.005	<0.005	<0.005	<0.005 - 0.006	<0.005	0.005	<0.005	<0.005	<0.005
Silver, dissolved	mg/L	<0.003	<0.003	<0.003		<0.003	<0.003		<0.003	<0.003	<0.003
Uranium, dissolved	mg/L	<0.001 - 0.001	0.006 - 0.009	<0.001 - 0.005	<0.001	<0.001	0.02	0.028	0.027	0.019 - 0.087	0.002 - 0.006
Uranium, suspended	mg/L	<0.001	<0.001	<0.001		<0.001				<0.001 - 0.003	<0.001
Vanadium, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02 - 0.03	<0.02
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01 - 0.05	<0.01	<0.01	<0.01	<0.01	<0.01
Lead 210, dissolved	pCi/L	<1 - 1.29	<1	<1		<1				<1 - 1.46	<1
Lead 210, suspended	pCi/L	<1	<1	<1		<1 - 3.26				<1 - 1.55	<1
Polonium 210, dissolved	pCi/L	<1	<1	<1		<1				<1	<1
Polonium 210, suspended	pCi/L	<1	<1	<1		<1				<1	<1
Ra-226, dissolved	pCi/L	<0.2	<0.2 - 0.2	<0.2 - 0.46	0.2	<0.2 - 1.35	<0.2	0.29	<0.2	<0.2 - 0.31	<0.2
Ra-226, suspended	pCi/L	<0.2	<0.2	<0.2		<0.2 - 1.12				<0.2 - 0.3	<0.2
Ra-228, Dissolved	pCi/L	<1 - 1.34	<1 - 1.1	<1 - 1.52	<1	<1 - 1.22	<1	<1	<1	<1	<1
Th-230, dissolved	pCi/L	<0.2	<0.2	<0.2		<0.2				<0.2	<0.2
Th-230, suspended	pCi/L	<0.2	<0.2	<0.2		<0.2 - 0.28				0.28 - 0.46	<0.2
Gross Alpha	pCi/L	<2 - 3.55	3.1 - 9.5	<2 - 11.1	<2	<2 - 7.4	16.3	23	15	13.6 - 48.7	3.61 - 5.6
Gross Beta	pCi/L	8.7 - 14.3	8.1 - 22.9	8.6 - 27.6	6.9	10.5 - 28.7	20	31.4	20	12.9 - 48.5	3.9 - 11.6
Anion Sum	meq/L	1.21 - 2.45	7.63 - 12.39	3.09 - 10.72	1.48	1.02 - 3.21	27.01	24.76	26.58	16.38 - 36.47	2.75 - 19.69
Cation Sum	meq/L	1.33 - 2.48	8.02 - 12.96	3.02 - 10.72	1.49	0.93 - 3.09	26.44	26.69	25.55	15.48 - 36.87	2.79 - 19.37
Total Anion/Cation Balance	%	0.45 - 4.95	0.72 - 2.47	0.01 - 2.04	0.34	0.16 - 4.62	1.07	3.74	1.97	0.55 - 2.83	0.72 - 1.97
Total Dissolved Solids (calc)	mg/L	70 - 130	430 - 690	170 - 610	80	50 - 170	1480	1360	1390	870 - 1950	150 – 680

Source: Table 2.7-14 (Strata, 2011a)

Table 2.5-4 Range in Parameter Concentrations for the Preoperational Monitoring of the On-Site Industrial and Livestock Water Supply Wells

Parameter	Units	Livestock Water Supply Wells		Industrial Water Supply Wells	
		P50883W	TWWELL03	19XX18	22X-19
Field Conductivity	µmhos/cm	658-699	1381-1437	2790-3120	1987-2720
Field pH	s.u.	7.78-8.02	8.91-9.07	8.5-8.8	8.9-9.0
Field turbidity	NTUs	1.35-19.48	0.51-0.9	0.3-2.1	0.2-2.9
Temperature	Deg C	10.5-11	10.9-11.5	8.7-14.2	10.4-13.1
Dissolved oxygen	mg/L	4.37-5.58	1.81-7.5	4.0-7.5	1.2-1.6
Dissolved oxygen, pct	%	39.3-51.5	16.7-67.6		
Alkalinity (as CaCO3)	mg/L	296-340	596-603	521-659	462-472
Ammonia	mg/L	<0.1-0.1	<0.1-0.2	<0.1-0.2	0.3-0.5
Fluoride	mg/L	0.2	1.3-1.5	0.5-0.6	0.6-0.7
Laboratory conductivity	µmhos/cm	588-686	1440-1490	2320-2410	1840-2080
Laboratory pH	s.u.	8.1-8.2	8.7-8.8	8.5-8.6	8.6-8.7
Nitrate/Nitrite	mg/L	0.1-0.2	<0.1	0.1-0.5	<0.1
Total Dissolved Solids	mg/L	370-430	970-1000	1660-1790	1420-1520
Calcium	mg/L	33-44	2-3	7-8	5-6
Magnesium	mg/L	16-20	1-2	2-3	2
Potassium	mg/L	6-7	4-7	4-5	4-5
Sodium	mg/L	81	360-374	499-655	444-507
Bicarbonate	mg/L	361-414	657-664	605-770	520-547
Carbonate	mg/L	<5	35	15-27	13-26
Chloride	mg/L	3	2	6-8	10-13
Sulfate	mg/L	39-44	195-201	616-685	511-538
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.5	<0.5	<0.5	<0.5
Boron, dissolved	mg/L	<0.1	0.5-0.6	0.4	0.4
Cadmium, dissolved	mg/L	<0.002	<0.002	<0.002	<0.002
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	0.07-0.09	<0.05	<0.05	<0.05-0.06
Iron, total	mg/L	0.23-1.6	<0.05	<0.05-0.14	<0.05-0.07
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Manganese, total	mg/L	0.02-0.05	<0.02	<0.02	<0.02
Mercury	mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005
Silver, dissolved	mg/L	<0.003	<0.003	<0.003	<0.003
Uranium, dissolved	mg/L	0.025-0.028	<0.001	0.074	0.02-0.022
Uranium, suspended	mg/L	<0.001	<0.001	<0.001	<0.001
Vanadium, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Zinc, dissolved	mg/L	0.04-0.07	<0.01	<0.01	<0.01
Lead 210, dissolved	pCi/L	<1	<1	2.41-6.13	<1
Lead 210, suspended	pCi/L	<1	<1	1.43-2.8	1.21-1.46
Polonium 210, dissolved	pCi/L	<1	<1	<1-6.4	<1
Polonium 210, suspended	pCi/L	<1	<1	3.91-5.9	<1-1.12
Ra-226, dissolved	pCi/L	<0.2-7.7	<0.2	37.3-47.23	3.05-3.38
Ra-226, suspended	pCi/L	<0.2	<0.2	0.28-0.31	<0.2
Ra-228, Dissolved	pCi/L	<1-1.27	<1	<1-1.65	<1-1.4
Radon-222	pCi/L			18000	9100
Th-230, dissolved	pCi/L	<0.2	<0.2	<0.2	<0.2
Th-230, suspended	pCi/L	<0.2	<0.2	<0.2	<0.2
Gross Alpha	pCi/L	15.4-16.9	<3.1-6.7	167.7-324	38.5-47.9
Gross Beta	pCi/L	6.4-10.1	<6.7-6.9	39.7-81.4	7.3-12.3
Anion Sum	meq/L	6.82-7.8	16.12-16.39		
Cation Sum	meq/L	6.64-7.5	16.01-16.65		
Total Anion/Cation Balance	%	1.29-1.98	0.34-0.79		
Total Dissolved Solids (calc)	mg/L	360-400	570-950		

Sample parameters based on permitted use.
Usage based on current use as listed in Table TR RAI 11-1 (Strata, 2012b)
Source: Tables 2.7-45 and 2.7-46 (Strata, 2011a)

Table 2.5-5 Range in Parameter Concentrations for the Preoperational Monitoring of the Nearby (within 2 Kilometer) Livestock Water Supply Wells

Parameter	Units	HBWELL03	HBWELL04	P21128P	P22582P
Field Conductivity	μmhos/cm	1542-1862	1477-1761	964-1051	1026-1141
Field pH	s.u.	7.45-7.87	7.2-7.45	8.47-8.6	8.9-9.11
Field turbidity	NTUs	7.83-21.1	2.15-6.23	3.52-130	1.05-1.99
Temperature	Deg C	8.3-11	6.6-10.2	11.2-12.1	8.7-10.5
Dissolved oxygen	mg/L	1.03-2.3	0.92-1.38	2.66-3.34	1.68
Dissolved oxygen, pct	%	9.4-20.4	8.2-11.3	24.4-30.4	15
Alkalinity (as CaCO3)	mg/L	460-531	351-444	414-438	440-491
Ammonia	mg/L	<0.1-0.3	<0.1	<0.1-0.1	<0.1-0.6
Fluoride	mg/L	0.2	0.2	0.1-0.2	0.6-0.9
Laboratory conductivity	μmhos/cm	1520-1800	1620-1740	956-973	972-1120
Laboratory pH	s.u.	8-8.2	7.8-8	8.4-8.5	8.6-8.7
Nitrate/Nitrite	mg/L	<0.1	0.9-1.2	1.1-1.6	<0.1
Total Dissolved Solids	mg/L	1140-1370	1370-1420	620-640	610-730
Calcium	mg/L	79-106	195-203	13-20	6-12
Magnesium	mg/L	44-56	58-64	7-11	3-6
Potassium	mg/L	14-20	7	15-20	4-5
Sodium	mg/L	178-275	117-141	185-207	234-277
Bicarbonate	mg/L	561-648	429-542	491-514	500-536
Carbonate	mg/L	<5	<5	7-13	18-31
Chloride	mg/L	8-15	12-17	2-3	2-4
Sulfate	mg/L	402-540	583-654	91-96	85-112
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1-0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.5	<0.5	<0.5	<0.5
Boron, dissolved	mg/L	0.1-0.2	<0.1	<0.1	0.2-0.3
Cadmium, dissolved	mg/L	<0.002	<0.002	<0.002	<0.002
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	0.55-4.14	<0.05	<0.05-0.1	<0.05-0.07
Iron, total	mg/L	2.33-7.22	0.07-0.95	0.13-16.5	0.11-0.22
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Manganese, total	mg/L	0.15-0.9	0.07-0.08	<0.02-0.51	<0.02
Mercury	mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	0.103-0.165	<0.005
Silver, dissolved	mg/L	<0.003	<0.003	<0.003	<0.003
Uranium, dissolved	mg/L	0.002-0.006	0.033-0.034	0.271-0.388	<0.001-0.003
Uranium, suspended	mg/L	<0.001	<0.001	0.002-0.004	
Vanadium, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Zinc, dissolved	mg/L	<0.01-0.25	0.03-0.05	<0.01	<0.01
Lead 210, dissolved	pCi/L	<1	<1	1.76-17.4	
Lead 210, suspended	pCi/L	<1-1.21	<1-1.8	1.26-1.8	
Polonium 210, dissolved	pCi/L	<1	<1	<1	
Polonium 210, suspended	pCi/L	<1	<1	<1	
Ra-226, dissolved	pCi/L	0.77-1.03	0.28-0.52	0.21-0.3	<0.2
Ra-226, suspended	pCi/L	0.32-0.5	<0.2-0.59	0.7-0.91	
Ra-228, Dissolved	pCi/L	<1-1.2	<1	<1	<1-2.59
Radon-222	pCi/L		1600		
Th-230, dissolved	pCi/L	<0.2	<0.2	<0.58	
Th-230, suspended	pCi/L	<0.2	<0.2	0.209-0.49	
Gross Alpha	pCi/L	7-10.1	12.1-23	178-239	2.7-2.8
Gross Beta	pCi/L	9.3-17.3	7.9-17.4	67.9-128	<3-4.1
Anion Sum	meq/L	17.83-21.51	19.75-22.92	10.36-10.8	10.72-12.25
Cation Sum	meq/L	17.32-20.83	19.72-21.56	10.19-11.34	11.34-12.69
Total Anion/Cation Balance	%	1.44-2.39	0.14-3.06	0.83-2.95	1.77-2.83
Total Dissolved Solids (calc)	mg/L	1030-1270	1190-1350	580-610	610-700

Sample parameters based on permitted use.
Usage based on current use as listed in Table TR RAI 11-1 (Strata, 2012b)
Excluded wells outside of 2 kilometer of the Ross Project
Source: Tables 2.7-49 and 2.7-46 (Strata, 2011a)

Table 2.5-6 Range in Parameter Concentrations for the Preoperational Monitoring of the Nearby (within 2 Kilometer) Domestic Water Supply Wells

Parameter	Units	CSWELL01	CSWELL03	DWWELL01
Field Conductivity	µmhos/ cm	1635-3310	599-682	2980-3430
Field pH	s.u.	7.94-8.44	7.89-8.28	8.21-8.69
Field turbidity	NTUs	0-0.27	4.61-84.5	4.86-37.7
Depth to Water	ft	148.8		
Temperature	Deg C	7.8-17.3	10.4-11.6	8.4-14.8
Dissolved oxygen	mg/L	0.83-2.08	1.64-2.89	1.19-2.7
Dissolved oxygen, pct	%		15-26.4	
Alkalinity (as CaCO3)	mg/L	633-792	318-336	586-647
Ammonia	mg/L	<0.1-0.1	<0.1-0.3	0.4-1.2
Fluoride	mg/L	0.3-0.4	0.1-0.2	0.6-0.7
Laboratory conductivity	µmhos/ cm	1550-2600	543-654	2210-2690
Laboratory pH	s.u.	8.3-8.4	8.1-8.4	8.4-8.5
Nitrate/Nitrite	mg/L	<0.1-0.9	<0.1	<0.1
Total Dissolved Solids	mg/L	1030-1920	370-430	1760-1880
Calcium	mg/L	9-43	28-38	15-17
Magnesium	mg/L	6-33	15-20	6
Potassium	mg/L	8-14	9	11-13
Sodium	mg/L	393-574	74-97	558-665
Bicarbonate	mg/L	748-931	379-410	682-774
Carbonate	mg/L	5-18	<5	8-18
Chloride	mg/L	2-7	3-4	7-16
Sulfate	mg/L	224-723	28-32	663-794
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.5	<0.5	<0.5
Boron, dissolved	mg/L	0.3-0.4	<0.1	0.5-0.6
Cadmium, dissolved	mg/L	<0.002	<0.002	<0.002
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	0.16-0.83	0.21-1.96
Iron, total	mg/L	<0.05	1.3-3.94	1.71-5.02
Lead, dissolved	mg/L	<0.02	<0.02	<0.02
Manganese, total	mg/L	<0.02-0.02	0.08-0.34	0.03-0.07
Mercury	mg/L	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005-0.009	<0.005-0.006	<0.005
Silver, dissolved	mg/L	<0.003	<0.003	<0.003
Uranium, dissolved	mg/L	0.004-0.02	<0.001-0.001	<0.001
Uranium, suspended	mg/L	<0.001	<0.001	<0.001
Vanadium, dissolved	mg/L	<0.02	<0.02	<0.02
Zinc, dissolved	mg/L	<0.01	<0.01-0.01	<0.01
Lead 210, dissolved	pCi/L	<1	<1	<1
Lead 210, suspended	pCi/L	<1	<1	1.21-1.78
Polonium 210, dissolved	pCi/L	<1	<1	<1
Polonium 210, suspended	pCi/L	<1	<1	8.91-9.2
Ra-226, dissolved	pCi/L	<0.2-0.86	0.3-0.4	<0.2-0.4
Ra-226, suspended	pCi/L	<0.2	<0.2	<0.2
Ra-228, Dissolved	pCi/L	<1-1.66	<1	<1-2.84
Radon-222	pCi/L	1600		
Th-230, dissolved	pCi/L	<0.2	<0.2	<0.2
Th-230, suspended	pCi/L	<0.2	<0.2	<0.2
Gross Alpha	pCi/L	7.2-18.3	<2-5.53	10.7-17.3
Gross Beta	pCi/L	<2-13.2	7.36-8.8	5.1-11.8
Anion Sum	meq/L	17.4-30.39	7.05-7.47	25.79-28.57
Cation Sum	meq/L	18.28-29.96	6.78-7.33	25.79-30.51
Total Anion/Cation Balance	%	0.31-3.22	0.93-1.97	0.01-3.27
Total Dissolved Solids (calc)	mg/L	1020-1830	360-390	1610-1850

Sample parameters based on permitted use.
Usage based on current use as listed in Table TR RAI 11-1 (Strata, 2012b)
Excluded wells outside of 2 kilometer of the Ross Project
Source: Tables 2.7-49 and 2.7-46 (Strata, 2011a)

Table 2.5-6 (continued) Range in Parameter Concentrations for the Preoperational Monitoring of the Nearby (within 2 Kilometer) Domestic Water Supply Wells

Parameter	Units	HBWELL05	P42868W	SBWELL 02	TW01	TW02
Field Conductivity	µmhos/ cm	1343-1575	1167	789-1043	1616-2680	1889-2890
Field pH	s.u.	7.51-7.84	8.71	7.7-8.15	8.05-8.42	7.81-8.29
Field turbidity	NTUs	14.46-141	1.71	0.94-1.75	0.19-1.35	0.56-2.05
Depth to Water	ft				27.7	20.4
Temperature	Deg C	8.5-12.6	10.8	10.4-10.8	7.5-13.2	5.5-13.6
Dissolved oxygen	mg/L	2.72-4.72		0.82-2.36	1.03-1.29	0.78-2.29
Dissolved oxygen, pct	%			7.7-21.1		
Alkalinity (as CaCO3)	mg/L	499-543	547	387-488	668-836	613-654
Ammonia	mg/L	<0.1	<0.1	<0.1-0.2	<0.1-0.2	0.2-0.3
Fluoride	mg/L	0.2-0.3	0.3	<0.1-0.2	1.2	0.5-0.6
Laboratory conductivity	µmhos/ cm	1370-1660	1250	735-1010	2000-2150	1840-2190
Laboratory pH	s.u.	8-8.2	8.7	8.1-8.3	8.4-8.5	8.3-8.5
Nitrate/Nitrite	mg/L	<0.1-0.5	<0.1	<0.1-0.4	<0.1	<0.1
Total Dissolved Solids	mg/L	1090-1160	810	480-650	1350-1440	1450-1550
Calcium	mg/L	79-90	2	19-39	8-9	19-26
Magnesium	mg/L	33-38	1	11-26	4-5	8-12
Potassium	mg/L	7-8	3	12-16	6-8	11-13
Sodium	mg/L	229-258	321	98-205	438-509	466-544
Bicarbonate	mg/L	609-662	616	472-595	793-935	742-780
Carbonate	mg/L	<5	25	<5	8-42	<5-18
Chloride	mg/L	4-6	1	<1-1	4-8	8-15
Sulfate	mg/L	327-381	117	37-78	331-393	467-576
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	0.02	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Boron, dissolved	mg/L	0.2	0.2	0.1-0.2	0.5-0.59	0.4-0.52
Cadmium, dissolved	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	0.17-1.55	<0.05	0.06-0.2	<0.05	<0.05-0.06
Iron, total	mg/L	2.4-32.8	<0.05	0.12-0.61	<0.05-0.12	<0.05-0.22
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, total	mg/L	0.08-0.17	<0.02	0.04-0.05	<0.02	0.02-0.03
Mercury	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005-0.007	<0.005	<0.005	<0.005	<0.005
Silver, dissolved	mg/L	<0.003		<0.003	<0.003	<0.003
Uranium, dissolved	mg/L	0.01-0.015	<0.001	<0.001-0.005	<0.001	<0.001
Uranium, suspended	mg/L	<0.001		<0.001	<0.001	<0.001
Vanadium, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Zinc, dissolved	mg/L	<0.01-0.01	<0.01	<0.01	<0.01-0.02	0.01-0.03
Lead 210, dissolved	pCi/L	<1		<1	<1	<1
Lead 210, suspended	pCi/L	<1-1.56		<1-1.11	<1	<1
Polonium 210, dissolved	pCi/L	<1		<1	<1	<1
Polonium 210, suspended	pCi/L	<1		<1	<1	<1
Ra-226, dissolved	pCi/L	<0.2-0.2	<0.2	<0.2-0.21	<0.2-0.32	0.31-1.1
Ra-226, suspended	pCi/L	<0.2		<0.2-7	<0.2	<0.2
Ra-228, Dissolved	pCi/L	<1	<1	<1-1.22	<1	<1-1.54
Radon-222	pCi/L					
Th-230, dissolved	pCi/L	<0.2		<0.2	<0.2	<0.2
Th-230, suspended	pCi/L	<0.2		<0.2	<0.2	<0.2
Gross Alpha	pCi/L	7.1-12.7	<2	2.7-4.1	<2-4.2	<2-4.61
Gross Beta	pCi/L	6.4-10	<2	7.6-12.3	<2-8.55	<2-11.7
Anion Sum	meq/L	17-18.61	13.43	8.56-11.41	21.5-23.9	22.59-25.36
Cation Sum	meq/L	17.03-18.73	14.24	8.62-11.07	20.03-23.14	22.76-25.55
Total Anion/Cation Balance	%	0.33-4.86	2.91	0.13-1.5	0.44-3.54	0.29-4.39
Total Dissolved Solids (calc)	mg/L	1020-1080	770	450-620	870-1370	1370-1560

Table 2.5-7 Range in Parameter Concentrations for the Preoperational Monitoring of the On-Site Monitoring Wells

Parameter	Units	Zone			
		SA	SM[1]	OZ	DM[2]
Field conductivity	µmhos/cm	725 - 2030	1436 - 2630	1654 - 3660	1525 - 4000
Field pH	s.u.	7.9 - 10.3	8.78 – 10.91	8.4 - 9.4	8.98 - 11.53
Field turbidity	NTUs	0.1 - 99.4	0.03 - 26[3]	0 - 154	1.01 – 780
Depth to water	ft	10.6 - 50.9	52.5- 155.64	84.0 - 303.9	83.01 - 287.95
Temperature	Deg C	9.3 - 20.2	9.6 – 16.3	10.1 - 14.4	10.1 - 21.7
ORP	millivolts	-185 - 193	-351 - 220	-233 - 257	-431 - 83
Dissolved oxygen	mg/L	1.7 - 6.1	0.75 – 7.49	0.9 - 6.7	0.86 - 7.92
Alkalinity (as CaCO3)	mg/L	151 - 531	303 - 685	471 - 568	336 – 605
Ammonia	mg/L	<0.1 - 0.5	<0.1 – 1.2	0.2 - 0.8	<0.1 - 2.9
Fluoride	mg/L	0.1 - 0.5	0.8 - 2.1	0.3 - 1.2	0.8 - 1.6
Laboratory conductivity	µmhos/cm	554 - 1860	1200 - 2160	1640 - 2810	1600 – 3390
Laboratory pH	s.u.	8.1 - 10	8.7 – 10.6	8.4 - 9	8.7 - 11.1
Nitrate/nitrite	mg/L	<0.1 - 1.1	<0.1	<0.1 - 0.3	<0.1
Total dissolved solids	mg/L	370 - 1230	940 - 1350	1140 - 2070	960 – 2130
Calcium	mg/L	2 - 46	<1 - 3	4 - 9	1 – 6
Magnesium	mg/L	<1 - 33	<1 - 2	1 - 3	<1 – 2
Potassium	mg/L	7 - 22	4 - 47	4 - 17	8 – 37
Sodium	mg/L	84 - 400	323 - 542	368 - 644	369 – 807
Bicarbonate	mg/L	84 - 572	12 - 752	478 - 662	<5 – 488
Carbonate	mg/L	<5 - 193	25 - 250	8 - 52	22 – 324
Chloride	mg/L	2 - 86	2 - 8	3 - 10	139 - 818
Sulfate	mg/L	91 - 343	206 - 574	295 - 937	<1 – 234
Aluminum, dissolved	mg/L	<0.1	<0.1 - 05	<0.1 - 0.5	<0.1 - 0.5
Arsenic, dissolved	mg/L	<0.005	<0.005 - 0.023	<0.005	<0.005 - 0.014
Barium, dissolved	mg/L	<0.5	<0.5	<0.5	<0.5
Boron, dissolved	mg/L	<0.1 - 0.3	0.2 - 0.8	0.3 - 0.6	0.5 - 1
Cadmium, dissolved	mg/L	<0.002	<0.002	<0.002	<0.002
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05 - 0.18	<0.05 – 0.21	<0.05 - 0.69	<0.05 - 0.4
Iron, total	mg/L	<0.05 - 5.68	<0.05 - 35	<0.05 - 3.38	<0.05 – 23.3
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Manganese, total	mg/L	<0.02 - 0.36	<0.02 - 0.88	<0.02 - 0.06	<0.02 - 0.37
Mercury	mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02 - 0.06	<0.02 - 0.02	<0.02	<0.02 - 0.03
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005 - 0.009	<0.005 - 0.03
Silver, dissolved	mg/L	<0.003 - 0.006	<0.003 - 0.011	<0.003	<0.003 – 0.005
Uranium, dissolved	mg/L	<0.001 - 0.007	<0.001 - 0.004	0.005 - 0.109	<0.001 - 0.003
Uranium, suspended	mg/L	<0.001	<0.001	<0.001 - 0.003	<0.001 - 0.001
Vanadium, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Zinc, dissolved	mg/L	<0.01 - 1.32	<0.01 - 0.02	<0.01 - 0.02	<0.01 - 0.04
Gross beta	pCi/L	5.3 - 15.8	<3 - 319	4.2 - 43.2	6.6 - 41

Source: After Table 2.7-29 (Strata, 2011; 2013)

1 Samples from 34-18SM, 1st , 2nd & 3rd Qtr 2010 and 12-19SM 1st and 2nd Qrt 2010 removed from database due to high pH.

2 Samples from 12-18DM, 1st & 2nd Qtr 2010, 314-18DM 1st Qrt 2010 and 42-19DM 1st Qrt 2010 removed from database due to high pH.

3 Field turbidity for sample 12-18SM 4th Qrt 2011 is likely an error (value of 884) and discounted

Table 2.5-7 (continued) Range in Parameter Concentrations for the Preoperational Monitoring of the On-Site Monitoring Wells

Parameter	Units	Zone SA	SM[1]	OZ	DM[2]
Lead 210, dissolved	pCi/L	<1	<1 – 5.2	<1 - 4.89	<1 - 1.2
Lead 210, suspended	pCi/L	<1	<1 – 1.4	<1 - 32.2	<1 - 1.5
Polonium 210, dissolved	pCi/L	<1	<1 – 1.9	<1 - 22.9	<1 – 1.3
Polonium 210, suspended	pCi/L	<1	<1	<1 - 35	<1
Ra-226, dissolved	pCi/L	<0.2 - 0.5	<0.2 – 3.7	0.71 - 12.01	<0.2 - 0.7
Ra-226, suspended	pCi/L	<0.2 - 0.24	<0.2 - 0.28	<0.2 - 4.24	<0.2 – 0.8
Ra-228, dissolved	pCi/L	<1 - 1.2	<1 - 2.27	<1	<1 – 2.2
Radon-222	pCi/L	NM	<28 - 443	4580 - 35100	<25 - 156
Th-230, dissolved	pCi/L	<0.2	<0.2	<0.2	<0.2 - 0.24
Th-230, suspended	pCi/L	<0.2	<0.2 – 0.4	<0.2 - 0.95	<0.2 - 0.325
Gross alpha	pCi/L	<2 - 13.8	<2 - 12.2	15.4 - 222	<2 - 28.3
Gross beta	pCi/L	5.3 - 15.8	<3 - 319	4.2 - 43.2	6.6 - 41

Source: After Table 2.7-29 (Strata, 2011; 2013)

1 Samples from 34-18SM, 1st , 2nd & 3rd Qtr 2010 and 12-19SM 1st and 2nd Qrt 2010 removed from database due to high pH.

2 Samples from 12-18DM, 1st & 2nd Qtr 2010, 314-18DM 1st Qrt 2010 and 42-19DM 1st Qrt 2010 removed from database due to high pH.

3 Field turbidity for sample 12-18SM 4th Qrt 2011 likely is an error (reported value of 884) and discounted

Table 2.6-1: Ross ISR Project Air Particulate Sampling Results (2010)

Period	Location	Sample Results			
		U-nat (µCi/ml)	Th-230 (µCi/ml)	Ra-226 (µCi/ml)	Pb-210 (µCi/ml)
Q1	Met	<3.12E-17	<6.25E-17	<6.25E-17	3.87E-15
	Southwest	8.02E-17	<5.98E-17	<5.98E-17	4.19E-15
	South	<2.95E-17	<5.90E-17	<5.90E-17	4.39E-15
	East	<3.28E-17	<6.56E-17	<6.56E-17	4.20E-15
	Office	<1.16E-17	<2.31E-17	<2.31E-17	3.84E-15
Q2	Met	<3.65E-17	<7.29E-17	<7.29E-17	1.64E-15
	Southwest	1.17E-16	<5.81E-17	<5.81E-17	1.51E-15
	South	<3.35E-17	<6.70E-17	<6.70E-17	1.64E-15
	East	<3.41E-17	<6.83E-17	<6.83E-17	1.64E-15
	Office	4.04E-17	<2.01E-17	<2.01E-17	1.52E-15
Q3	Met	3.59E-16	<7.17E-17	<7.17E-17	4.77E-15
	Southwest	<3.48E-17	<6.97E-17	<6.97E-17	9.44E-15
	South	<3.25E-17	9.74E-17	0.00E+00	8.74E-15
	East	<3.63E-17	<7.26E-17	<7.26E-17	1.11E-14
	Office	3.59E-17	3.77E-17	<1.88E-17	1.14E-14
Q4	Met	<2.57E-17	2.57E-17	<2.57E-17	1.83E-14
	Southwest	<4.16E-17	8.31E-17	<4.16E-17	2.54E-14
	South	<4.14E-17	2.07E-16	<4.14E-17	1.61E-14
	East	<4.11E-17	1.23E-16	<4.11E-17	2.20E-14
	Office	1.04E-17	2.08E-17	2.08E-17	1.09E-14

Source: Adapted from Addendum 2.9-D Table 1 of the technical report (Strata, 2011a)

Shaded cells are analyte concentrations below the analytical laboratory's detection limit (DL). The DL was sample specific as reported by the analytical laboratory, which met or exceeded the NRC DL recommendations in Regulatory Guide 4.14 (Uranium = 1.0E-16 µCi/ml, Th-230 = 1.0E-16 µCi/ml, Ra-226 = 1.0E-16 µCi/ml, Pb-210 = 1.0E-16 µCi/ml).

Table 2.6-2 Ross ISR Project Radon Concentrations

Location		Period							
No.	ID	Q1		Q2		Q3		Q4	
		(pCi/L)	+/- σ	(pCi/L)	+/- σ	(pCi/L)	+/- σ	(pCi/L)	+/- σ
1	Oshoto Field Office	1.7	0.12	0.7	0.05	0.8	0.06	0.5	0.04
2	Met Station	2.0	0.13	0.6	0.05	0.4	0.04	0.2	0.02
3	SW Station	1.9	0.13	1.1	0.07	1.0	0.07	0.5	0.05
4	E Station	1.7	0.12	0.7	0.05	0.6	0.05	0.6	0.05
5	S Station	0.5	0.05	0.8	0.06	0.8	0.06	0.6	0.04
6	Welsey Res.	0.9	0.08	1.0	0.07	0.9	0.08	0.5	0.04
7	Wood Res.	1.1	0.09	0.9	0.06	1.3	0.08	0.5	0.04
8	Strong Res.	0.8	0.07	0.7	0.05	0.9	0.06	0.5	0.04
9	E. Evap Pond	0.3	0.04	0.9	0.06	0.8	0.06	0.9	0.06
10	E CPP	0.4	0.04	0.8	0.06	1.2	0.05	0.7	0.05
11	W Evap Pond	0.6	0.06	0.6	0.04	0.6	0.05	0.5	0.04
12	W CPP	0.5	0.05	0.8	0.06	0.7	0.05	0.4	0.03
13	Former R & D	1.7	0.12	0.8	0.06	1.2	0.08	0.7	0.05
14	N Mineralized	0.8	0.07	0.6	0.04	0.8	0.06	0.6	0.04
15	S Mineralized	0.7	0.07	0.8	0.06	0.7	0.05	0.5	0.04
16	N CPP			1.4	0.10	0.8	0.06	0.6	0.05
17	N Evap Pond			1.4	0.10	0.8	0.06	0.5	0.04

Source: Adapted from Addendum 2.9-D Tables 2-5 of the technical report (Strata, 2011a)

Table 2.6-3 Ross ISR Project Radon Exposure

Location		Period							
No.	ID	Q1		Q2*		Q3§		Q4‡	
		Reported Exposure (mrem)	Average Exposure Rate (μR/hr)	Reported Exposure (mrem)	Average Exposure Rate (μR/hr)	Reported Exposure (mrem)	Average Exposure Rate (μR/hr)	Reported Exposure (mrem)	Average Exposure Rate (μR/hr)
C_1	Control	29.4	11.2	24.3	10.1	30.5	10.1	28.7	9.6
C_2	Control			17.2	9.8	21.7	9.1	25.1	9.1
C_3	Control							21.3	8.3
1	Oshoto Field Office	35.5	14.0	30	12.7	35.7	12.5	32.2	11.2
2	Met Station	32.1	12.5	30.2	12.8	38.7	14.0	31.5	10.9
3	SW Station	31.3	12.1	29.2	12.4	36.2	12.8	29	9.7
4	E Station	29.6	11.3	32.7	14.0	34.3	11.9	30.7	10.3
5	S Station	32.3	12.5	26.3	11.0	31	10.3	29.1	9.6
6	Welsey Res.	35.0	13.8	32.1	13.7	37.0	13.2	30.5	10.4
7	Wood Res.	33.6	13.1	30.4	12.9	38.2	13.7	31.7	11.0
8	Strong Res.	33.8	13.2	29.6	12.5	36.1	12.7	27.7	9.1
9	E. Evap Pond	32.7	13.2	23.2	9.6	38.7	14.0	30.2	13.8
10	E CPP	34.8	14.2	21.9	8.9	36.2	12.8	9.2	13.4
11	W Evap Pond	33.7	13.6	31.1	13.2	27.2	11.7	28.5	10.4
12	W CPP	34.4	14.0	32.4	13.9	28.4	12.3	28.1	10.3
13	Former R & D	34.2	13.4	28.4	12.0	28.7	12.5	29.8	11.3
14	N Mineralized	34.9	13.7	31.2	13.3	29	12.6	28.2	10.5
15	S Mineralized	32.8	12.8	31.1	13.2	29.9	13.0	26.9	9.9
16	N CPP			23.2	12.7	28.7	12.5	28.4	11.6
17	N Evap Pond			21.9	11.8	30.1	13.1	26.8	10.9

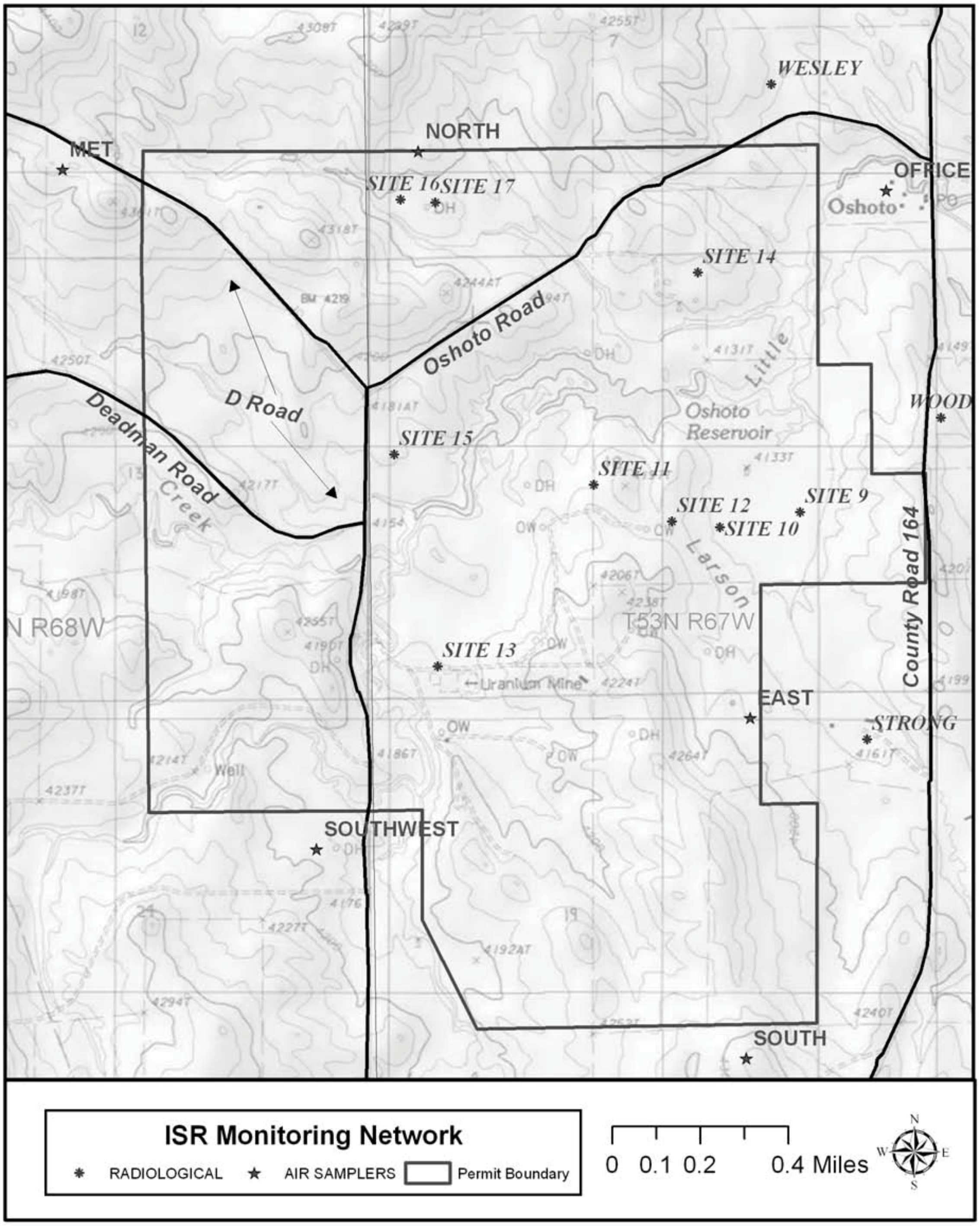
Source: Adapted from Addendum 2.9-D Tables 7-10 of the technical report (Strata, 2011a)

*C_1 is applied to TLDs 1-15 C_1 = 2.8 mrem; C_2 is applied to badges 16-17 C_2 = 4.6 mrem
§C_1 is applied to TLDs 1-10 C_1 = 9.2 mrem; C_2 is applied to badges 10-17 C_2 = 2.4 mrem
‡C_1 is applied to TLDs 1-8 C_1 = 8.2 mrem; C_2 is applied to badges 9-15 C_2 = 5.7 mrem; C_3 is applied to badges 16-17 C_3 = 3.6 mrem

Table 2.6-4. Correlation of Ross ISR Project Soil Ra-226 Concentrations and Gamma Radiation Exposure Rates

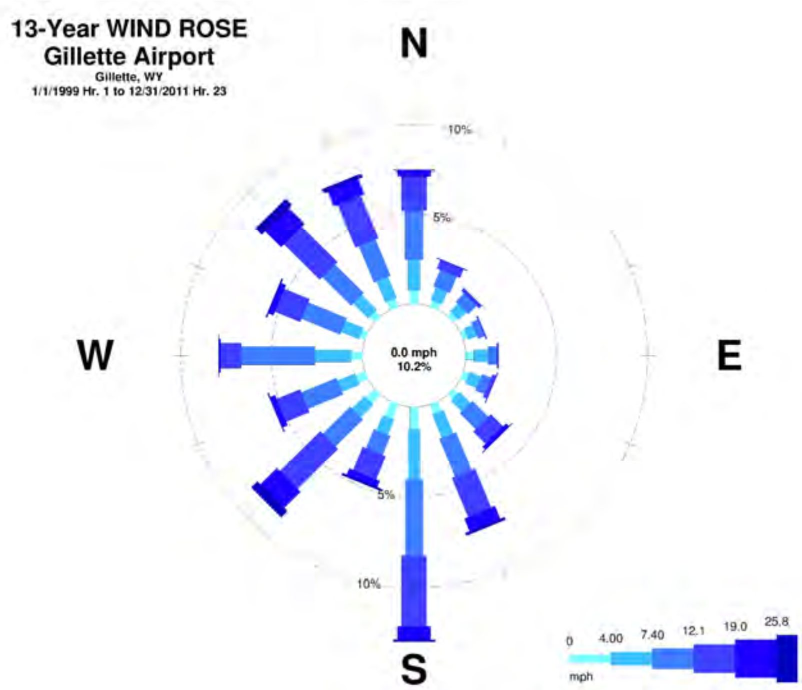
Soil Correlation ID	Ra-226 Concentration in Soil (pCi/g)	Standard Deviation (+/-)	γ Radiation Exposure Rate (μR/hr)
ROSS-CORR1	1.15	0.37	10.0
ROSS-CORR2	1.96	0.48	10.7
ROSS-CORR3	1.97	0.36	10.2
ROSS-CORR4	1.81	0.43	11.9
ROSS-CORR5	14.3	1.9	19.1
ROSS-CORR6	1.18	0.32	9.0
ROSS-CORR7	0.93	0.25	9.8
ROSS-CORR8	1.60	0.40	12.5
ROSS-CORR9	1.44	0.41	10.7
ROSS-CORR10	1.53	0.42	12.6

Source: Table 2.9-12 in the technical report (Strata, 2011a)



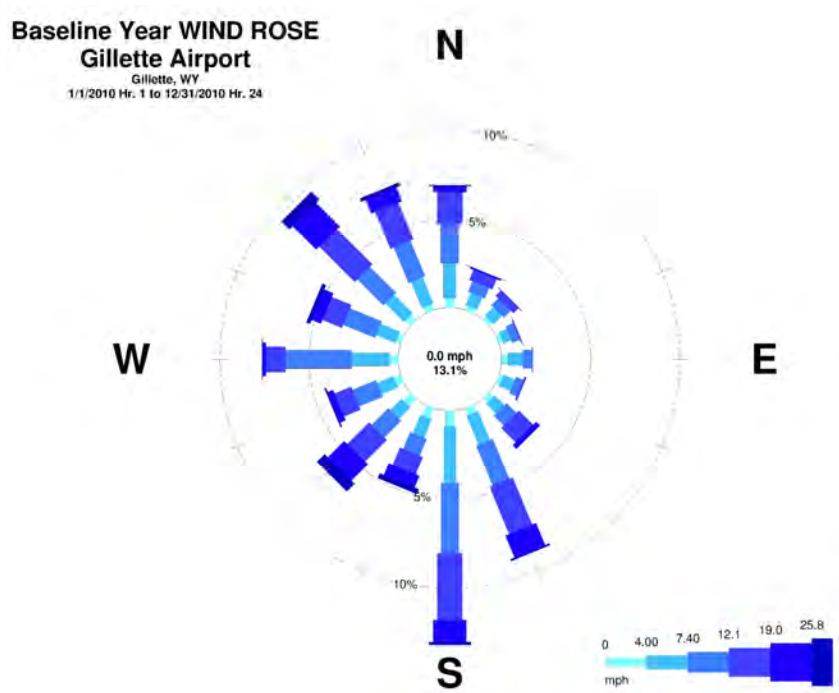
Source: Figure 3 of Addendum 3.6-A to the environmental report (Strata, 2011a)

Figure 2.2-1 Ross Project Meteorological and Baseline Radiological Monitoring Locations



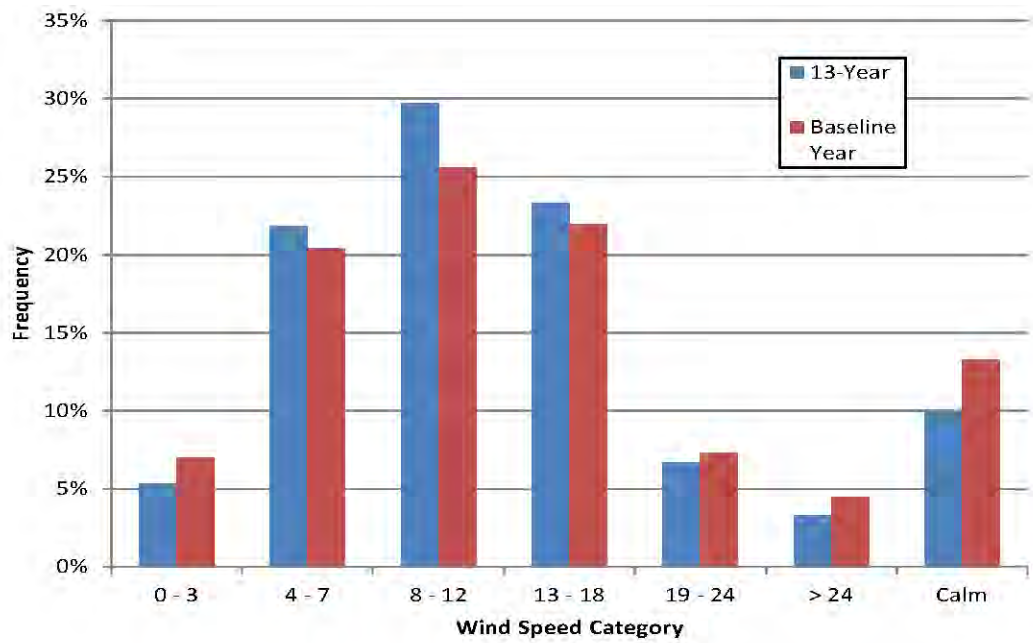
Source: Figure TR RAI 5-1 (Strata, 2012b)

Figure 2.2-2 Thirteen-Year Period Wind Rose for Gillette, Wyoming Airport (1999-2011)



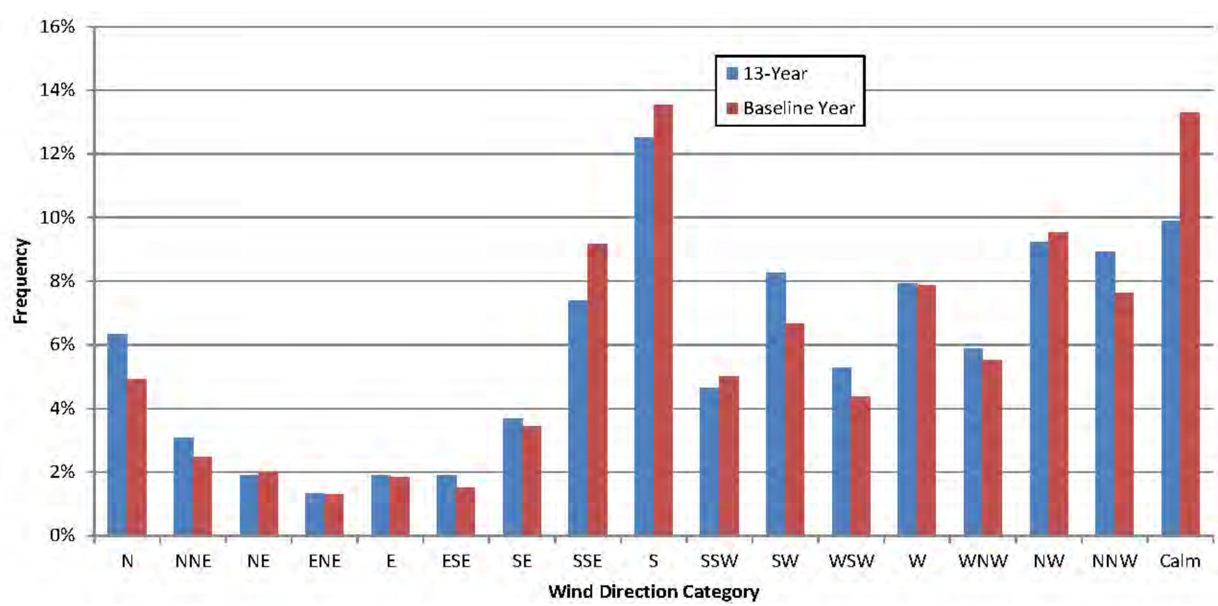
Source: Figure TR RAI 5-2 (Strata, 2012b)

Figure 2.2-3 Short-Term Wind Rose for Gillette, Wyoming Airport (2010)



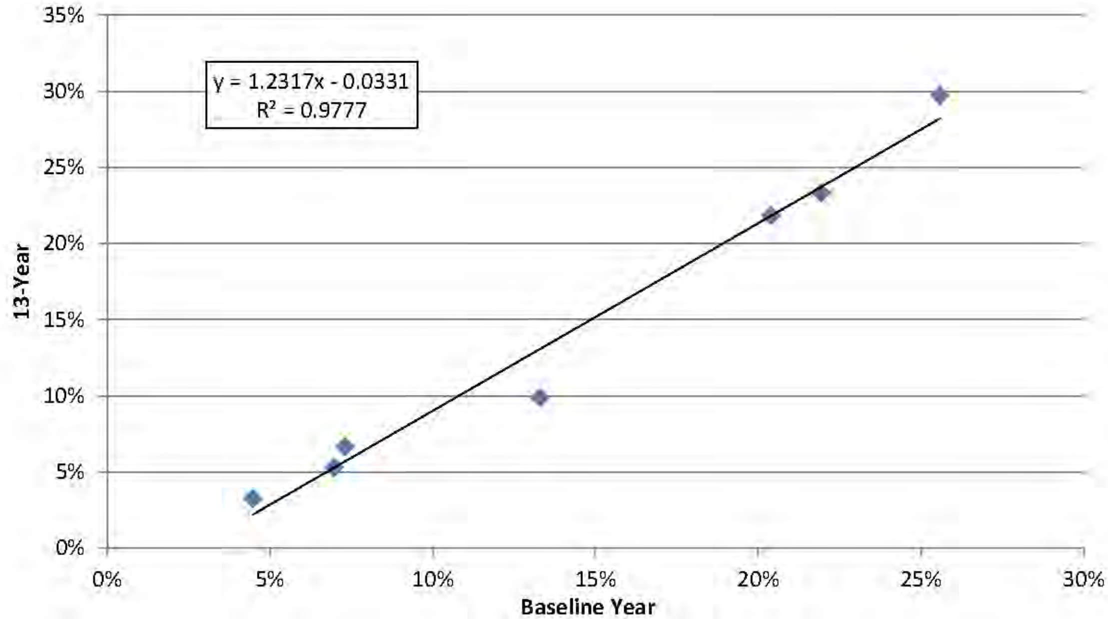
Source: Figure TR RAI 5-3 (Strata, 2012b)

Figure 2.2-4 Frequency of Short- and Long-Term Wind Speeds at the Gillette, Wyoming Airport



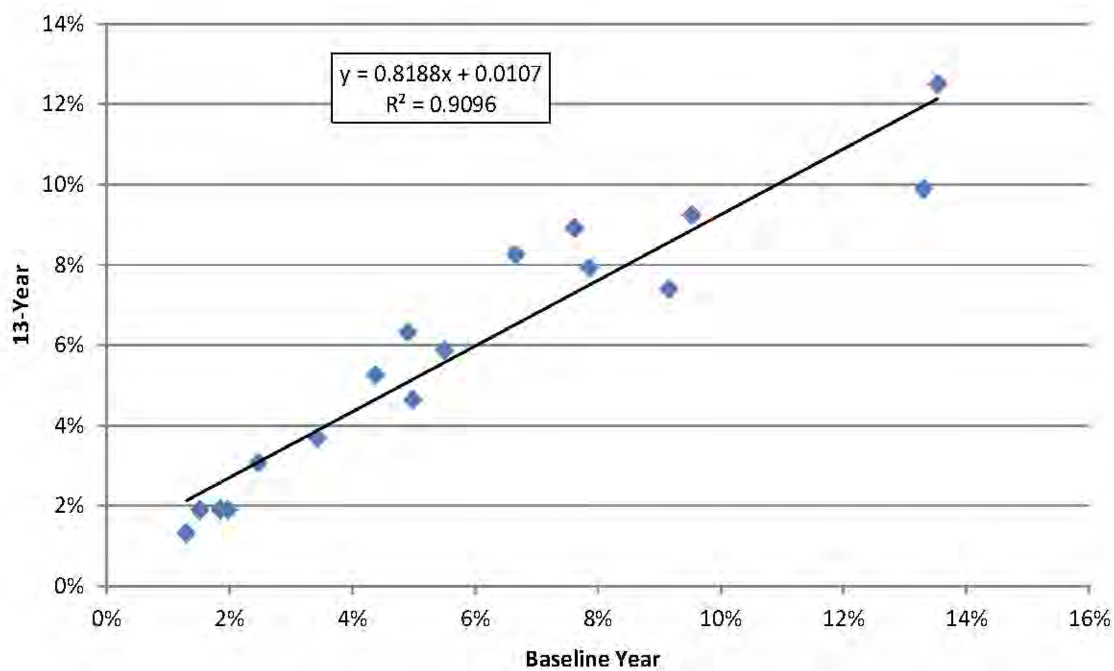
Source: Figure TR RAI 5-4 (Strata, 2012b)

Figure 2.2-5 Frequency of Short- and Long-Term Wind Directions at the Gillette, Wyoming Airport



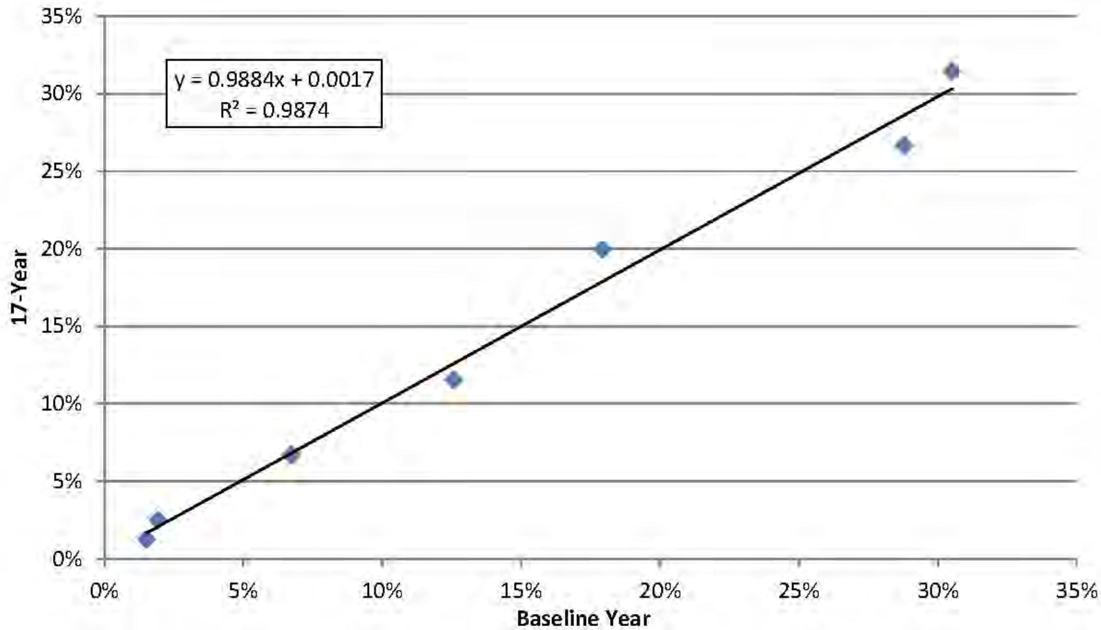
Source: Figure TR RAI 5-5 (Strata, 2012b)

Figure 2.2-6 Correlation between the Short- and Long-Term Wind Speed at the Gillette, Wyoming Airport



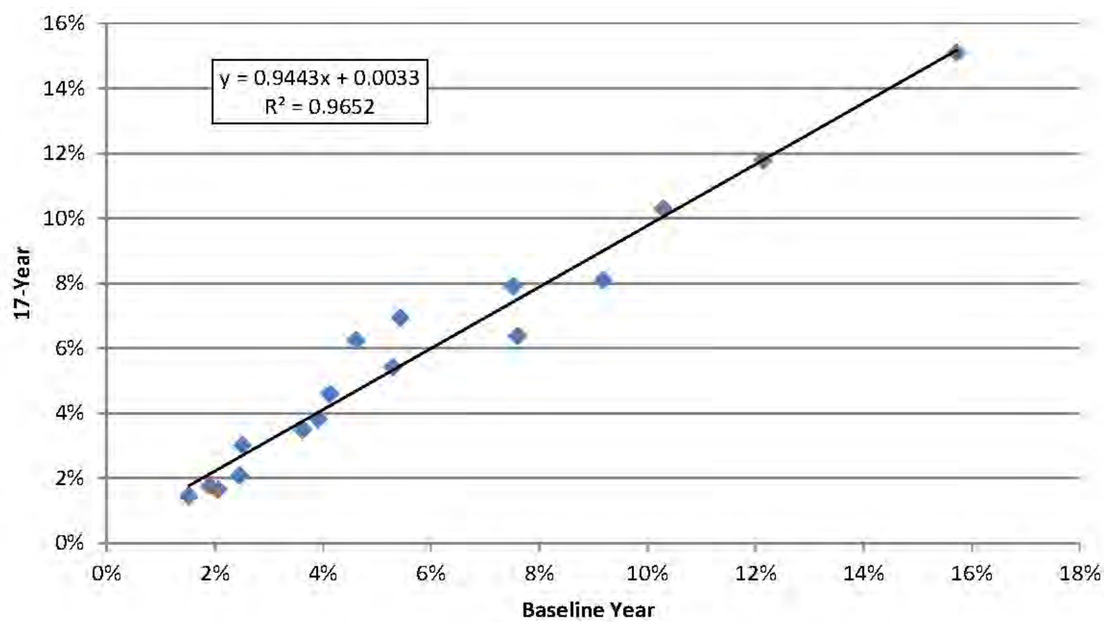
Source: Figure TR RAI 5-6 (Strata, 2012b)

Figure 2.2-7 Correlation between the Short- and Long-Term Wind Direction at the Gillette, Wyoming Airport



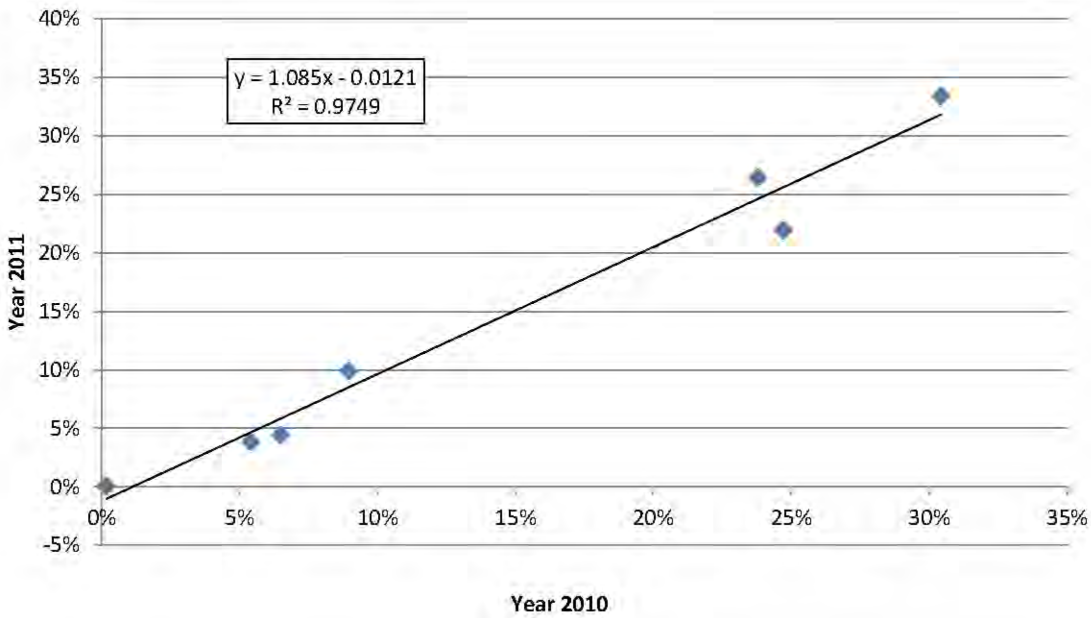
Source: Figure TR RAI 5-7 (Strata, 2012b)

Figure 2.2-8 Correlation between the Short- and Long-Term Wind Speed at the Dry Fork Mine, Gillette, Wyoming



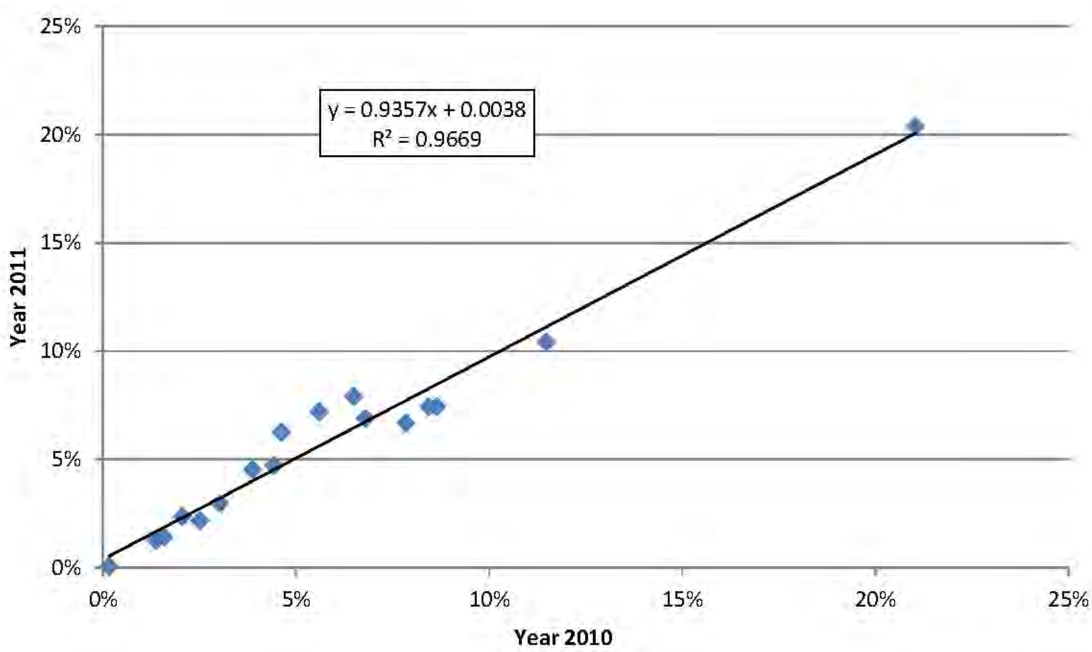
Source: Figure TR RAI 5-8 (Strata, 2012b)

Figure 2.2-9 Correlation between the Short- and Long-Term Wind Direction at the Dry Fork Mine, Gillette, Wyoming



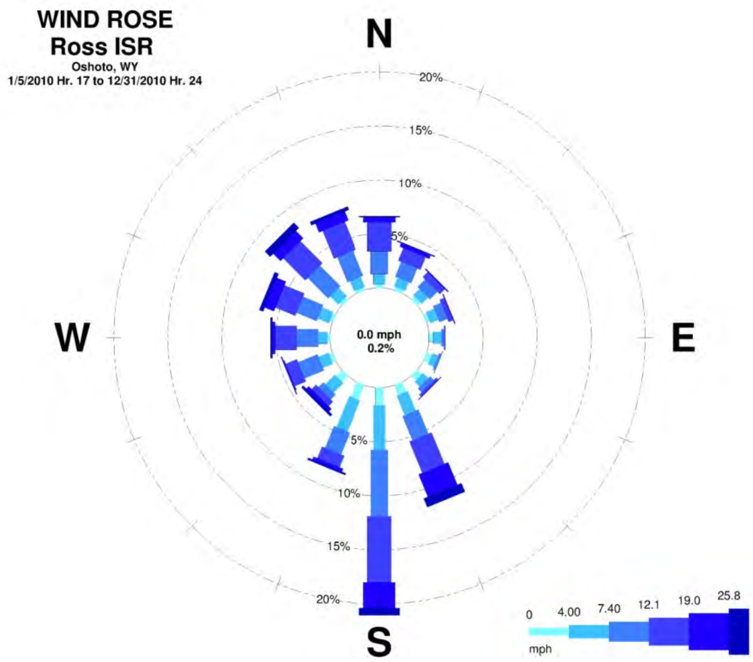
Source: Figure TR RAI 5-9 (Strata, 2012b)

Figure 2.2-10 Correlation between the 2010 and 2011 Wind Speed at the Ross Project, Oshoto, Wyoming



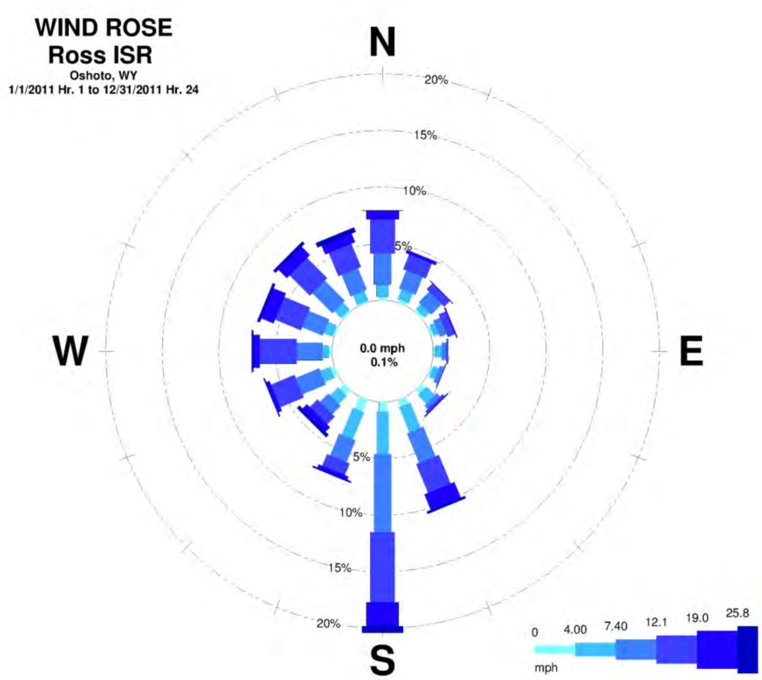
Source: Figure TR RAI 5-10 (Strata, 2012b)

Figure 2.2-11 Correlation between the 2010 and 2011 Wind Direction at the Ross Project, Oshoto, Wyoming



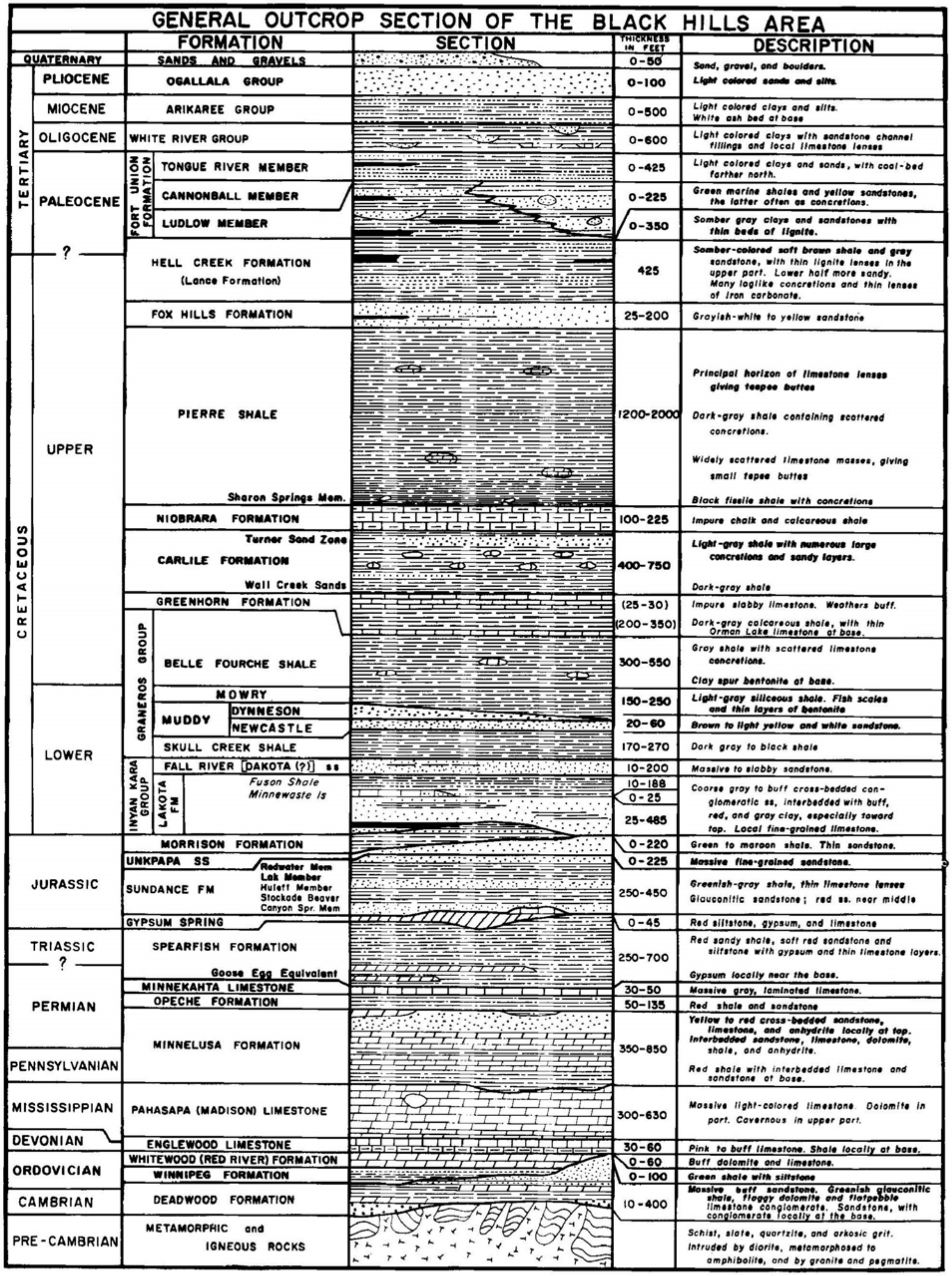
Source: Figure TR RAI 5-11 (Strata, 2012b)

Figure 2.2-12 2010 Wind Rose for the Ross Project, Oshoto, Wyoming



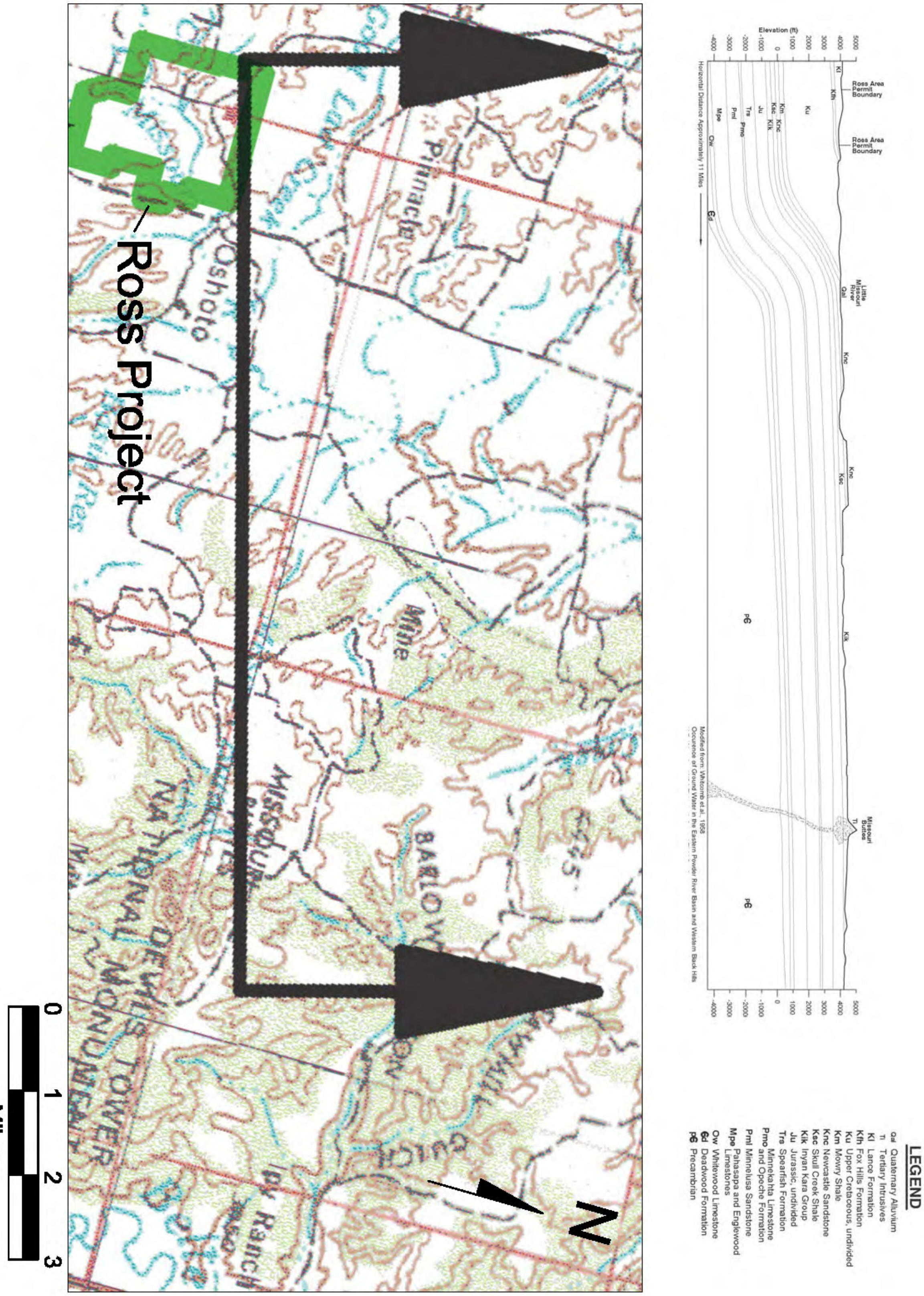
Source: Figure TR RAI 5-11 (Strata, 2012b)

Figure 2.2-13 2011 Wind Rose for the Ross Project, Oshoto, Wyoming



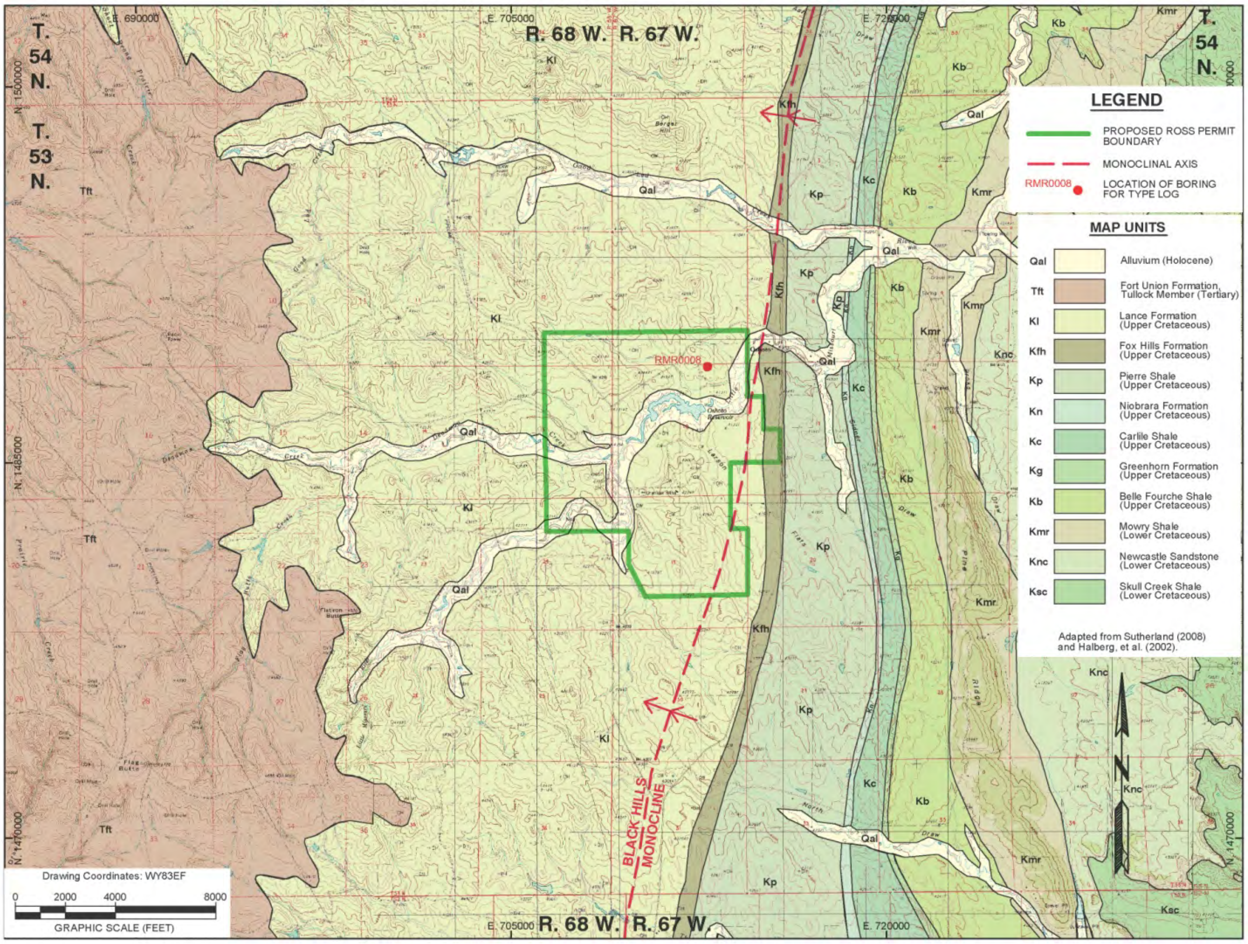
Source: Figure 2.6-3 (Strata, 2011a)

Figure 2.3-1 Regional Stratigraphic Column



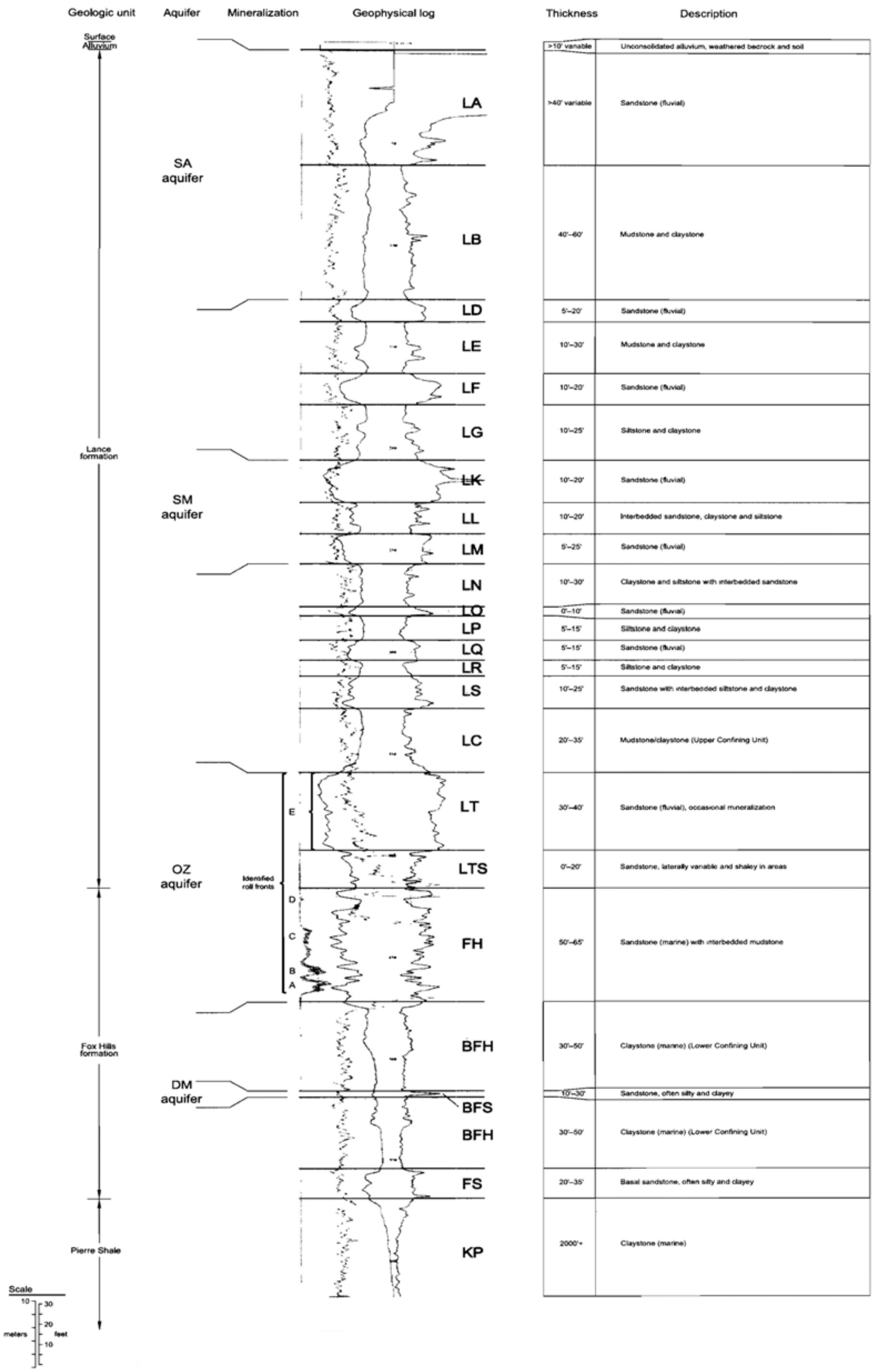
Source: Modified after Figure 2.6-5 (Strata, 2011a)

Figure 2.3-2 Regional Generalized Geologic Cross-Section



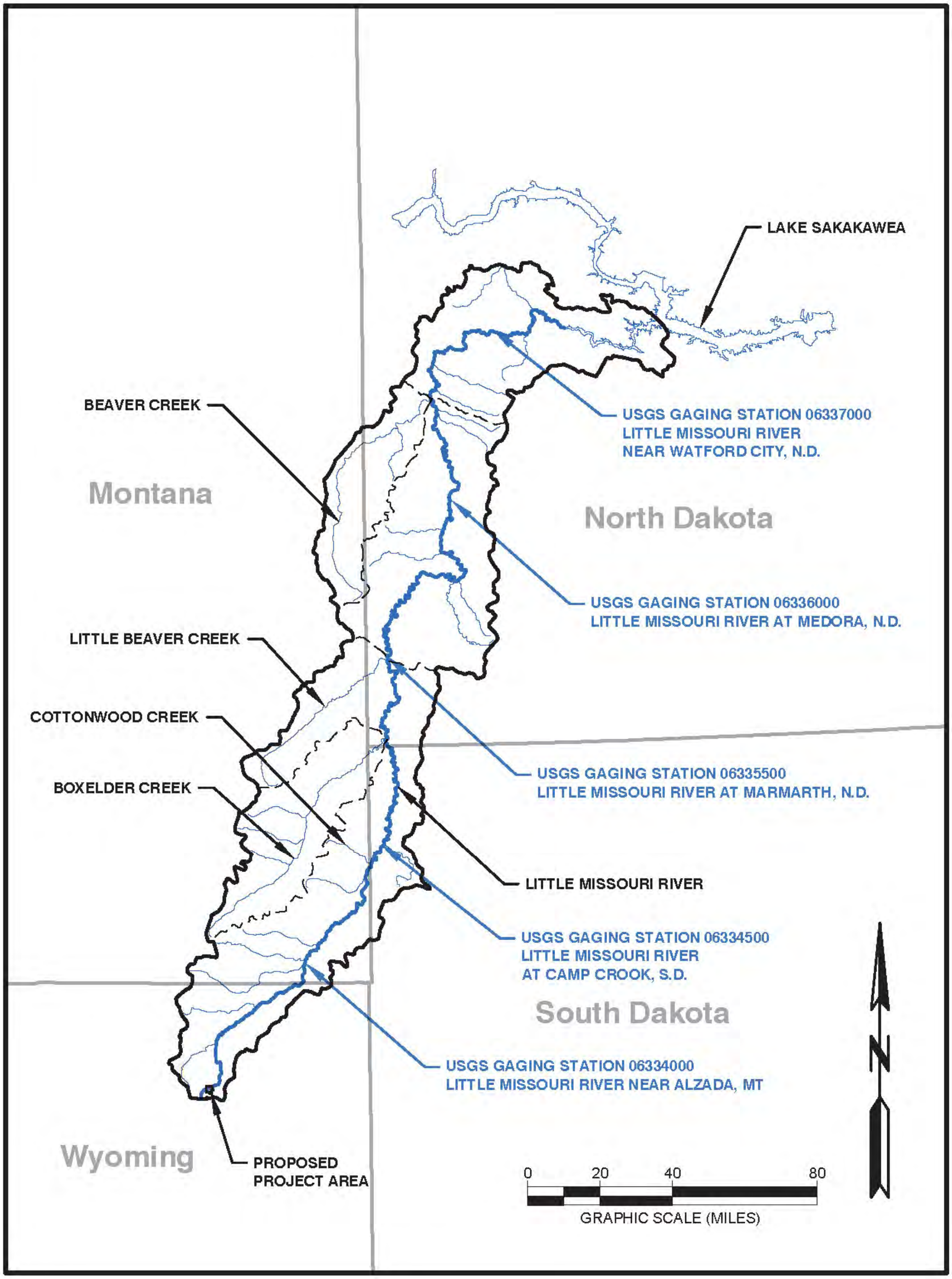
Source: Modified after Figure 2.6-5 (Strata, 2011a)

Figure 2.3-3 Bedrock Geologic Map



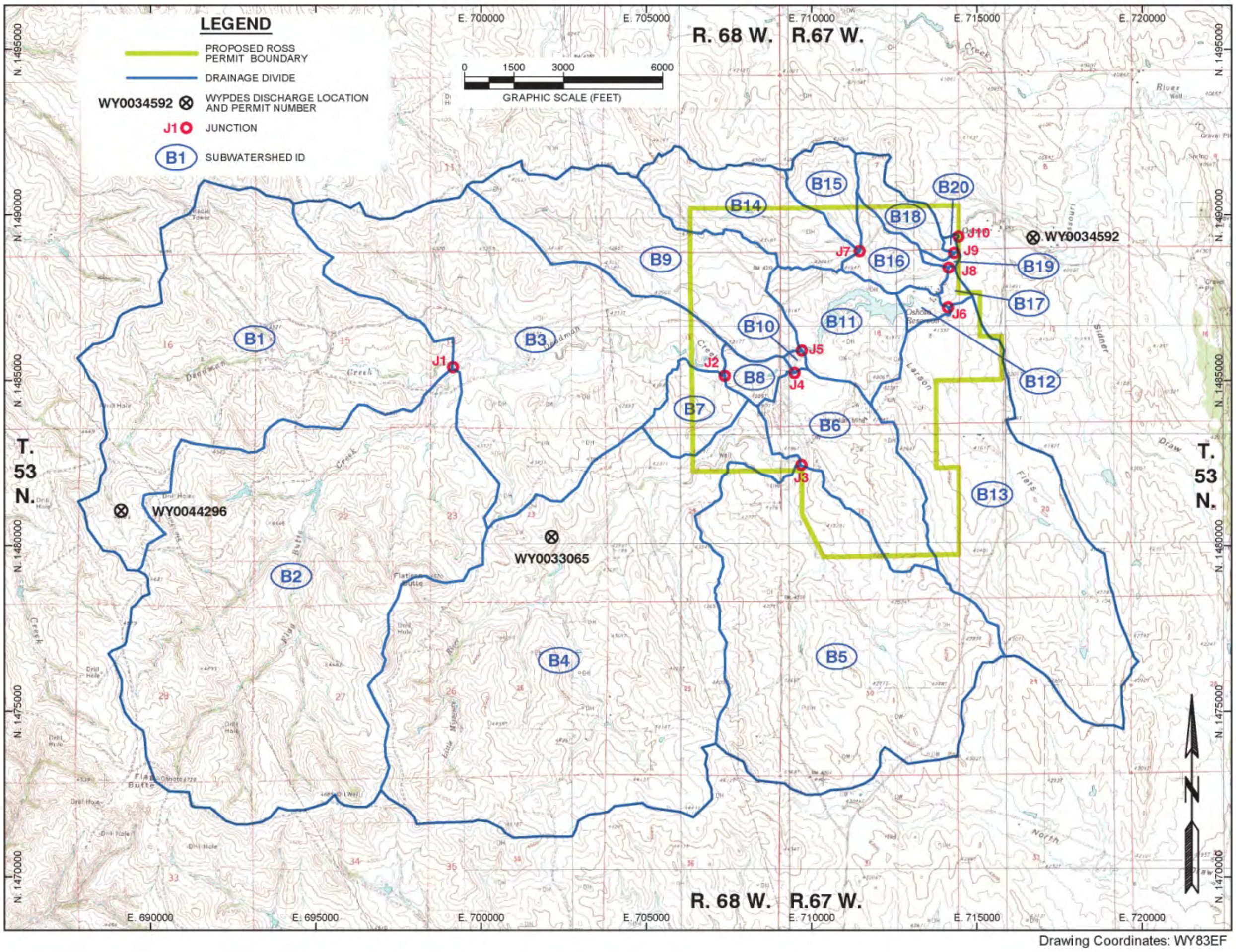
Source: Figure 2.6-7 (Strata, 2011a)

Figure 2.3-4 Site-Specific Stratigraphic Column of the Upper Cretaceous Pierre Shale, Fox Hills Formation and Lance Formation



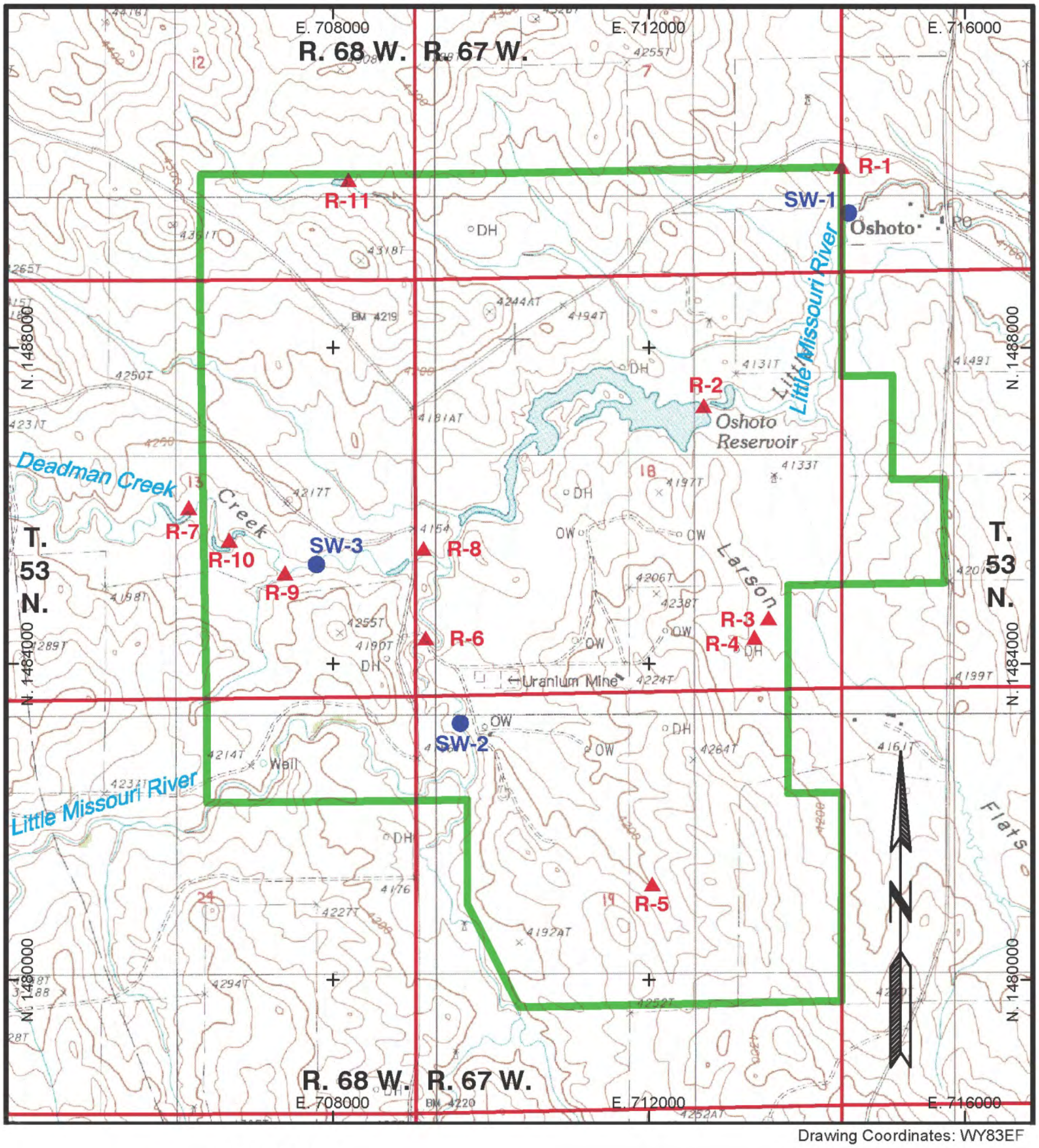
Source: Figure 2.7-1 (Strata, 2011a)

Figure 2.4-1 Location Map of the Little Missouri River Basin



Source: Figure 2.7-3 (Strata, 2011a)

Figure 2.4-2 Watersheds in the Ross Project



LEGEND

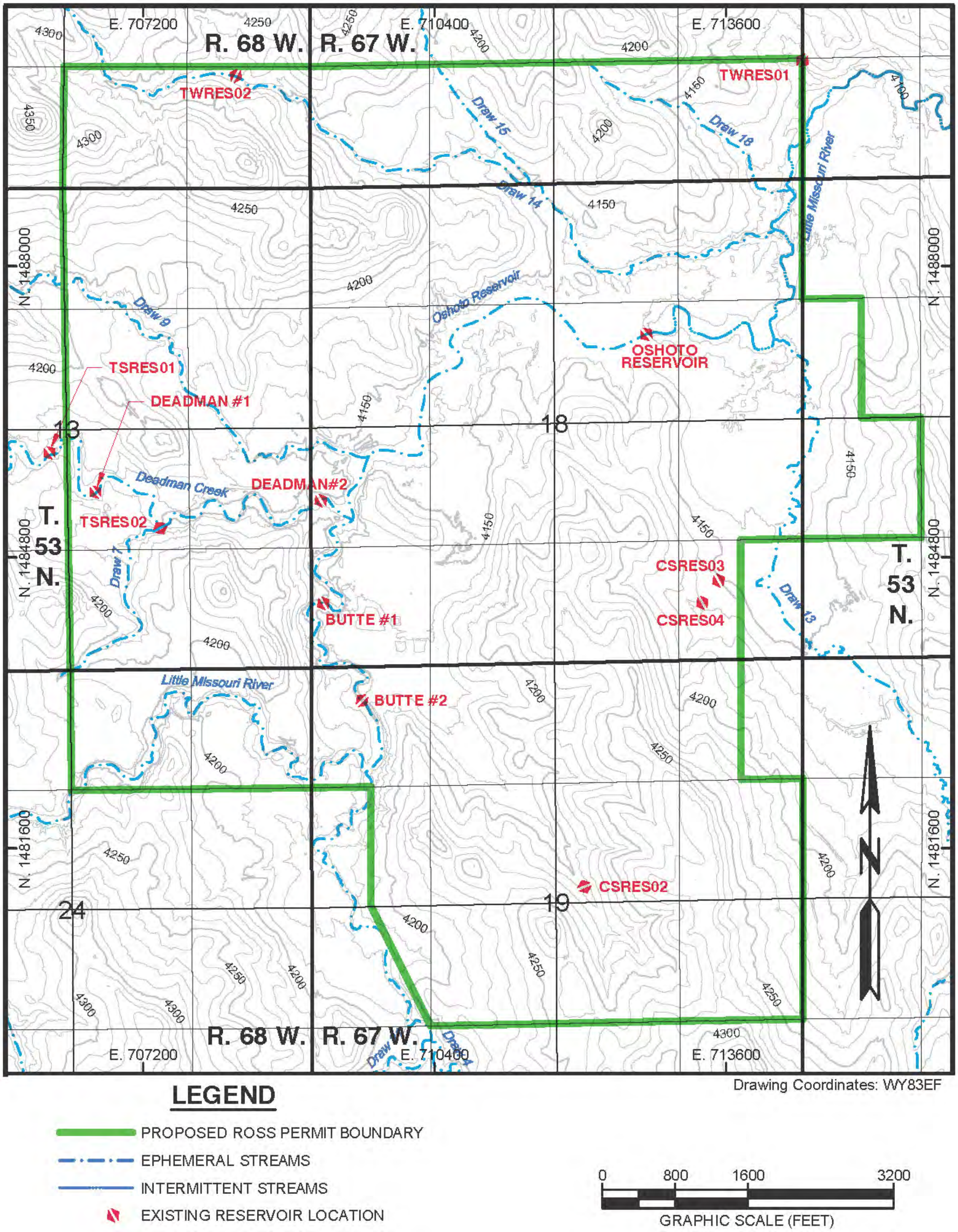
- PROPOSED ROSS PERMIT BOUNDARY
- SW-2 ● SURFACE WATER MONITORING STATION
- R-5 ▲ RESERVOIR

0 1000 2000 4000

GRAPHIC SCALE (FEET)

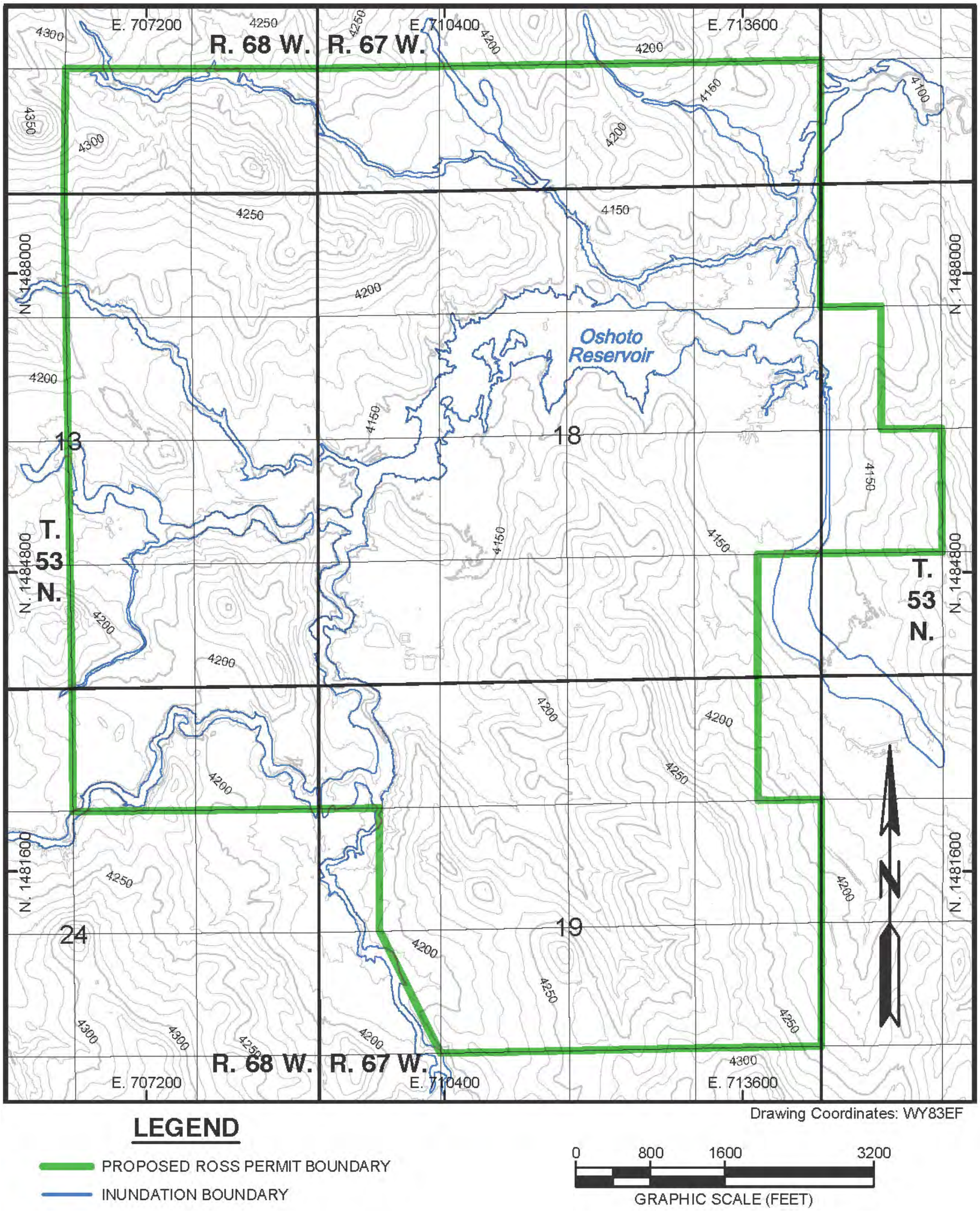
Source: Figure 2.7-7 (Strata, 2011a)

Figure 2.4-3 Location Map of On-Site Surface Water Gaging Stations



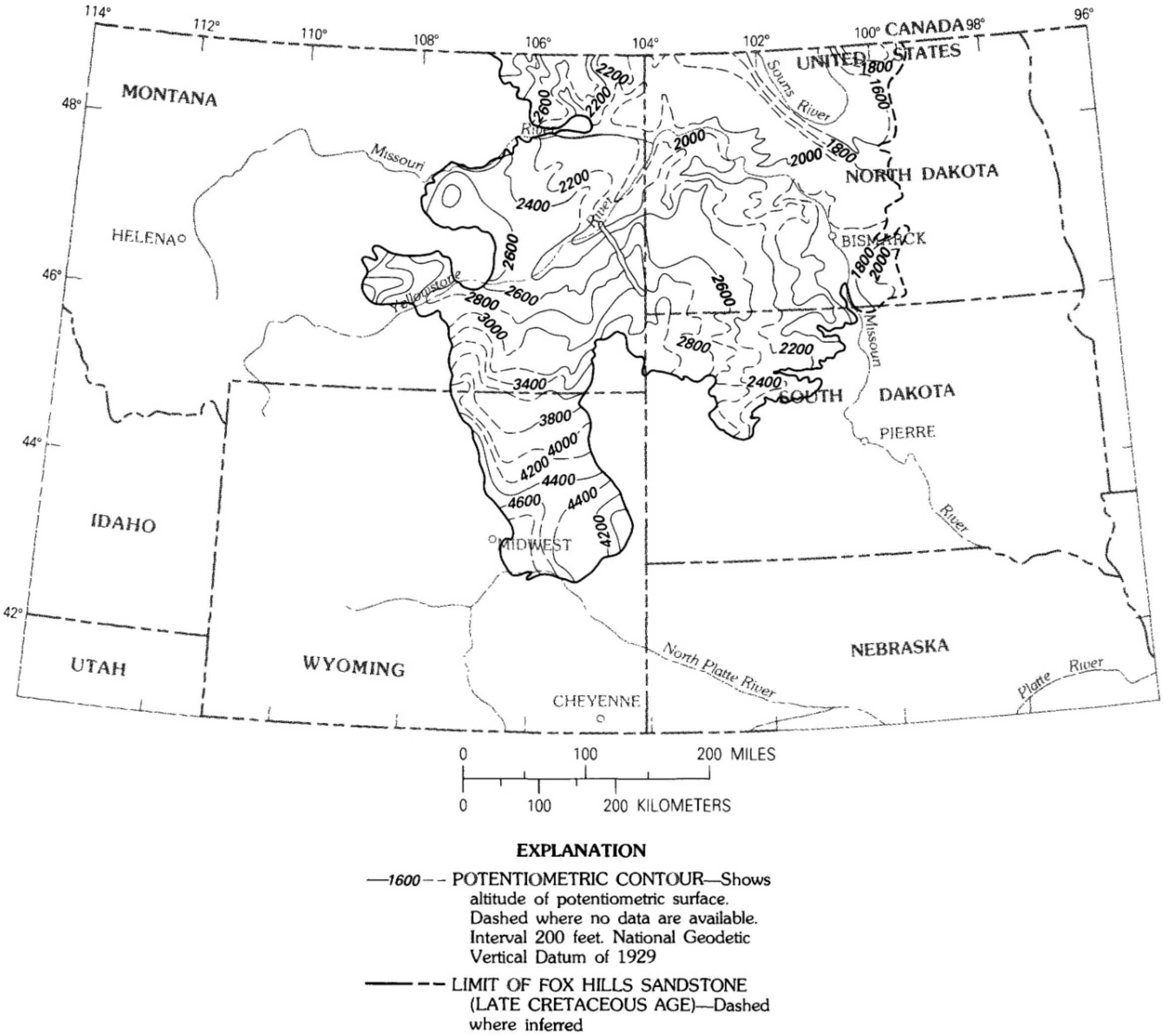
Source: Figure 2.7-6 (Strata, 2011a)

Figure 2.4-4 Location Map of Reservoirs within the Ross Project



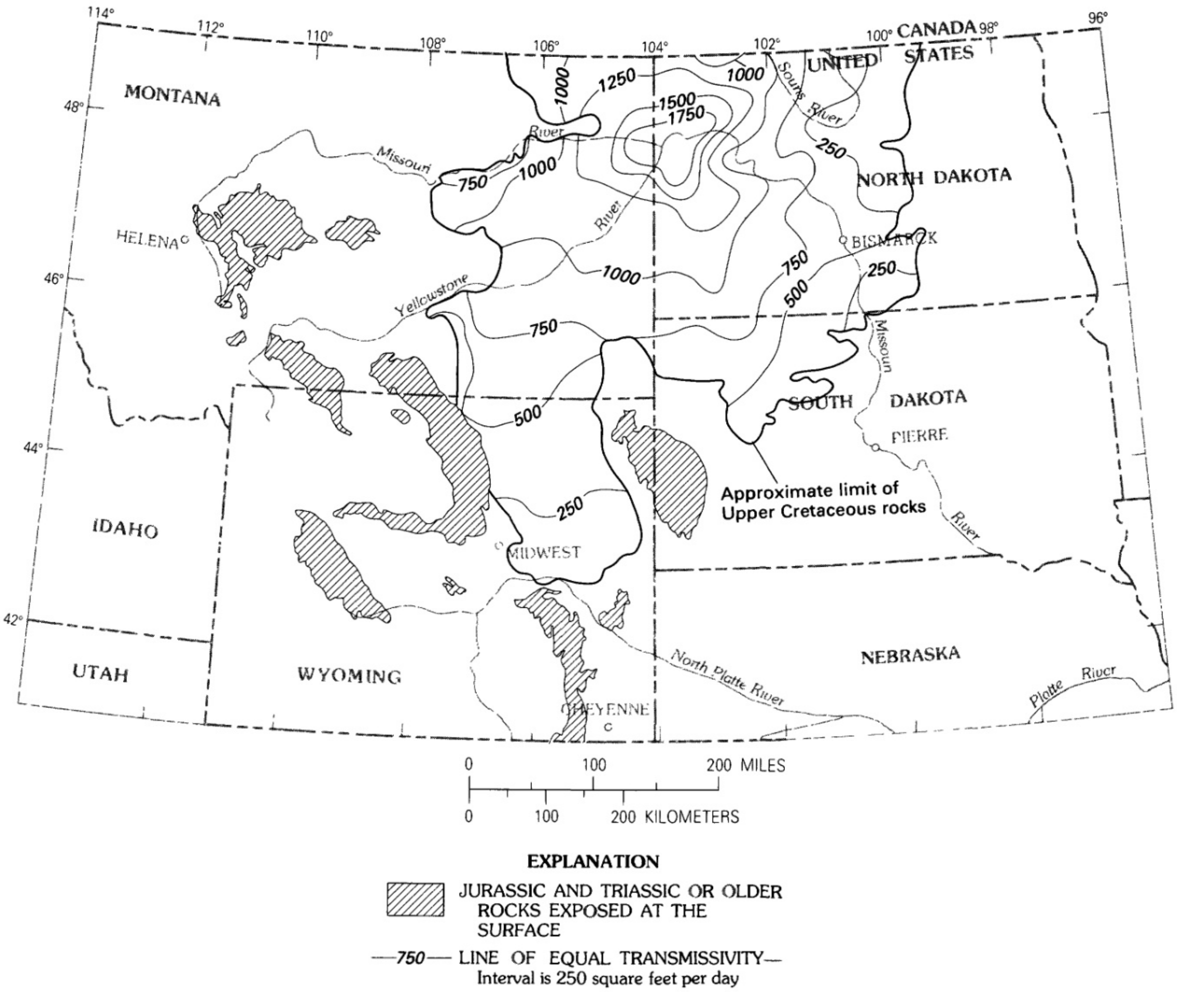
Source: Figure 2.7-4 (Strata, 2011a)

Figure 2.4-5 Location Map of Expected Inundated Areas within the Ross Project during the 100-year Flood Event



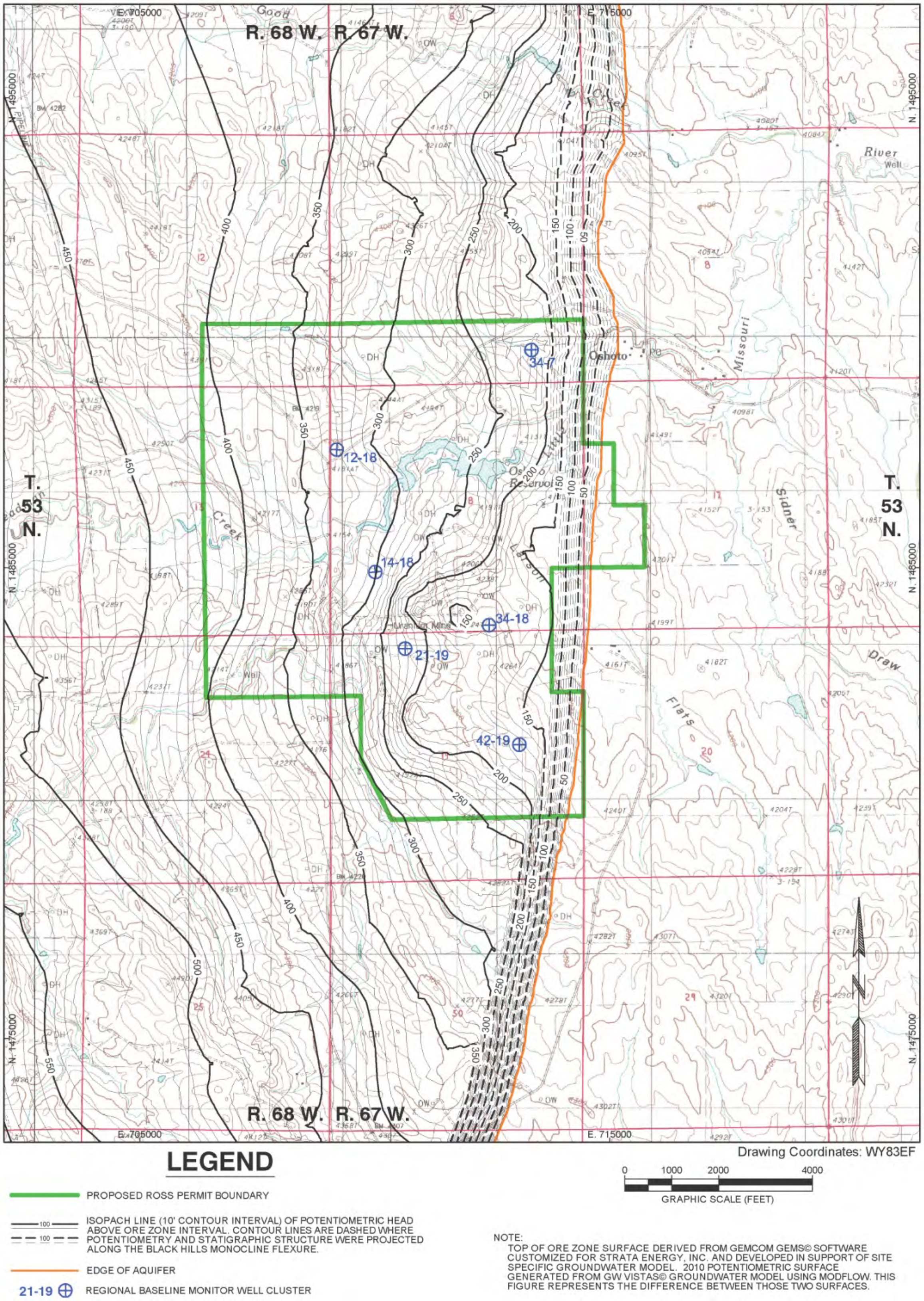
Source: (Downey,1986)

Figure 2.4-6 Regional Extent and Potentiometric Surface Isopleth Contour Map of the Lance-Fox Hills Aquifer



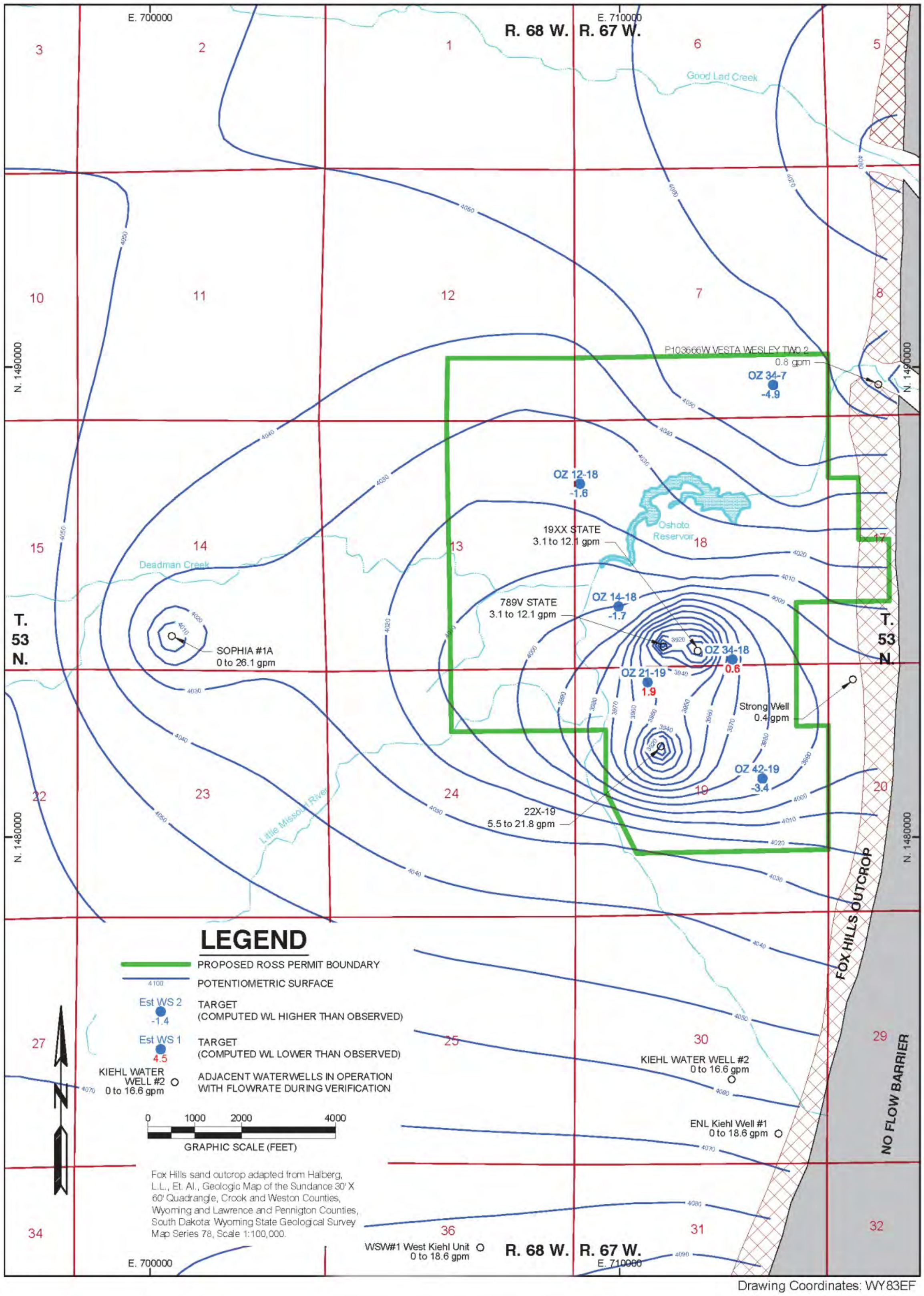
Source: (Downey, 1986)

Figure 2.4-7 Regional Variation in the Transmissivity of the Lance-Fox Hills Aquifer



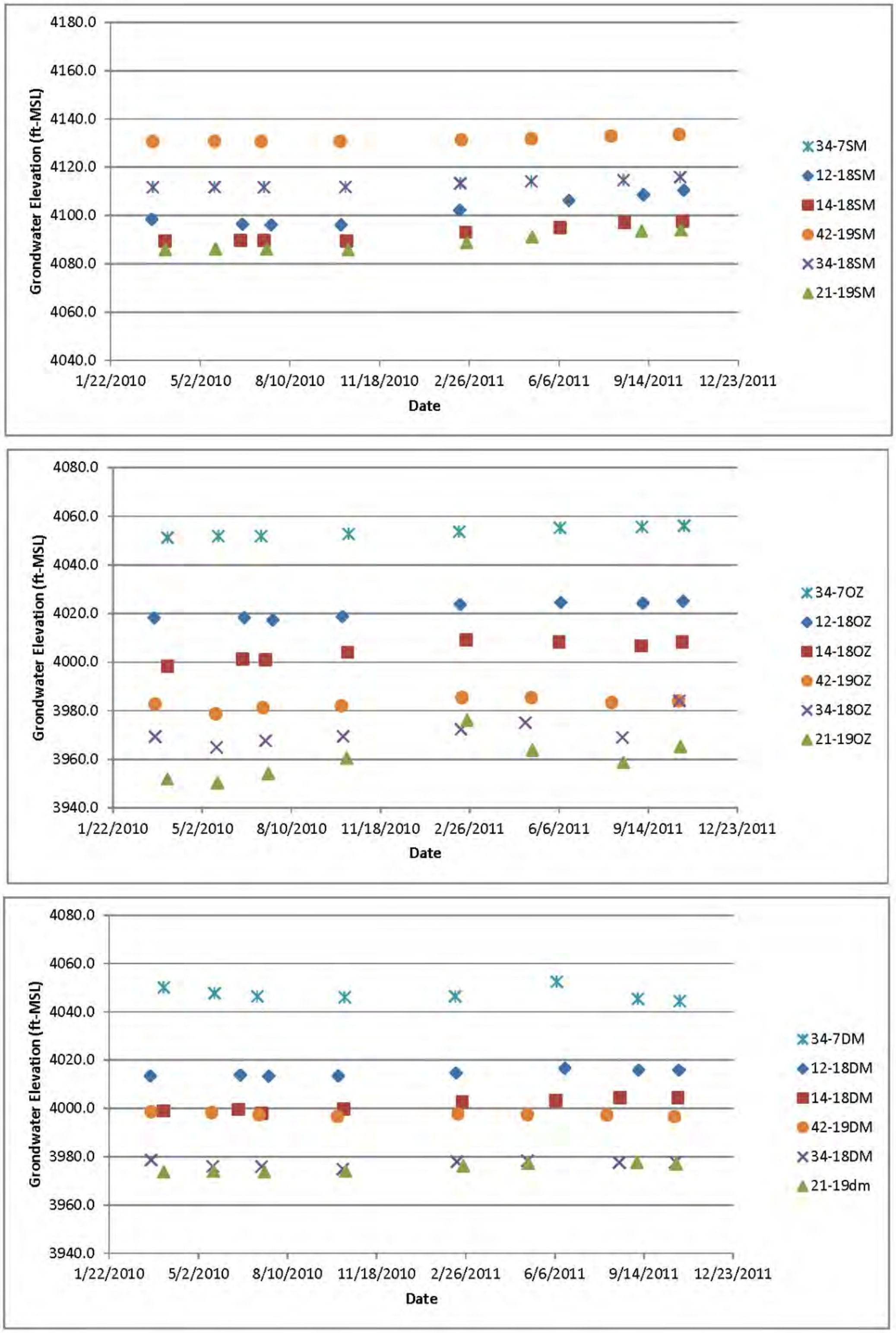
Source: Figure 2.7-23 (Strata, 2011a)

Figure 2.4-8 Contour Map of the Available Water Column above the OZ Aquifer



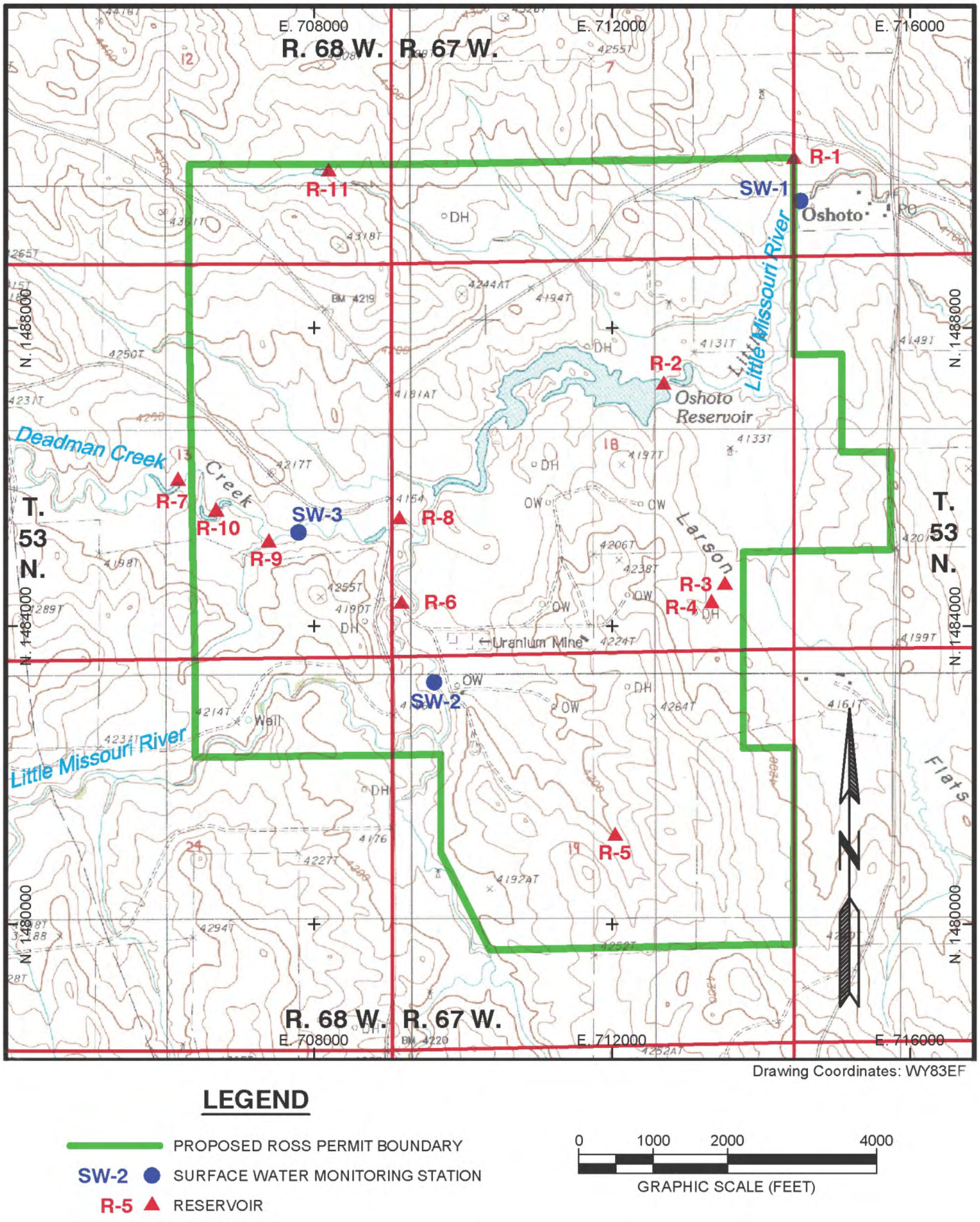
Source: Figure 4.7-5 of Addendum 2.7-H (Strata, 2011a)

Figure 2.4-9 Contour Map of the Existing Potentiometric Surface for the OZ Aquifer



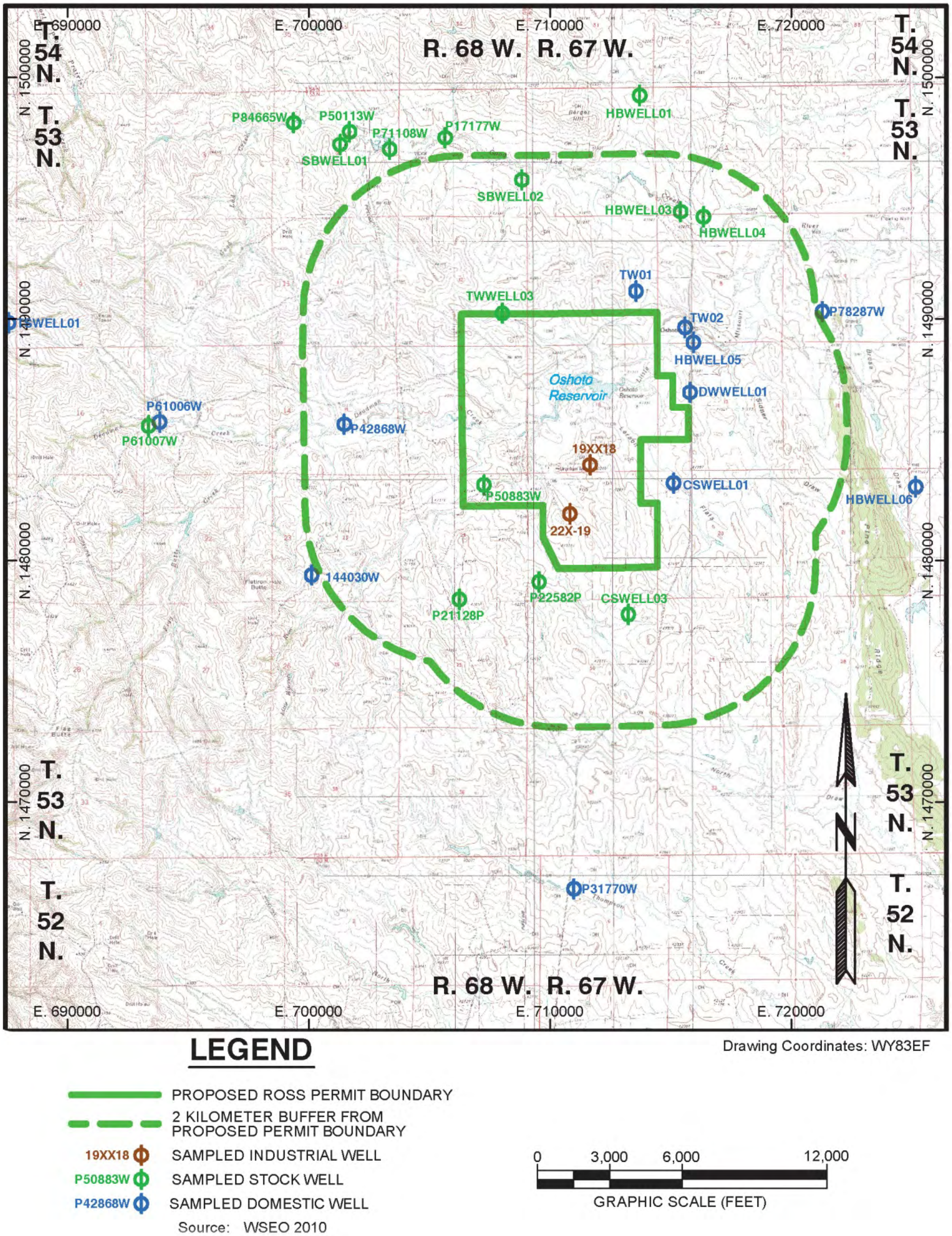
Source: (Strata, 2012b)

Figure 2.4-10 Variation in Groundwater Elevations at Selected Monitoring Wells during 2010 and 2011



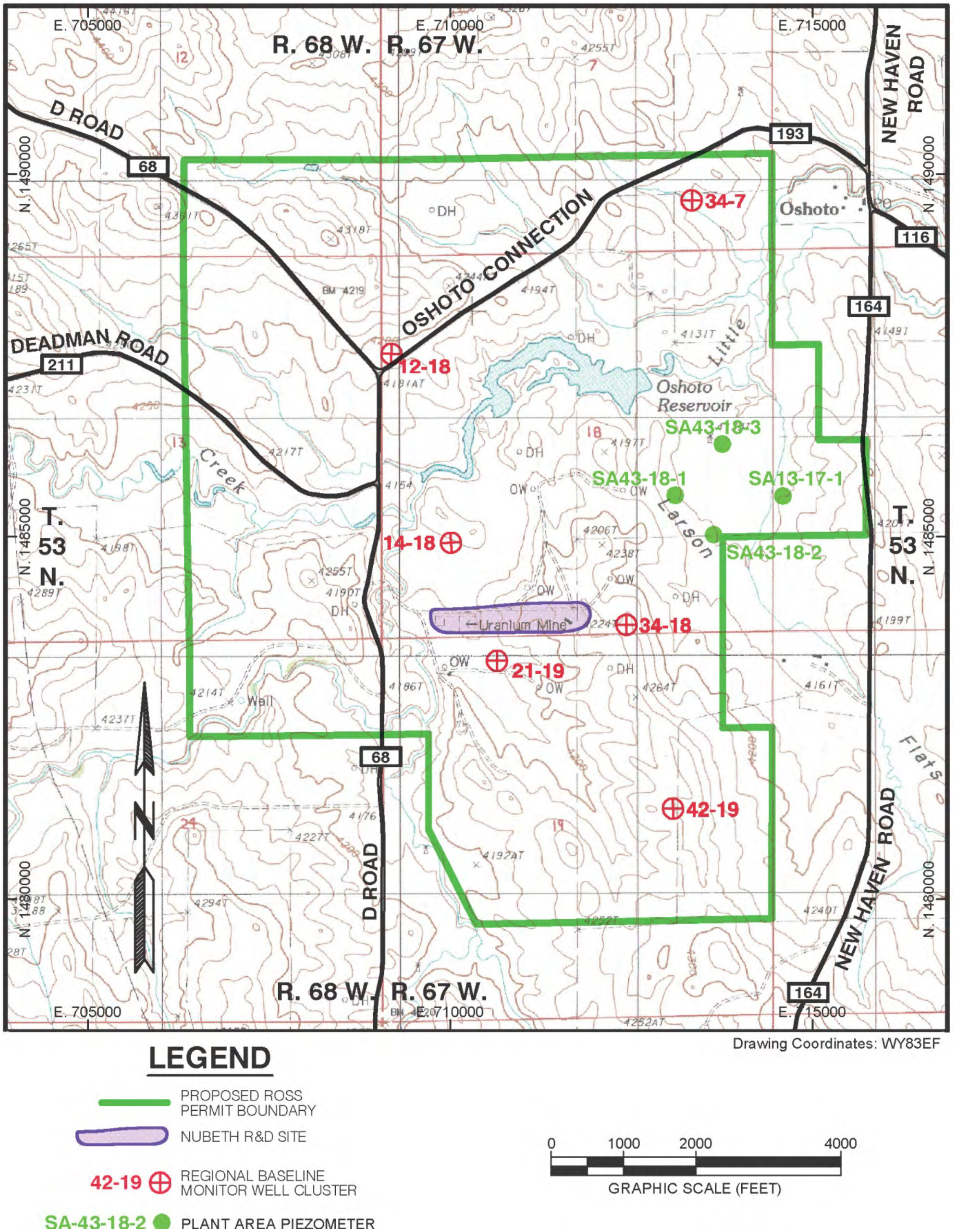
Source: Figure 2.7-7 (Strata, 2011a)

Figure 2.5-1 Location Map of Surface Water Sampling Locations used for the Preoperational Monitoring Program



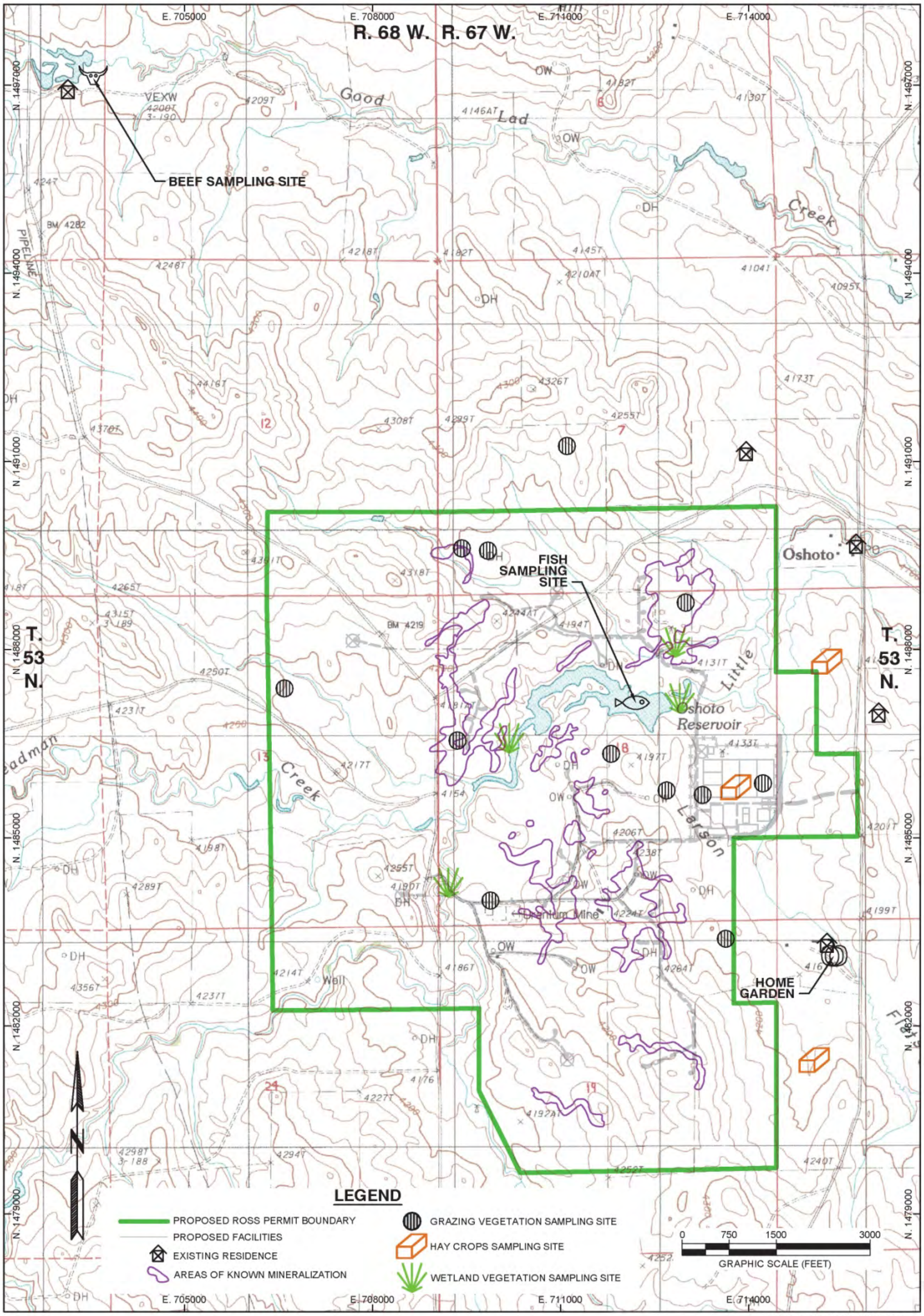
Source: Figure 2.7-33 (Strata, 2011a)

Figure 2.5-2 Location Map of the Nearby Water Supply Wells used for the Preoperational Monitoring Program



Source: Figure 2.7-14 (Strata, 2011a)

Figure 2.5-3 Location Map of the Onsite Monitoring Wells used for the Preoperational Monitoring Program



Source: Figure 2.9-31 (Strata, 2011a)

Figure 2.6-1 Vegetation, Food, and Fish Sampling Locations at the Ross Project

3.0 DESCRIPTION OF PROPOSED FACILITY

3.1 IN SITU RECOVERY (ISR) PROCESS AND EQUIPMENT

3.1.1 REGULATORY REQUIREMENTS

General requirements for contents of an application for a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(h) specifies that an application must clearly demonstrate how requirements and objectives set forth in 10 CFR Part 40 Appendix A are addressed. Technical Criterion 5E sets forth requirements and objectives for applicants to consider mill process designs that will provide the maximum practicable recycling of solutions and conservation of water in developing and conducting groundwater protection programs. Technical Criterion 7A sets forth requirement for and objectives to set up a detection monitoring program for the Commission to use for setting the site-specific groundwater protection criteria as required by Criterion 5B(5).[32] Section 10 CFR 40.41(c) requires that a Part 40 licensee has the ability to confine the licensee's possession and use of source and byproduct material to locations and purposes authorized by the license and 10 CFR 40.32(c) requires that an applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property. At an ISR facility, meeting these requirements includes determining that the applicant's processes, equipment and procedures are appropriate to confine the regulated material to the designated areas, including the subsurface.

The staff determines whether or not the applicant's descriptions of the in situ recovery equipment, processes and procedures are adequate to meet the above regulatory requirements such that issuance of a license based on the proposed activities is not inimical to the common defense and security or to the health and safety of the public in accordance with requirements of 10 CFR 40.32(d).

3.1.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with applicable requirements of 10 CFR Part 40 using review procedures in Section 3.1.2 and acceptance criteria outlined in Section 3.1.3 of the Standard Review Plan (NRC, 2003).

3.1.3 STAFF REVIEW AND ANALYSIS

The following sections present the staff's review and analysis of various aspects of the in situ recovery process and equipment for the Ross Project. Review areas addressed in this SER section include wellfield infrastructure, operations in the subsurface, and the proposed schedule for operations. Information presented in SER Section 3.1.3, unless otherwise stated, is from Section 3.1 of the Technical Report (Strata, 2011a).
To evaluate the implementation of the ISR process at the Ross Project, staff reviews information on the ore body characteristics and mine unit infrastructure, examining such features as well

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[32] Criteria in Appendix A are written for conventional mill setting. The conventional mill setting differs from an ISR setting in that (1) at a conventional mill, all activities conducted under the license are performed above ground whereas at ISR settings, the uranium extraction from the ore is performed in situ (or in the subsurface), and (2) at a conventional mill, a solid byproduct material, the mill tailings, is stored above ground in a tailing pile whereas at ISR settings, no mill tailings are generated. Staff is applying these criteria to ISR facilities because 10CFR 40.31(h) specifies that not only the requirements but objectives of the technical criteria in Appendix A are met.

installation and completion, mechanical integrity testing, mine unit piping, header house design, water balances, and wastewater disposal capacity. The staff then reviews the ISR mine unit operations to ensure that the applicant will be able to conduct its in-situ recovery operations in a safe manner. Health and safety requirements under 10 Part 20 for radiological aspects of those operations or features are evaluated in SER Section 4.0 (Effluent Control Systems) and Section 5.0 (Operations).

In Sections 1.0, 3.1 and 4.2 of the Technical Report (Strata, 2011a), the applicant describes key equipment and processes to be employed at the proposed facility as follows:

- The licensed area consists of 1721 acres in portions of Sections 7, 18 and 19 in Township 53N , Range 67W, and Sections 12 and 13 in Township 53N, Range 68W.
- The production area (wellfields and processing plant) consists of 125 to 145 acres within the licensed area.[33]
- The proposed wellfields are divided into two mine units, which are further delineated into modules; an estimated total number of modules is between 15 and 25.
- The total number of production wells (injection and recovery) to be installed in the wellfields is estimated at 1400 to 2200 wells.
- The total number of monitoring wells is estimated at 140 to 250 wells.
- Fluids injected into and extracted from the production wells within a module will be piped to a single module building[34], which includes manifolds, piping, process monitoring and controls for that specific module. From the module building, the fluids are piped to the process plant through underground trunk-line piping.
- Controlled access to the wellfield areas (production and monitoring wells in a module and module building) will be maintained by perimeter fencing primarily to eliminate access by livestock.
- The production zone consists of up to 5 mineralized roll fronts located at distinct stratigraphic horizons within the Upper Fox Hills Formation and lower Lance Formation. The total estimated recoverable uranium is 5.5 million pounds.
- The licensed area will include 5 deep wells for injection of liquid waste with a total design disposal capacity of 662 to 1514 Lpm [175 to 400 gpm].
- The process plant area consists of the Central Processing Plant (CPP), ancillary buildings, and two lined retention ponds with a storage capacity of 119.1 acre –feet.
- The CPP will include ionic exchange and elution circuits. The maximum production throughput is 28400 Lpm [7500 gpm]; the maximum restoration throughput is 4150 Lpm [1100 gpm]. The annual yellow cake production rate is 1.35 million kilograms [3 million pounds] per year.
- In addition to typical ISR operations, the CPP is designed to handle equivalent feed for toll milling and includes an additional elusion circuit for vanadium.
- A dewatering system is proposed for the process plant area due to high water table conditions.
- The anticipated life for the Ross Project is 10 years though life of the CPP and ancillary equipment may be extended longer should other areas in the applicant's Lance District be licensed for ISR operations.

[33] Wellfield is used as a generic description of the production area including to the abutting monitoring well ring.
[34] A module building is commonly referred to as a header house at other ISR facilities.

The following 11 topics are listed in the approximate order of the acceptance criteria in Section 3.1.3 of the SRP (NRC, 2003)

3.1.3.1 Ore Body

The applicant describes the ore body at the Ross Project as stacked roll fronts and tabular ore bodies in saturated sandstones of two Late Cretaceous host formations, the upper Fox Hills Formation and the lower Lance Formation (Strata, 2011a). The depth to the top of the ore bodies ranges from 91.4 to 213 meters [300 to 700 feet] with an average of 149 meters [490 feet]. The average thickness of the ore bodies is 8.9 feet. The aerial distribution of ore bodies within the Ross Project is shown on SER Figure 3.1-1.

In Section 2.6 of the Technical Report (Strata, 2011a), the applicant describes the roll fronts in the upper Fox Hills Formation as generally thicker and more massive due to the thicker sandstones in the upper Fox Hills Formation and roll fronts in the lower Lance Formation as narrow and often stacked due to the narrow fluvial channel sands that comprise that formation. The average dimensions of the mineralized roll fronts and tabular bodies are 35.1 meters [115 feet] in width, 4.3 meters [14 feet] in thickness, and 610 to 915 meters [2000 to 3000 feet] in length (Strata, 2011a). The average grade for the ore is 500 ppm (0.05%) equivalent U_3O_8.

The ore bodies formed as oxidized, uranyl-bearing groundwater entering the system in the uplifted areas, migrated primarily down dip through the host formations. The uranyl-bearing groundwater eventually diverted to a more northerly flow due to the complex depositional environment for strata in the Upper Cretaceous formations (Strata, 2011a). As a result, the roll front geometry is complex, forming what the applicant refers to as active, stagnant or passive roll fronts. The applicant provided mapping of the delineation of economically viable distribution of ore bodies based on the current data (SER Figure 3.1-1). The applicant did not provide mapping on the orientation of the reducing/oxidized environments associated with those deposits; however, that mapping is found in Buswell's thesis (Buswell, 1982), which the applicant presented in Addendum 2.6-A of the Technical Report (Strata, 2011a).

In Section 2.6 of the Technical Report (Strata, 2011a), the applicant states that the roll front deposits developed during the Tertiary Period as the migrating oxidized, uranyl-bearing groundwater encountered reducing conditions in the host formations. As a result, uranium minerals precipitated from groundwater as a coating on sand grains of the host formation at the oxidation/reduction front. The deposition of uranium minerals within the ore deposits is dependent upon various factors such as permeability of the host strata, reducing groundwater conditions and groundwater flow (Strata, 2011a).

In Section 2.6 of the Technical Report (Strata, 2011a), the applicant reports that vanadium is associated with uranium in the ore body at an average ratio of 0.6:1.0 (vanadium: uranium). In Sections 1.0 and 3.2 of the Technical Report (Strata, 2011a), the applicant discusses potentially incorporating a vanadium recovery circuit in the CPP.

NRC staff reviewed this information in the application and finds it consistent with the acceptance Criterion (1) of SRP Section 3.1.3 because the provided information is sufficiently detailed and adequately reflects site-specific conditions. Moreover, the ore body characteristics including grade, mineralogy and roll-front deposit types (see SER Section 2.3.3), and hydrogeologic setting (see SER Section 2.4.3) are generally consistent with those properties at existing NRC-licensed ISR facilities where operations have been conducted in a manner that is protective of workers' and public health and safety and the environment. The differences in properties

between the Ross Project and existing NRC-licensed facilities have been discussed and evaluated by staff in the referenced SER Sections.

3.1.3.2 Well Design, Testing and Inspection

The applicant describes three methods in which the extraction[35], injection and monitoring wells will be constructed (Strata, 2011a). The wells will be constructed of polyvinyl chloride (PVC) or fiberglass material with a sufficient pressure rating to withstand the maximum anticipated pressures during operations. The casing will have a minimum rating for the SDR-17 PVC casing with an outer diameter between 5 and 6.5 inches. The applicant commits to using O-ring and spline joint locking systems for the well casings and not using screw and glue joints, which experience at other facilities has shown to fail over time. The annulus will be backed-filled with neat-cement, and after its hardening, will be reamed to a diameter of 8 to 14 inches at the selected completion interval. A screen filter may be installed within the completion interval. A riser pipe would extend 3.0 meters [10 feet] from the top of the screen or open interval and be sealed within the casing above the completion interval using one or more K-packers (Strata, 2011a).

For the extraction and injection wells, the applicant will enclose the wellhead at ground surface with an insulated, fiberglass box which will served to protect the wellhead from accidental damage, freezing from cold temperatures and spills or leaks. The wellhead enclosure will have the ability to contain small leaks and incorporate a leak detection system to notify the applicant of a leak before it is released to the environment (Strata, 2011a).

The well completions will be identical for both extraction and injection wells to give the applicant flexibility for using the wells either as an extraction or injection well during the life of the wellfield (Strata, 2011a). However, the downhole equipment within each well is a function of its intended use. For injection wells, the downhole equipment consists of HDPE stringers to deliver the lixiviant to the ore zone and an air release valve at the wellhead to relieve any excess pressure that may build up in the casing (Strata, 2011a). For the extraction wells, the downhole equipment consists of submersible pumps and associated piping to extract the solutions from the aquifer and pump them to the module building.

The applicant indicates that each well will be developed following its installation by pumping, air lifting, jetting and/or swabbing (Strata, 2011a). The purpose for developing a well is to provide good communication between the well and formation by removing drilling fluids and fine materials that may have become imbedded in the formation adjacent to the well completion interval during well installation. The applicant will monitor well-development progress at a well by measuring several parameters (pH, turbidity and specific conductance) in the extracted groundwater during development. Development is determined complete when measurement of those parameters stabilize. The applicant states that it expects water produced from a well during its development will meet standards for a Wyoming temporary discharge permit and thus can be discharged to the ground surface.

A well may need to be redeveloped during the life of the well. Redevelopment, for maintenance or enhancement, may include chemical treatment in addition to procedures used for the initial well development (Strata, 2011a). The applicant provides examples of chemicals that may be used such as a weak acid or sodium hypochlorite (bleach). The applicant commits to collecting

[35] The applicant refers to the extraction well as recovery well.

the water produced from redevelopment and placing it in the retention ponds or injecting it into the deep disposal wells (Strata, 2011a).

The applicant states that all wells will undergo an initial mechanical integrity test (MIT) prior to being placed into operations (Strata, 2011a). MITs will also be performed at 5-year intervals after they become in-service and after any workovers or suspected surface or subsurface damage. MIT procedures consist of isolating the casing interval between the top of the screened horizon and ground surface using downhole packers, filling the isolated interval with water, pressurizing the water to a specified pressure, and measuring the ability of that well casing to maintain the pressure for a selected time interval.

The applicant states that the MIT pressure will be the maximum injection pressure plus a safety factor of 25 percent (Strata, 2011a). The maximum injection pressure for the piping in the module building is 140 psi (Strata, 2011a); thus, the pressure for the MIT tests will be 175 psi. To pass an MIT, the applicant states that the well casing must maintain the pressure within 10 percent of the initial level for a period of 10 minutes. If the well fails this requirement, the applicant will repair and retest the well. If the applicant cannot repair the well, the applicant will plug and abandon the well. Monitoring wells, which are abandoned due to an MIT failure, will be replaced. The applicant will document all MITs and maintain the records on-site for NRC review (Strata, 2011a).

NRC staff reviewed the applicant's well design, testing and inspection procedures and finds they are consistent with acceptance Criterion (2) of SRP Section 3.1.3 because the proposed design, testing and procedures reflect standard industry practices for in-situ recovery operations and have been accepted by NRC staff as protective safety measures for such operations. The staff will include the standard license condition for conducting MITs. The standard license condition includes language to better define "before operations" and preliminary corrective actions. In addition, the applicant did not propose maximum pressures for MIT's of monitoring wells. Monitoring wells will not be subjected to operational pressures and thus the maximum pressure for the MIT on monitoring wells may be less. The applicant will be required as part of the preoperational license condition to develop SOPs (see SER Section 3.1.4). The SOP for MITs would specify pressures for monitoring wells.

Based on review of the regional water quality in Section 2.5.3 of SER, staff identified incomplete well development of monitoring wells in low-yielding portions of the underlying and overlying aquifers. To ensure that future monitoring wells in low-yielding aquifers are properly developed, staff will include a license condition that the applicant will develop a suitable SOP to properly develop these wells prior to sampling (see SER Section 3.1.4).

Finally, experience from past licensees indicates a well casing with an inner diameter of 4.5 inches may lead to overheating of the pump, which in turn leads to partial melting of the casing and/or damage to the pump. In staff conversations with the applicant on the size of the piping, the applicant stated that they are using a casing with a minimum inner diameter of 5 inches. The existing pre-operational monitoring wells installed by the applicant are constructed with 5-inch inner diameter SDR-17 casing (Strata, 2011a).

3.1.3.3 Excursion Monitoring Wells

The applicant states that the monitoring wells, including those for the excursion monitoring program, will be constructed in a manner similar to the design for the production wells (see SER Section 3.1.3.2). For the monitoring wells in the perimeter ring, which will be used to monitor

horizontal excursions, the applicant states that each wellfield will be surrounded by perimeter monitoring wells at a spacing of 122 to 183 meters [400 to 600 feet] and at an approximate distance of 122 to 183 meters [400 to 600 feet] from the edge of the wellfield (Strata, 2011a). The wells will be screened throughout the entire production zone. The applicant states that results of the numeric groundwater flow model included in the application supports spacing of the wells in the ring of 183 meters [600 feet] (Strata, 2011a); however, the applicant commits to a spacing of 122 meters [400 feet] in response to staff's RAIs (Strata, 2012b).

On Figure 3.1-14 in the Technical Report (Strata, 2011a), the applicant provides a typical wellfield area displaying the relationship between production area and perimeter monitoring wells. On Figure ER RAI GEN-1-3 in the applicant's response to staff's environmental RAIs (Strata, 2012a), the applicant depicts three perimeter rings, one ring encompassing the entire Mine Unit 1 plus the northern half of Mine Unit 2, and the other two rings surrounding isolated ore bodies in the southern portions of Mine Unit 2. In addition, the applicant states that production wells in an abutting non-production wellfield may serve as temporary perimeter wells for a wellfield (see SER Section 5.7.8.3.1.2).

The applicant states that the spacing of excursion monitoring wells in the overlying SM aquifer and underlying DM aquifer will be at a density of one well per three to four acres of wellfield (Strata, 2011a). The wellfield production area is approximately 90 acres. Based on the projected production area, the applicant estimates that 24 sets of monitoring wells will be needed to satisfy the frequency density. On Figure 5.7-9 in the Technical Report (Strata, 2011a), the applicant graphically displays the a proposed location of the 24 baseline cluster wells, each cluster will include a monitoring well in the overlying and underlying aquifers for the excursion detection monitoring program in addition to a well in the ore zone to establish baseline water quality.

The applicant did not include monitoring in the uppermost SA aquifer in the excursion detection monitoring program. The applicant did include an operational monitoring program that consists primarily of monitoring the SA aquifer in the vicinity of the CPP.

NRC staff reviewed the applicant's well design for the excursion monitoring program and finds it is consistent with acceptance Criterion (3) of SRP Section 3.1.3 because the proposed design reflects standard industry practices for in-situ recovery operations that have been accepted by NRC staff as protective safety measures for such operations with the following clarifications:

- The Ross Project includes areas in which the uppermost aquifer is found at shallow depths and, in fact, within saturated unconsolidated alluvium. The uppermost aquifer at many ISR facilities in Wyoming is found at sufficient depths that monitoring is suspended; however, staff requires monitoring of the uppermost aquifer for facilities with a shallow uppermost aquifer. Therefore, staff will include a license condition for monitoring areas in which the uppermost aquifer (SA aquifer) is found in shallow alluvium. (see SER Section 5.7.8.4)

- The applicant proposes a minimum density of one baseline well for three to four acres of production area. As discussed in SER Section 2.4.3.4.3, staff finds that a minimum density of one baseline well for two acres of production area is appropriate for the Ross Project. The finding will be included in the license condition for background quality data as discussed in SER Section 5.7.8.4.

The operational component of the excursion monitoring program is evaluated by staff in SER Section 5.7.8.

3.1.3.4 Timely Detection and Cleanup of Leaks between Wellfield and CPP

The applicant states that the wellfield control and monitoring are based largely on controls within each module, which then relays data to a Master Control System (MCS) to be located in the Central Processing Plant (Strata, 2011a). The MCS will be able to remotely monitor and terminate any process in any module but will not be able to restart those processes; the starting capabilities reside solely in the module buildings (Strata, 2011a). The leak detection and monitoring equipment will include instrumentation, alarms, and control features both at the remote location and at the MCS to detect conditions outside of normal operating parameters and will require corrective action from the on-site personnel. For example, flows and pressures on the main injection and recovery pipelines will be displayed continuously in the MCS, and an out-of-ordinary low- and high-pressure condition will result in an audible alarm. In some cases (e.g., sufficient fluid accumulation in the sump in a module building), corrective actions will be automated (Strata, 2011a).

The applicant states that it will conduct an inspection program on a routine basis to provide early time detection of a leak or spill (Strata, 2011a). The piping used for the trunk lines will undergo leak testing after installation and prior to burial. The piping will be buried in trenches two to six feet below grade, and the trenches, after leak testing, are backfilled in accordance with the manufacturer's recommendations or industry standards. Pressure monitoring will be conducted during operations to monitor for leaks.

NRC staff reviewed information regarding the applicant's design, instrumentation, alarms, and control features for the surface and near-surface piping from the wellfield and processing plant. The staff finds that this information is acceptable because it is consistent with features used safely at existing NRC-licensed facilities for several years and includes state-of-the art adaptation to those features, and those features will provide timely detection and cleanup of leaks and spills between the CPP and wellfields. Based on the above, staff finds the information is consistent with acceptance Criterion (4) in SRP Section 3.1.3.

Staff will include a license condition that requires the applicant to retain information on spills for the life of the license, and criteria for spills to be reported in a timely manner to NRC (see SER Section 5.2.4).

3.1.3.5 In Situ Leaching Process

a) <u>Down-hole pressure</u>

The applicant commits to using materials for the well construction with a sufficient pressure rating to withstand the maximum injection pressure, maximum external collapsing pressure and the maximum pressure of cementing (Strata, 2011a). The applicant states that the maximum injection pressure (as measured in the module building) is 140 psi and will be less than the formation fracture pressure, which the applicant estimates for the Ross Project at 325 psi. The applicant commits to using material with the minimal pressure ratings equivalent to a PVC SDR-17 (4.5- to 6.0-inch inner diameter) casing.

Staff verified that selected manufacturer's specifications on the pressure rating for SDR-17 PVC casing is between 160 and 250 psi. Furthermore, the pressure rating for the casing increases if the casing is cement-lined as the applicant proposes (see SER Section 3.1.3.2). The maximum injection pressure of 140 psi is equivalent to 95.7 meters [314 feet] of water, which is sufficient for the proposed injection flow rates. Based on the above verification and the fact that similar pressures and equipment have been used at existing licensed facilities in a manner that is protective of health and the environment, staff finds the applicant's down-hole pressures consistent with SRP acceptance Criterion 3.1.3(5)(a).

b) Production versus Injection Rates

The applicant commits to a production rate that would exceed the injection rate by 0.5 to 2.0 percent, with an average of 1.25 percent, of the production rate. At the maximum throughput of 28400 Lpm [7500 gpm], the average difference between production and injection rate, which is referred to as "bleed," is equivalent to 356 Lpm [94 gpm]. The applicant acknowledges that the bleed is necessary to maintain hydraulic control on fluids in the production area. In Section 6.1 of the Technical Report (Strata, 2011a), the applicant proposes restoration improvements that includes maintaining a bleed for modules that are between production and restoration.

The applicant estimates that the operational production capacity on a module basis would be between 2270 and 3800 Lpm [600 and 1000 gpm] per module (Strata, 2011a). The operations at each module will be phased with several modules being in operation and while others in restoration and/or started later in the life of the project (see SER Section 3.1.3.6). For its estimated schedule, the applicant assumes an average operational production capacity of 2700 Lpm [715 gpm] per module in Section 6.1 of the Technical Report (Strata, 2011a). In Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant used a production capacity for a module of 2650 Lpm [700 gpm] per module in the numeric groundwater flow model simulation. Based on 40 extraction wells per module, the applicant's production capacity equates to a range of extraction rates for a recovery well from 56.8 to 94.6 Lpm [15 to 25 gpm].

The injection rates for individual injection wells depend upon the geometry of the production pattern and the number of adjacent patterns. The applicant states that the targets for flows to individual injection wells will be determined on a per pattern basis and balanced on a weekly basis.

Staff reviewed the applicant's information and finds the applicant's pressure descriptions consistent with SRP acceptance Criterion 3.1.3(5)(b) because the information is consistent with what was reported throughout the application, consistent with production flow rate regimes at existing ISR operations that have been shown to be protective of human health and the environment, and consistent with the hydrogeologic setting as discussed in SER Section 2.4.3. Staff will include a standard license condition that requires the applicant to maintain the bleed (hydraulic control) at a wellfield during its life cycle (see SER Section 3.1.4).

c) Proposed Plant Material Balances and Flow Rates

The applicant provides three water balances that reflect the three operational stages. The three stages are: (1) operation only; (2) concurrent operation and restoration; (3) restoration only (Strata, 2011a). The flow rates used for the three stages consisted of the maximum throughputs, i.e., 28400 Lpm [7500 gpm] for operations and 4200 Lpm [1100 gpm] for restoration (290 Lpm [75 gpm] assigned to groundwater sweep and 3910 Lpm [1025 gpm] assigned to groundwater treatment). The bleed rates assigned to the stages are: 1.25 percent

for operations during operations only; 1.25 percent under the operation only stage, 100 percent for groundwater sweep and 3.2 percent for groundwater treatment under the concurrent operation and restoration stage; and 100 percent for groundwater sweep and 8.8 percent for groundwater treatment under the restoration only stage.

The resulting wastewater generation rates for the three stages noted above are 360, 760 and 625 Lpm [94, 202, and 165 gpm], respectively. In addition to the wastewater generated by the plant processes of producing yellowcake, the applicant included a constant 94.6 Lpm [25 gpm] rate for disposal of spent eluate and other waste in the scenarios for each of the three stages (Strata, 2011a). During the restoration only phase, the applicant states that plant process make-up water would be needed, the source of which may be excess permeate from the lined ponds or increasing the bleed from the aquifer restoration.

Staff reviewed the applicant's information and finds the applicant's material balance and flow rate descriptions consistent with SRP acceptance Criterion 3.1.3(5)(c) because the information is consistent with what was reported throughout the application, consistent with material balance and flow rates regimes at existing ISR operations that have been shown to be protective of human health and the environment, consistent with the hydrogeologic setting as discussed in SER Section 2.4.3, and consistent with the disposal capacity as discussed in SER Section 4.2.3.

Staff will include a standard license condition on the production throughput (see SER Section 3.1.4)

d) <u>Lixiviant Makeup</u>

The applicant proposes to use a lixiviant that consists of fortified native groundwater with gaseous oxygen or hydrogen peroxide as the oxidant, and sodium bicarbonate or carbon dioxide as the complexing agent (Strata, 2011a). The applicant estimates that the maximum carbonate/bicarbonate concentration in the lixiviant is 4 grams per liter (g/L), and the maximum oxidant concentration of 1 g/L. The applicant reports the range in concentrations of other constituents in the pregnant lixiviant (SER Table 3.1-1).

The applicant states that a similar lixiviant makeup was used for the former Nubeth R&D facility and is being used successfully at other existing ISR facilities in Wyoming (Strata, 2011a). The applicant proposes to add the oxidant to the lixiviant at the module building and possibly the carbon dioxide complexing agent as well (versus at the CPP) (Strata, 2011a). If carbonate will be the complexing agent, then the applicant will add it to the lixiviant at the CPP. Due to difficulties in restoration and/or fouling of the aquifer the applicant eliminates the use of ammonium-based or acid-based lixiviants for the Ross Project (Strata, 2011a).

The applicant states that a portion of the injection solution will be processed through the reverse osmosis system (Strata, 2011a). The applicant's water mass balance calculations are based on flows of 833 Lpm [220 gpm] of the total throughput of 28400 Lpm [7500 gpm] will be processed through the reverse osmosis system. The applicant believes that this additional treatment will maintain the water quality of the injection solution and ultimately aid in restoration activities.

Staff reviewed the applicant's information and finds the applicant's lixiviant makeup descriptions consistent with SRP acceptance Criterion 3.1.3(5)(c) because the information is consistent with what was reported throughout the application and lixiviant makeup at existing ISR operations

that have been shown to be protective of human health and the environment. Staff will include a standard license condition on the lixiviant makeup (see SER Section 3.1.4).

e) Gaseous, Liquid and Solid Wastes and Effluents

The applicant identifies the gaseous, liquid and solid waste and effluents that will be generated at the CPP in Section 4.0 of the Technical Report (Strata, 2011a). Staff provides an evaluation and review the applicant's description of those waste streams, proposed monitoring and controls in SER Section 4.0.

f) Control of Lixiviant Migration

In Sections 2.6 and 2.7 of the Technical Report (Strata, 2011a), the applicant presents its conceptual model of the geologic and hydrogeologic setting and supporting data which would provide a setting for the control for the migration of lixiviant. In SER Section 2.3.3, staff evaluated the applicant's conceptual model and supporting data and finds it acceptable as documented in SER Section 2.3.4.

The applicant proposes the production units will be either a 5-spot pattern, 7-spot pattern, line drive or staggered line drive (Strata, 2011a). The proposed spacing between injection wells and/or recovery wells is 15.2 to 45.7 meters [50 to 150 feet] (Strata, 2011a). The staff finds that these proposed production patterns are acceptable as these patterns are currently being used at existing ISR operations and have been shown to adequately control the lixiviant migration at those facilities.

The applicant commits to maintaining an inward gradient at all production area throughout the production and restoration phases (Strata, 2011a). If a hiatus should develop between the production and restoration phases, the applicant commits to maintaining an inward gradient during that period as well (see SER Section 6.1.3). Staff will memorialize this commitment in a license condition (see SER Section 3.1.4).

The applicant proposes an excursion detection monitoring program for timely detection of lixiviant migration from the production area. Staff finds the proposed excursion detection monitoring program adequate to control the lixiviant migration. Staff's review and analysis of this program are documented in SER Section 5.7.8.

During the license period, the applicant states it will perform effluent and leak detection monitoring programs and proposes an operational monitoring program for potential impacts of a release of lixiviant or other fluids at the CPP (Strata, 2011a). Staff finds the effluent and leak detection programs adequate to control the lixiviant migration. Staff's review and analysis of the effluent monitoring program are documented in SER Section 5.7.7.

Except at the CPP operational monitoring program, the applicant did not propose any detection monitoring program for the uppermost aquifer. The SA aquifer is located at shallow depths and may include potential alluvial deposits that will likely provide a preferred migration path for migration of lixivant to the nearby receptor, e.g., surface water bodies. Staff will include a license condition that requires monitoring the SA aquifer for wellfields at which the uppermost aquifer includes saturated alluvium (See SER Section 5.7.8.4).

In Section 6.1 of the Technical Report (Strata, 2011a), the applicant commits to restoring the groundwater quality in an aquifer subjected to ISR operations to the groundwater protection

standards listed in Criterion 5B(5) in Appendix A of 10 CFR Part 40. The applicant provides an analysis of restoration success at the former Nubeth R&D facility and existing Wyoming ISR facilities as analogs to the Ross Project. Staff finds that the proposed restoration is adequate to control the lixiviant migration. Staff's review and analysis of the effluent monitoring program are documented in SER Sections 5.7.8.3 and 5.7.9.3.

In Section 2.7 of the Technical Report (Strata, 2011a), the applicant acknowledges that abandoned exploratory drill holes may provide preferential and unwanted pathways for fluid migration from the production aquifer to the surrounding aquifers, principally the overlying aquifer, but also the underlying aquifer, if improperly abandoned. In Addendum 2.7-F of the Technical Report (Strata, 2011a), the applicant attributes responses observed in water levels at wells in the underlying aquifer during pumping at several OZ aquifer wells to abandoned drill holes. The applicant commits to re-enter all drill holes within 0.25-mile of perimeter ring and abandon them in accordance with its SOP prior to conducting principal activities at a wellfield (see SER Section 2.3.3). Staff will memorialize this commitment in a license condition (see SER Section 2.3.4)

Three wells from the former R&D facility exist on-site, which are currently used as water supply sources for enhanced recovery (water flooding) at on-site oil and gas fields. Based on results of its numeric groundwater flow model, the applicant indicates that the past operation of those wells during the previous 30 years has lowered the potentiometric surface of the aquifers, and that future concurrent operation will have an impact on the ISR operations and vice versa. The applicant proposes to obtain an agreement with the oil lessee for an alternative water supply, or limit operations if the water supply wells continue in the future.

If an agreement is reached on an alternative water supply thus eliminating oil and gas operations at the three existing wells, staff will include a license condition that the wells will have to be plugged and abandoned, or, at a minimum, the completed interval reduced from entire Fox Hills/Lance aquifer to one of the applicant's designated aquifers (SM, Oz or DM aquifer). If the water supply wells continue operation, staff will include a license condition which would prohibit principal activities near the water supply wells (see SER Section 5.7.8.4). Based on the applicant's commitments and proposed license conditions, staff finds that the three water supply wells will not affect the control of lixiviant migration. Staff's review and analysis of the effluent monitoring program are documented in SER Sections 5.7.8.3 and 5.7.9.3.

Based upon the above, staff finds that the applicant's descriptions of the in situ leaching process are consistent with the review procedures in Section 3.1.2 and acceptance Criterion 3.1.3(5) of the SRP (NRC, 2003), and, as supplemented or memorialized by a license condition, provides reasonable assurance that the applicant has the ability to confine its possession and use of source and byproduct material to locations and purposes authorized by the license and that the applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property.

3.1.3.6 Operating Plans and Schedules

The applicant provides operating plans and schedules including timetables for construction, wellfield operations, groundwater restoration and surface reclamation periods (Strata, 2011a). The periods overlap as the applicant proposes a phased approach for initiation of operations at a specific wellfield. Based on Figure 1.9-1 of the Technical Report (Strata, 2011a), the applicant estimates that the construction phase will occur between years 0 and 3.5, wellfield operations

between years 1 and 5.3, restoration between years 3.75 and 7.0, and surface reclamation (decommissioning) between 5.5 and 9.5.

The applicant's plan for operation and restoration is based on a wellfield module basis (Strata, 2011a).[36] The applicant estimates that a total of15 to 25 modules will be established for both mine units at the Ross Project. Based on the numerical groundwater flow modeling documented in Addendum 2.7-H of the technical Report (Strata, 2011a), the applicant quantifies the impacts of the ISR operations based on operation of 17 modules with a maximum of 10 modules in operations at any one time during the life of the project. The applicant states that operations at approximately 6 modules will be completed in a single year.

The applicant estimates that each module will be in production for approximately 21 months, followed by a hiatus of 9 to 12 months during which only the inward gradient is maintained, followed by restoration activities for 8 months, and followed by a stability period during which only monitoring is performed for 12 months.

Based on the Table 4.9-1, *Simulated ISR Schedule in GW-Vistas*, in Addendum 2.7-H of the Technical Report (Strata, 2011a), the applicant provides a schedule on a per module basis. The schedule consists of 17 modules with operations and active restoration beginning in year 2 and ending in year 8. This schedule is consistent with the narrative in the application except that the operation and restoration phases in the addendum table begin and end one year later than the narrative descriptions.

Staff reviewed and evaluated the waste balance in SER Section 4.1.3 and adequacy of liquid waste disposal in SER Section 4.2.3. Staff reviewed the proposed restoration schedule and stability monitoring program and finds the proposed schedule is consistent with acceptance Criterion (6) of SRP Section 3.1.3 provided that the applicant updates the schedule as needed in order to comply with the requirements of 10 CFR 40.42.

3.1.3.7 Flood and Flood Velocities

In SER Section 2.3.3, staff reviewed and verified the applicant's flood analysis. In summary, the applicant estimates that the design criteria is the maximum event during the life of the project, which would be flows resulting from the 24-hour, 100-year storm event. Based on that event, the applicant estimates flows in the watersheds throughout the project, and based on measured cross-sections, demonstrates that the flows for the design maximum event will be limited to the banks of the existing, deeply incised channels. The applicant commits to avoiding those areas when constructing any facility including wells.

Staff finds this information and commitment acceptable (see SER Section 2.3.3).

3.1.3.8 Diversion Channel

In Section 2.7 of the Technical Report (Strata, 2011a), the applicant proposes to divert the channel in the area of the proposed CPP during the project.   In SER Section 2.3.3, staff verified the design criteria (storm event) for the diversion. In summary, the applicant will construct a channel that includes a box culvert under the proposed access to the CPP, erosion protection

[36] The applicant proposes a baseline water quality on a mine unit basis but operations and restoration on a wellfield module basis. As discussed in SER Section 3.1, this disparity has several impacts on the regulatory process.

downstream of the culvert and vegetative cover for the remainder of the channel (Strata, 2011a). Staff reviewed the diversion design for flood control in SER Section 4.2.3.1.9.8. The diversion channel will be located outside of the proposed containment wall and will be subject to weekly inspections (see SER Section 4.2.3.1.9.10).

3.1.3.9 Construction Plans, Specifications, Inspection Programs and QA/QC

In Section 1.9 of the Technical Report (Strata, 2011a), the applicant states its construction plans and presents a Gant Chart graphically displaying its schedule (SER Figure 3.1-2). Construction of the CPP will occur during the first year after receipt of a license (and by license condition, all required permits from other agencies). The applicant proposes construction of the wellfields to extend through the first four years of operation (Strata, 2011a).

In Section 2.6 of the Technical Report (Strata, 2011a), the applicant discusses methods and material for construction of the production and monitoring wells (for staff's evaluation, see SER Section 2.3.3).

In Addendum 3.1-A of the Technical Report (Strata, 2012b), the applicant provides construction plans and design criteria for the CPP area, including those for the retention ponds, containment barrier wall and foundation for the structures. In Section 2.6.6.5 of the Technical Report (Strata, 2011a), the applicant commits to using Wyoming's seismological design criterion for construction of its buildings (see SER Section 2.3). In section 3.2 of the Technical Report, the applicant provides details of the construction material for the CPP and ancillary equipment (see SER Section 3.2.3).

In Section 4.2 of the Technical Report (Strata, 2011a), the applicant provides details on the design and construction of the deep wells for the deep well injection of byproduct material (see SER Section 4.2).

In Section 5.3 of the Technical Report (Strata, 2011a), the applicant presents details on the proposed plans and schedules for inspection of the ponds, diversion and wellfields (see SER Section 5.3).

In Section 5.7.8 of the Technical Report (Strata, 2011a), the applicant discusses the environmental programs to be conducted during construction of the facility (see SER Section 5.7.8).

In Section 5.7.10 of the Technical Report (Strata, 2011a), the applicant commits to establishing a Quality Assurance (QA) program that meets the regulatory guidelines and regulations (see SER Section 5.7.9). In addition, during review of the sampling procedures and analytical data presented in the application, staff verified the accuracy and precision of the submitted data to ensure that the applicant performed proper Quality Assurance/Quality Control (QA/QC). Proper QA/QC consists of procedures commonly employed by the industry and used as accepted engineering practices in the environment field studies. Staff finds that the applicant adhered to proper QA/QC practices for the data presented in the application.

As documented in the referenced SER sections, staff reviewed the construction plans, specifications, inspection programs and QA/QC and finds that the applicant descriptions are clear and consistent with designs for an ISR facility used at other licensed facilities which have been shown to be protective of human health and the environment. Staff finds the applicant's proposed schedule for construction reasonable and consistent other ISR facilities.

3.1.3.10 Results from R&D Operations

The applicant reports results of the former Nubeth R&D facility that operated a single-pattern pilot scale operation in 1978. The operations were licensed by NRC; restoration and decontamination was approved, and the license was terminated in 1986. The applicant acquired rights to the exploratory drillholes completed by the former licensee of the R&D operation and used those results in establishing its conceptual model of the geologic and hydrogeologic setting for the proposed Ross Project.

The applicant addresses the problem of "loss of injection" potential that plagued the Nubeth operations. The applicant states that the losses of injection "were attributed to fines and organic material buildup in the wellfields and although filtering equipment was used, it was insufficient" (Strata, 2011a). The applicant states that improvements to well design and development and filtration systems will ensure removal of fine particles prior to operation and improvements to filtration systems upstream of the ion exchange columns will ensure that fine particles are not sent back to the injection wells (Strata, 2011a).

Staff requested additional information on the applicant's conclusion that the loss of injection was attributed to poor filtration (NRC, 2012b). In its request, staff cited a 1979 NRC staff evaluation report on an amendment request to change the composition of the lixiviant, which stated that the injection problems may have been attributed to swelling and plugging of the aquifer due to reactions between the sodium ion in the lixiviant and clays in the formation. In its response to staff's request for additional information (Strata, 2012b), the applicant reiterated its conclusion that inadequate filtering was the major factor in the loss of injection and provided more details on the size of the filtering material.

The applicant's response also addressed the potential reaction between the sodium in the lixiviant and clays in the formation (Strata, 2012b). Its conclusion is that clay in the formation is sodium rich and as such is currently at the maximum swelling potential. The addition of elevated levels of sodium in the lixiviant during operations over the levels existing in the native groundwater was likely not the cause of the loss of injection (Strata, 2012b).

Staff concurs in part with the applicant's conclusion that the clays in the formation are sodium rich and that the potential for additional swelling based on cation exchange is low because the clays are sodium rich.. However, the applicant did not address other factors that could affect the swelling potential of clays. The other factors include increased swelling under increased pressure and other properties of bentonite clays including its ability to form colloidal particles. The colloidal properties may lead to particles in suspension, which would be consistent with the applicant's conclusion that there was inadequate filtering during the former Nubeth operation.

The applicant did not provide any supporting documentation that inappropriate filtering was the major factor. Staff reviewed additional documents associated with the former Nubeth facility and is reasonably assured that the loss of injection problem was attributable to poor well construction. In its quarterly report for the period ending January 31, 1979 (Stoick, 1979a), the former licensee reported that it performed airlifting on wells to clean out wells that had loss of injection. In that report, the former licensee stated that the air samples revealed some "fresh" calcite precipitate and microorganisms. This information is consistent with the applicant's assertion in the application that the losses of injection were attributed to fines and organic material buildup if the reported fresh calcite precipitate meets the definition of fines.

Authogenic growth of calcite and/or gypsum as scale on well screens is a well-known problem in well hydraulics. To form calcite scale, the water conditions should be saturated with respect to calcite. The lixiviant chemical makeup for the former Nubeth operations had sufficient carbonate (bicarbonate) concentrations to form calcite, but the calcium concentrations were too low and the original application for the Nubeth R&D license acknowledged that well plugging could result if calcium levels increased in the lixiviant (Stoick, 1977). Because the former licensee did not attribute the loss of injection to plugging because of increased calcium concentrations in the lixiviant, it is likely that that was not the cause.

Staff finds that a likely source for the calcite scale may be attributed to a change in pH levels as noted in SER Section 2.5.3. A review of additional Nubeth documents shows that the licensee strove to maintain a lixiviant with elevated pH levels above 9.2) (Stoick, 1979a;b). Furthermore, quarterly reports suggest that at least two injection wells had loss of integrity and that a trickle of liquid seeping from the well annulus had a pH of 10.8 (Stoick, 1979c). In other documents, groundwater at wells that exhibit hydraulic isolation also had slightly higher pH levels compared to the other monitoring wells that were hydraulically connected (Stoick, 1979d).

Staff finds that the applicant's commitment to maintain a lixiviant with neutral pH levels (see SER Section 3.1.3.5(d)) and well completions and designs including requirements for construction, integrity testing, and maintenance of operational pressures, will decrease the potential loss of injection and thus provide reasonable assurance that the applicant will be able to operate within the design parameters.

3.1.3.11 Solid Byproduct Waste Disposal Agreement

The applicant lists several licensed facilities for which a solid byproduct waste disposal agreement could be obtained for disposal of wastes generated at the Ross Project (Strata, 2011a). The applicant committed to obtaining an agreement with one of the facilities prior to operations. The staff will impose a standard license condition that would make this commitment a requirement (See SER Section 4.2.4).

3.1.4 Evaluation Findings

The staff reviewed the ISR process and equipment proposed for use at the Ross Project in accordance with review procedures in Section 3.1.2 and acceptance criteria in SRP Section 3.1.3. The applicant adequately described the mine unit infrastructure, equipment and ISR operations for the Ross Project and based on these descriptions, staff finds the applicant has satisfactorily documented the ore body characteristics that are consistent with ore bodies that are undergoing safe operations at existing NRC-licensed ISR facilities. The staff finds that applicant provided commitments to protect against unwanted vertical and horizontal migration of fluids, including materials used in construction of the infrastructure and routine monitoring in the surface and subsurface. The staff finds that the applicant's proposed ISR processes will meet the following safety criteria:

- overall production rates are higher than injection rates to create and maintain a cone of depression;
- plant material balances and flow rates are appropriate;
- reasonable estimates of gaseous, liquid, and solid wastes and effluents are provided (used in evaluation of effluent monitoring and control measures in SRP Section 4.0).

Based on the staff's review of the applicant's components with respect to safety risk and current industry practice at existing NRC-licensed ISR facilities, the staff concludes that the applicant provided an acceptable description of the instrumentation and monitoring that will prevent and correct spills and/or excursions, as well as provided acceptable operating plans, schedules, and timetables for mine unit operation, surface reclamation, and groundwater restoration. Requirements for several aspects of the operations (in particular, lixiviant makeup, limitations on throughput capacity, ground water monitoring and spill reporting), will be enumerated in standard license conditions as follows:

Standard License Condition 10.1:

> The licensee shall use a lixiviant composed of native groundwater; carbon dioxide, sodium carbonate and/or sodium bicarbonate; and hydrogen peroxide and/or oxygen, as specified in Section 3.1.3.1 of the licensee's approved license application.

Standard License Condition 10.2:

> Facility Throughput. The Ross Project processing facility throughput shall not exceed a maximum instantaneous flow rate of 7,500 gallons per minute, excluding restoration flow. The annual production of dried yellowcake shall not exceed 3 million pounds.

Standard License Condition 10.5:

> Mechanical Integrity Tests. The licensee shall construct all wells in accordance with methods described in Section 3.1.2 of the approved license application. Mechanical integrity tests shall be performed on all wells (injection, extraction, and monitoring wells) before the well is utilized and on wells that have been serviced with equipment or procedures that could damage the well casing. Each well shall be retested at least once every five (5) years it is in use. Integrity tests shall be performed in accordance with Section 3.1.2.3 of the licensee's approved license application. Any failed well casing that cannot be repaired to pass the integrity test shall be appropriately plugged and abandoned in accordance with Addendum 2.6-E of the approved license application.

Standard License Condition 10.7:

> The licensee shall maintain a net inward hydraulic gradient at a wellfield as measured from the surrounding perimeter monitoring well ring starting when lixiviant is first injected into the production zone and continuing until initiation of the stabilization period.

The applicant has committed to performing and documenting results of daily inspections for leaks during routine field surveys/activities. Staff will include the following standard or facility specific license conditions to memorialize those commitments:

Facility Specific License Condition 10.14:

Facility and Wellfield Inspection. Injection manifold pressures and flow rates shall be measured and recorded daily by the in-line computer system and/or Wellfield Operator. During wellfield operations, injection pressures shall not exceed the maximum operating pressure as specified in Section 3.1.4 of the approved license application. To the extent possible, the weekly inspections shall include visual inspections and document leaks or other abnormalities in the wellfield piping, wellheads, or module buildings in accordance with Section 5.3.3 of the approved license application. The licensee shall conduct the weekly in-plant inspection and audit programs described in Section 5.3.1 of the approved license application. In addition, as described in Section 5.7 of the approved license application and supplements, the RSO shall document that radiation control practices are being implemented appropriately. Requirements for inspections of the on-site retention ponds are listed in LC 10.8.

Standard License Condition 11.1:

In addition to reports required to be submitted to NRC staff or maintained on-site by the applicable parts of Title 10 of the Code of Federal Regulations, the licensee shall prepare the following reports related to operations at the facility:

A) A quarterly report that includes a summary of the excursion indicator parameter concentrations, corrective actions taken, and the results obtained for all wells that were on excursion status during that quarter. This report shall be submitted to NRC within 60 days following completion of the reporting period.

B) A quarterly report summarizing daily flow rates and pressures for each injection manifold within the operating system. This report shall be made available for inspection upon request.

C) A semi-annual report that discusses: status of wellfields (or wellfield modules if appropriate) in operation (including last date of lixiviant injection), progress of wellfields (wellfield modules) in restoration, status of any long term excursions and a summary of MITs during the reporting period. This report shall be submitted to NRC within 60 days following completion of the reporting period.

D) Consistent with Regulatory Position 2 of Regulatory Guide 4.14 (as revised), a semiannual report that summarizes the results of the operational effluent and environmental monitoring program. For this program, the nearby water supply wells are those within 2 km of the perimeter ring monitoring wells for all wellfields undergoing recovery operations or restoration. This report shall be submitted to NRC within 60 days following completion of the reporting period.

E) An annual report pursuant to LC 9.4(E).

F) An annual report that summarizes modifications to the inventory of nearby water supply wells and land-use survey within 2 kilometers of any

production area. This report shall be submitted to NRC within 90 days following completion of the reporting period.

Staff will also include the following facility specific license condition to ensure that standard operating procedures are prepared and utilized during construction:

Facility Specific License Condition 12.11:

> Prior to the preoperational inspection, the licensee will provide to the NRC written standard operational procedures (SOPs) required for LC 10.4, which will include information to meet the following specific-site conditions:
>
> A) Development and sampling of low-yielding monitoring wells.
>
> B) Inspection procedures for the CPP dewatering system.
>
> C) A CPP effluent and environmental monitoring program (if not incorporated into the groundwater detection monitoring program required by LC 10.20).
>
> D) An emergency response program that includes hazard assessment of all chemicals used at the facility including an accident analysis for those chemicals.
>
> E) Transportation of licensed material outside of the License area.

Based upon the review conducted by the staff as indicated in this section, the information provided in the application as supplemented by the information to be collected and activities to be conducted in accordance with the noted license conditions, meet the applicable acceptance criteria of SRP Section 3.1.3 and thus meeting requirements of 10 CFR 40.32(c) and will meet requirements of 10 CFR 40.41(c), if issued a license. Staff finds that the proposed ISR operations are consistent with those currently being used at existing NRC-licensed facilities and are NRC-accepted practices. Based on commitments in the application and the license conditions identified above, NRC staff concludes that the applicant will be able to operate the ISR process in a manner that is safe for workers' and the public health and safety and the environment.

3.2 PROCESSING PLANT, WELLFIELDS, AND CHEMICAL STORAGE FACILITIES

3.2.1 REGULATORY REQUIREMENTS

The staff determines if the application has demonstrated that equipment and processes used in the processing plant and other facilities at the Ross Project during its operation meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.2.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria in Section 3.2.3 of the SRP (NRC, 2003).

3.2.3 STAFF REVIEW AND ANALYSIS

This section discusses the physical descriptions and operating characteristics of the major equipment that the applicant would use during processing. These descriptions pertain to the processing plant, the chemicals that the applicant would use on-site, and the potential radiological and chemical hazards associated with the operations. Information in SER Section 3.2.3, unless stated otherwise, is from Section 3.2 of the technical report (Strata, 2011a).

3.2.3.1 Processing Plant

The applicant states that the central processing plant (CPP) would be located In Crook County, Wyoming, in the NE1⁄4 of the SE1⁄4 of Section 18, Township 53N, Range 67W (Strata, 2011a). The CPP will be the largest building at the project with dimension of 113 meters [370 feet] in length, 61 meters [200 feet] in width and 15.2 meters [50 feet] in height (Strata, 2011a). The CPP would include a uranium recovery circuit, uranium elution circuit, uranium precipitation circuit, and yellowcake drying/packaging along with a vanadium removal and drying/packaging circuit. Adjacent buildings would house the administrative office, maintenance shop, and warehouse. Waste disposal facilities in the CPP area would include lined retention ponds and one of the five Class I Injection wells.

The applicant estimates that the total disturbed area for the surface features at the CPP area is 20.6 hectacres [51 acres] (Strata, 2011a). The CPP and adjacent buildings would be fenced to a height of 2.4 meters [8 feet] to exclude livestock and wildlife, and to control access to the site. Equipment located in the plant includes ion exchange (IX) and elution vessels, precipitation tanks for uranium and vanadium, thickeners, filter presses, vacuum dryers for uranium and vanadium, storage tanks, and the associated piping, pumps, and valves required to be able to move the solutions throughout the plant. The applicant has provided a drawing showing the layout of the major components within the plant in Figure 3.2-1 in the Technical Report (Strata, 2011a) (SER Figure 3.2-1).

The final products at the plant would be dried uranium oxide and ammonium metavanadate (Strata, 2011a).

The staff's review of aspects of the facility affecting radon exposure are found in SER Section 4.1. In Section 4.1 of the Technical Report (Strata, 2011a), the applicant discusses ventilation as follows: Areas within the CPP where radon exposure would be of concern include the de-sanding system, IX vessels, resin transfer area, and in fluid collection sumps. Pressurized down-flow IX vessels with vents in the top of each vessel would be used, which would minimize radon releases. The de-sanding system, resin shaker screens, and sumps would have exhaust hoods and redundant exhaust fans. Vents from these systems would be connected to a manifold and discharged through vents on the plant roof. Vents would be located away from plant ventilation intakes and would be located on the leeward side of the CPP. Exhaust fans for these systems would create a negative flow, ensuring that air would not enter the process areas from the vessels or systems. Redundant fans would be of identical size and capacity and would operate only when primary fans are down for repair or maintenance. The general plant area HVAC system would reduce further the radon exposure risks to personnel in the CPP. The general plant area ventilation system would circulate air within the CPP by exhausting air outside the building, forcing fresh air in. The general plant area HVAC system would be designed to provide a minimum of 6 air changes per hour, which would require fans sized to generate an intake flow rate of 300,000 cubic-feet per minute (cfm). Module buildings would have ventilation systems consisting of a roof- or wall-mounted fan as well as a separate radon

ventilation system with an intake located in the module building sump and exhaust point on the building roof (Strata, 2011a).

By describing the major components of the plant in sufficient detail and providing drawings showing the location and layout of the proposed ISR facilities (Strata, 2011a), the applicant has addressed SRP Section 3.2.3 acceptance Criterion (1) (NRC, 2003). Additionally, the staff observes that the processing plant design and proposed equipment are similar to those used in the ISR industry. For these reasons, these aspects of the proposed facility are acceptable to the NRC. SRP Section 3.2.3 acceptance Criteria (2), (3), and (4) address the areas where dust, fumes, or gases made occur and the monitoring of those areas. The applicant provides information on these criteria, which staff reviews and evaluates in SER Sections 4.1 and 5.7.3.

3.2.3.2 Controls

The applicant describes occupational and environmental safety controls in Section 3.2.9 of the Technical Report (Strata, 2011a). Throughout the CPP, the release of hazardous compounds to the atmosphere would be mitigated by staged filtration, as well as water scrubbing equipment installed in all ventilation circuits. Where particle control is needed, such as in drying and packaging circuits, bag house air filters would be used to ensure that no product is lost to the atmosphere. In acid producing systems, the ventilation systems would contain mist eliminating and recycling systems that feed into secondary particle filtration with discharge monitoring to further ensure containment. As discussed above, radon and possible other gaseous daughter products that can be liberated in the IX and elution transfer process would be captured by ventilation systems and discharged outside of the CPP.

The CPP would employ three levels of containment for liquid process fluids and effluents: process tanks, secondary containment berms, and an impermeable liner below the building foundation.

The staff finds that the controls and monitoring features planned for the processing plant are similar to those in use in the ISR industry, which have been shown to be protective of human health and the environment. The staff concludes that the applicant has proposed monitoring parameters that are important to operation of the facility. Because the information in the application describes the control features that would be used at the facility to protect radiological health and safety, the application is consistent with SRP Section 3.2.3 (NRC, 2003). Strata described plans for eliminating or mitigating the hazards in accordance with SRP Section 3.2.3 acceptance criteria (5) and (7). For these reasons, these aspects of the proposed facility are acceptable to the staff.

3.2.3.3 Chemical Storage Facilities

The applicant states in Section 3.2.8 of the Technical Report that chemical storage and feeding systems would include some or all of the following: sulfuric and/or hydrochloric acid, sodium hydroxide, hydrogen peroxide, carbon dioxide, oxygen, sodium chloride, sodium carbonate, barium chloride, anhydrous ammonia, and non-process related chemicals such as gasoline, diesel and propane (Strata, 2011a).

Process chemicals would be located either in the CPP or in the chemical storage area. The chemical storage area would be located adjacent to the CPP (Strata, 2011a). The chemical storage area would be divided into two areas, one of which would be enclosed in a building and one outside. Chemicals stored outside within the chemical storage area would include oxygen (if

stored at the CPP), ammonia, and carbon dioxide. Areas within the CPP and chemical storage area would be provided with secondary containment, which would consist of concrete berms as part of the floor of each area. Berms would divide areas to ensure that there is no mixing of incompatible fluids in the event of a leak or spill. Several of the chemicals handled in the uranium recovery process would be highly corrosive. Concrete floors, secondary containment, and sumps in areas where corrosive fluids could be spilled would be coated with corrosion resistant materials as recommended by the manufacturer. Pre-leach tanks, leaching tanks and thickeners would be of plain carbon steel construction lined with chlorobutyl or bromobutyl rubber and capable of operating at 175 F in a highly acidic environment. Elastomeric linings also would be used to resist abrasion from the slurries in these tanks. All slurry piping would use materials that are abrasion and corrosion resistant and solution piping would be appropriately corrosion resistant.

Non-process related chemicals that would be stored at or near the proposed CPP include gasoline, diesel and propane (Strata, 2011a). Due to the flammable and/or combustible properties of these materials, all bulk quantities would be stored outside of the CPP in a designated hydrocarbon storage area. All liquid storage tanks would be located above ground within secondary containment structures designed to accommodate at least 110% of the volume of the largest tank in the containment structure. If the aboveground hydrocarbon storage capacity exceeds 1,320 gallons, Strata has indicated it would prepare a Spill Prevention, Control, and Countermeasure (SPCC) plan in accordance with EPA requirements in 40 CFR Part 112.

All chemical storage tanks would be clearly labeled to identify the contents. Design criteria for chemical storage and feeding systems include applicable regulations of the International Building Code (IBC), National Fire Protection Association (NFPA), Compressed Gas Association (CGA), Occupational Safety and Health Administration (OSHA), Resource Conservation and Recovery Act (RCRA), and the Department of Homeland Security (DHS).

The applicant’s identification of applicable Federal and State regulations to ensure proper handling of hazardous chemicals is consistent with SRP Section 3.2.3 acceptance Criterion (6) (NRC, 2003). Additionally, the applicant has described the chemicals that would be used on site; the storage methods, and the potential impacts on radiological health and safety. The staff reviewed the chemicals, storage methods, and potential impacts on radiological health and safety and finds the applicant’s proposal is consistent with the SRP Section 3.2.3 acceptance Criterion (5) (NRC, 2003). In SER Section 6.1.3.2, staff evaluates the use and storage of reductants for aquifer restoration. One chemical used for a reductant is hydrogen sulfide, for which the use and storage poses significant safety issues. Because the applicant did not evaluate safety issues associated with the use and storage of hydrogen sulfide, staff includes a license condition, presented in SER Section 6.1.4, prohibiting use and storage of a reductant until the applicant evaluates all associated safety issues. Therefore, with the information presented on the applicant’s proposed use and storage of chemicals, and the noted license condition, the staff finds this information acceptable.

3.2.3.4 Geotechnical Study at the CPP Area

In Addendum 3.1-A (Strata, 2012b), the applicant provides results of a geotechnical study at the CPP area. The geotechnical study provides site information to be incorporated into the design of the retention ponds, containment barrier wall and dewatering system (see SER Section 4.2).

The geotechnical study evaluated the use of the subsurface soils as an adequate foundation for the structures in the CPP area. The safety concern for NRC staff in the geotechnical study is twofold. First, staff will evaluate the proposed diversion of the stream around the CPP area to ensure that future flooding is minimized during the life of the CPP area. Flooding of the CPP area would affect the operations involving both source and byproduct material. Second, the CPP area has a shallow water table. A shallow water table is able to trap air under the retention pond liners which may create a situation where the pond liner is "floating". A floating pond liner will impact the storage capacity and create a situation where the ponds are unusable.

3.2.4 EVALUATION FINDINGS

The staff reviewed the proposed equipment to be used and materials to be processed in the recovery plant and chemical storage facilities at the Ross Project in accordance with the review procedures and the acceptance criteria in SRP Section 3.2.2 and Section 3.2.3, respectively. The applicant described the equipment, facilities, and procedures that would be used to protect health and minimize danger to life or property.

Based upon the review conducted by the staff as indicated in SER Section 3.2, the information provided in the application meets the acceptance criteria of SRP Section 3.2.3 and thus meets requirements of 10 CFR 40.32(c) and will meet requirements of 10 CFR 40.41(c), if issued a license.

3.3 INSTRUMENTATION AND CONTROL

3.3.1 REGULATORY REQUIREMENTS

The staff determines if the application has demonstrated that the instrumentation and control proposed for the Strata Ross Project meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.3.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria in Section 3.3.3 of the SRP (NRC, 2003).

3.3.3 STAFF REVIEW AND ANALYSIS

Information in SER Section 3.3.3, unless otherwise stated, is from Section 3.3 of the Technical Report (Strata, 2011a). In Section 3.3, Strata describes the instrumentation and control that would be used in the processing plant at the facility. The applicant provides a description of the instrumentation and controls at the wellfields and module buildings (header houses) in Section 3.1.7 of the application.

The Master Control System (MCS) would reside at the CPP. Flow rates and line pressures would be monitored throughout the CPP at all key points in the process to manage and guide plant operations. In addition, level controls would be used in all tanks. The system would also have pressure-indicating transmitters on all pressurized tanks such as IX vessels and pH metering and control in the eluant system. The differential pressure across the IX and elution vessels would be monitored closely and used to trigger alarms and automatic shutdown sequences should the values exceed the safe limit. Level, pH, temperature, and flow also would be monitored throughout the site and used to automate to the desired level. The system would be controlled by the MCS with alarms and automatic shutoff capability built into the

control system at appropriate limits for each individual monitoring and control point. All pumps and motors would have individual Hand-Off-Auto hand switches and would be monitored and controllable through the MCS system. The overall control system would be designed so that appropriate redundancy exists for safe plant operation. Critical pumps would have backup pumps designed into the system such that if a failure occurs, the pumping operation can be easily controlled. Redundancy would also occur from installing multiple monitoring points for each process. If a monitoring point fails, other monitoring points can be used to provide an indication of plant conditions while a monitoring point is checked for replacement or repair.

Instrumentation and logging of the yellowcake dryer would include all parameters that are important to the efficient operation of the dryer and its safety features (Strata, 2011a). Monitored parameters would include: oil temperature in and out; off-gas temperature and pressure; and dryer pressure. Alarms and automatic shutoff switches would activate whenever these parameters are out of normal operating ranges. Hourly records of all important parameters would be collected and stored on site for a minimum of 3 years in accordance with 10 CFR, Part 40, Appendix A, Criterion 8.

Flows and pressures for the main injection and recovery trunklines would be monitored continuously and displayed at the CPP control room. Changes in flow or pressure that are outside of normal operating parameters would result in the activation of visual and audible alarms and eventually automatic sequential shutdown of pumps and control valves if the condition is not corrected promptly. The flows and pressures of the injection/recovery feeder lines and the individual injection/recovery wells would be monitored locally at the module buildings and on a display located at the CPP control room. If flows and pressures are not maintained within a set operating range, a visual and audible alarm would be activated at the CPP. Leak detection sensors would be located in the module building sumps and the valve manholes, which would trigger audible and visual alarms at the location and at the CPP if fluid is detected. Strata may also utilize dual leak detection in these areas, which would consist of two sensors at high and low levels within the containment systems. When fluid is detected at the first sensor, an audible and visual alarm would be triggered at the location and at the CPP. If fluid is detected at the second sensor, automatic pump shutdown would occur to prevent the fluid from overflowing the containment system and contaminating the surrounding environment. Sensors located in the wellhead sumps would detect piping and fitting leaks.

Staff reviewed the proposed monitoring network and notes that the applicant proposes to monitor parameters that can provide information on how the plant is operating. The staff concludes that monitoring of these parameters, combined with alarm set points would provide the operators with the ability to recognize and address problems that might arise. The NRC staff concludes that the applicant has identified instrumentation, monitoring parameters and processes, including wellfield pressures, yellowcake dryer parameters, and backup systems that are consistent with staff observations of practices at operating ISR facilities. By providing this information, the applicant has addressed all of the SRP Section 3.3.3 acceptance criteria 1-5 (NRC, 2003). Therefore, these aspects of the facility and approaches to overall control are acceptable to the staff.

3.3.4 Evaluation Findings

The NRC staff has completed its review of the instrumentation and control techniques proposed for use at the Strata Ross Project. This review included an evaluation using the review procedures in SRP Section 3.3.2 and the acceptance criteria in SRP Section 3.3.3. The instrumentation and control systems have been acceptably described for components, including

the wellfields, wellfield houses, trunk lines, and all plant systems. As discussed in SER Section 3.3.3, the instrumentation would allow for continuous monitoring and control of systems, including flow rates for total inflow to the plant, total waste flow exiting the plant, and liquid levels. Appropriate alarms and interlocks would be part of the instrumentation systems. Each control system would be equipped with an acceptable alternative that allows for shut down of the system in the event of an emergency or power failure.

Based on the information provided in the application and the staff's detailed review of the instrumentation and control for the Strata Ross Project, the staff concludes that the proposed instrumentation is acceptable and is in compliance with 10 CFR 40.32(c) and 10 CFR 40.41(c), if issued a license.

3.4 REFERENCES

Buswell, M. D., 1982. Subsurface Geology of the Oshoto Uranium Deposit, Crook County, Wyoming (Master's Thesis), South Dakota School of Mines and Technology, Rapid City, SD, In Appendix 2.6-A of Ross ISR Project USNRC License Application, Crook County, Wyoming, prepared by Strata Energy, Inc., Docket No. 040-09091. ADAMS Accession No. ML110120063, May 1982.

NRC, 2003. NUREG-1569, "Standard Review Plan for In-Situ Leach Uranium Extraction License Applications—Final Report", Washington, DC., June 2003.

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Stoick, A. F., 1977. "Application for a New Source Material License, Sundance R&D Project, Wyoming", Nuclear Dynamics, Inc., ADAMS Legacy Accession no. 9811120004, November 1977.

Stoick, A. F., 1979a. "Source Material License No. SUA-1331 Third Quarterly Report: Period Ending January 31, 1979", Report from Nuclear Dynamics to NRC, ADAMS Legacy Accession no. 7903190560, February 1979.

Stoick, A. F., 1979b. "License No. SUA-1331 Fourth Quarter Report: Period Ending April 30, 1979", Report from Nuclear Dynamics to NRC ADAMS Legacy Accession no. 7907060502, May 1979.

Stoick, A. F., 1979c. "License No. SUA-1331, Docket No. 40-8663", Letter report from Nuclear Dynamics to NRC regarding a leak in the vicinity of the casing for well I-1, ADAMS Legacy Accession no. 7908090364, June 1979.

Stoick, A. F., 1979d. "Source Material License No. SUA-1331: Sundance Project: Fifth Quarter Report: Period Ending July 31, 1979 ", Report from Nuclear Dynamics to NRC ADAMS Legacy Accession no. 7909290527, July 1979.

Strata, 2011a. Ross ISR Project USNRC License Application, Crook County, Wyoming, prepared by Strata Energy, Inc., Docket No. 040-09091. ADAMS Accession No. ML110120063, January 2011.

Strata, 2012a. Responses to the Request for Additional Information (RAI) for the Ross ISR Project Environmental Review Docket No. 040-09091. ADAMS Accession No. ML121030404, March 2012.

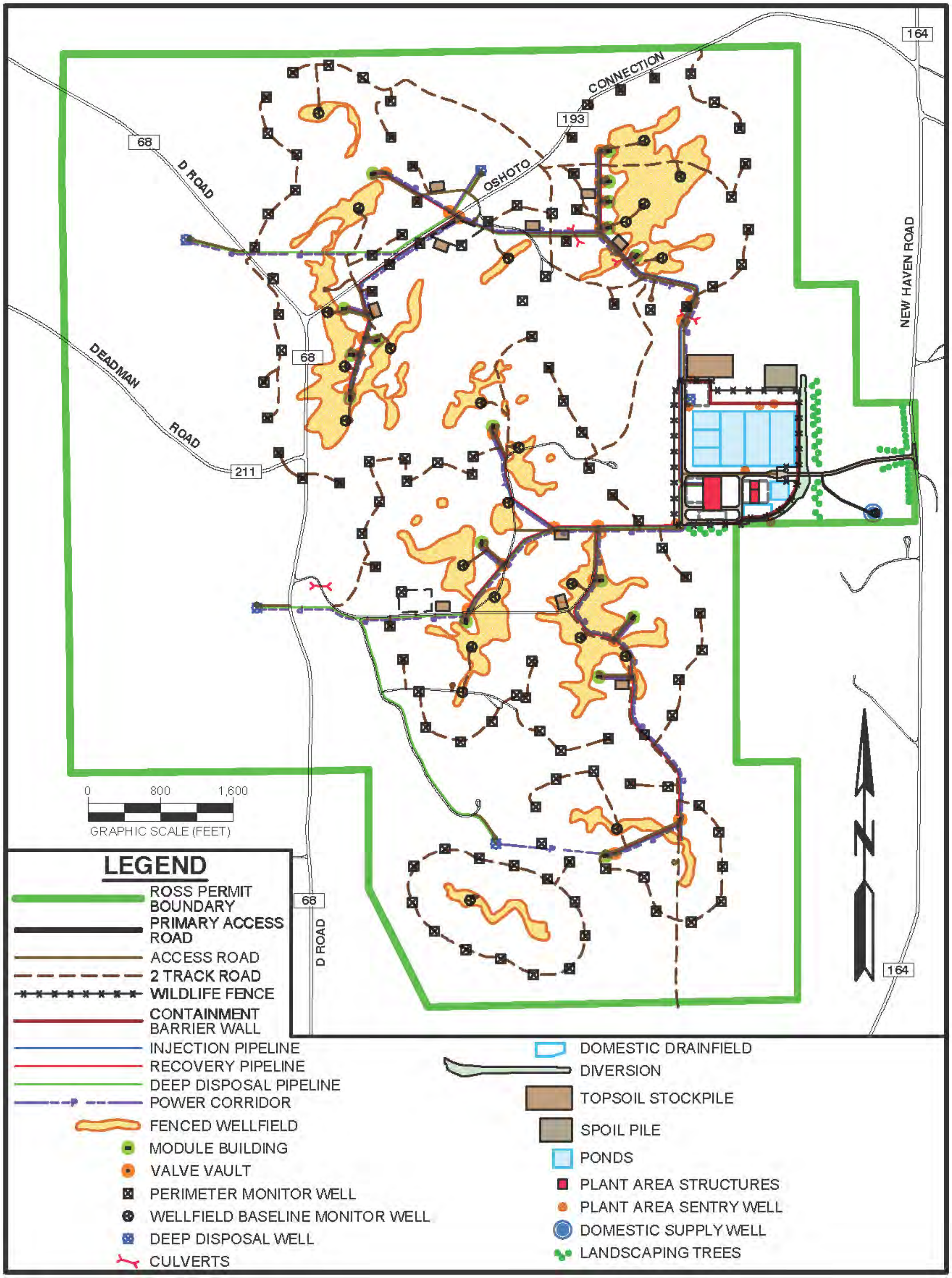
Strata, 2012b. Responses to the Request for Additional Information (RAI) for the Ross ISR Project Technical Review, Docket No. 040-09091. ADAMS Accession No. ML121020343, April 2012.

Table 3.1-1 Summary of the Proposed Lixiviant Makeup

Parameter	**Range**
Na	< 400 to 6,000
Ca	<20 to 500
Mg	<3 to 100
K	<15 to 300
CO_3	<0.5 to 2,500
HCO_3	<400 to 5,000
Cl	<100 to 5,000
SO_4	<400 to 5,000
U_3O_8	<1 to 700
V_2O_5	<1 to 400
TDS	<1,000 to 12,000
Ra-226	<300 to 2,000
pH	<6 to 8

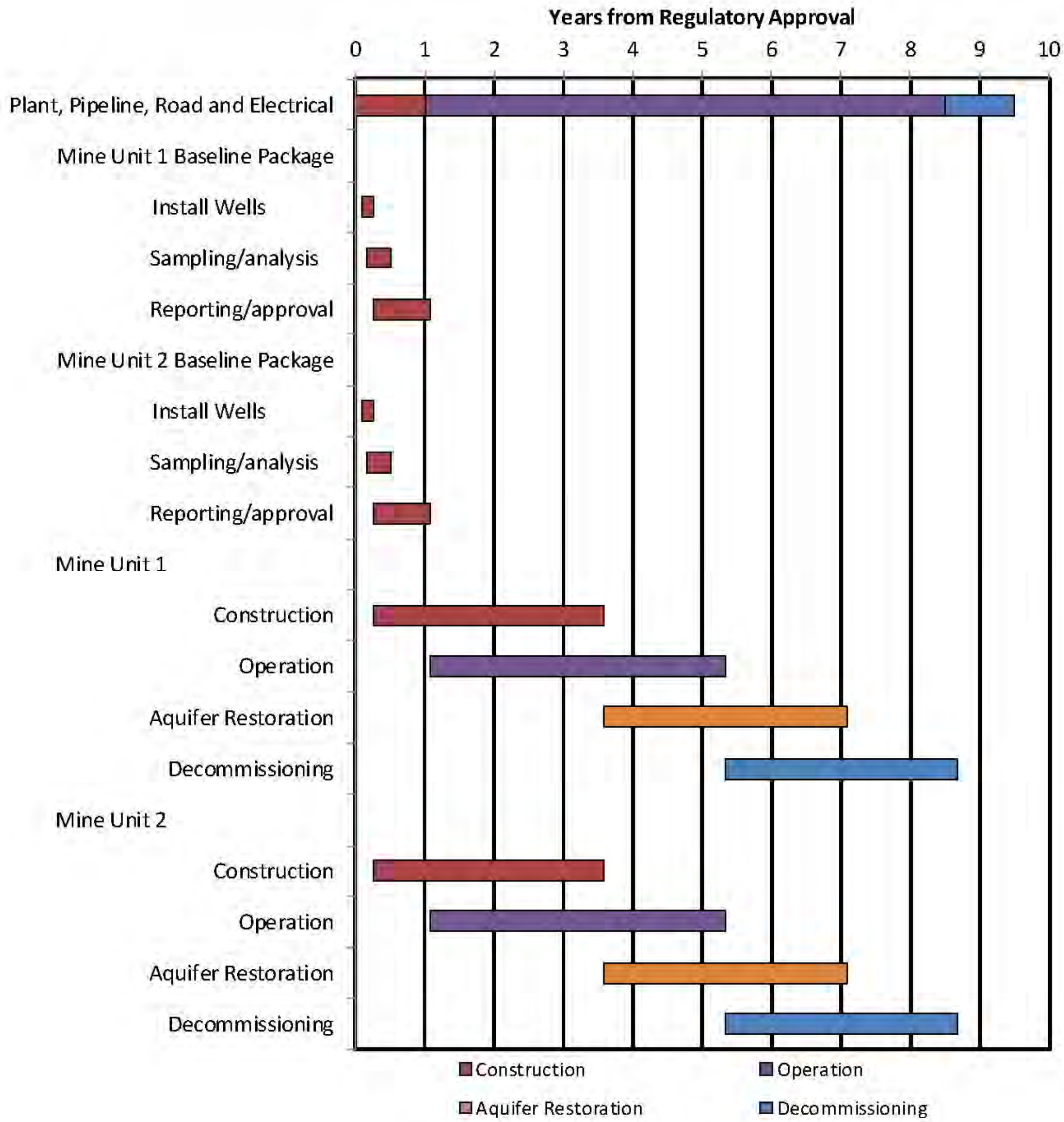
* All values are in mg/L except pH, which is expressed as standard units, and Ra-226, which is expressed in pCi/l.

Source: Table 3.1-1 (Strata, 2011a)



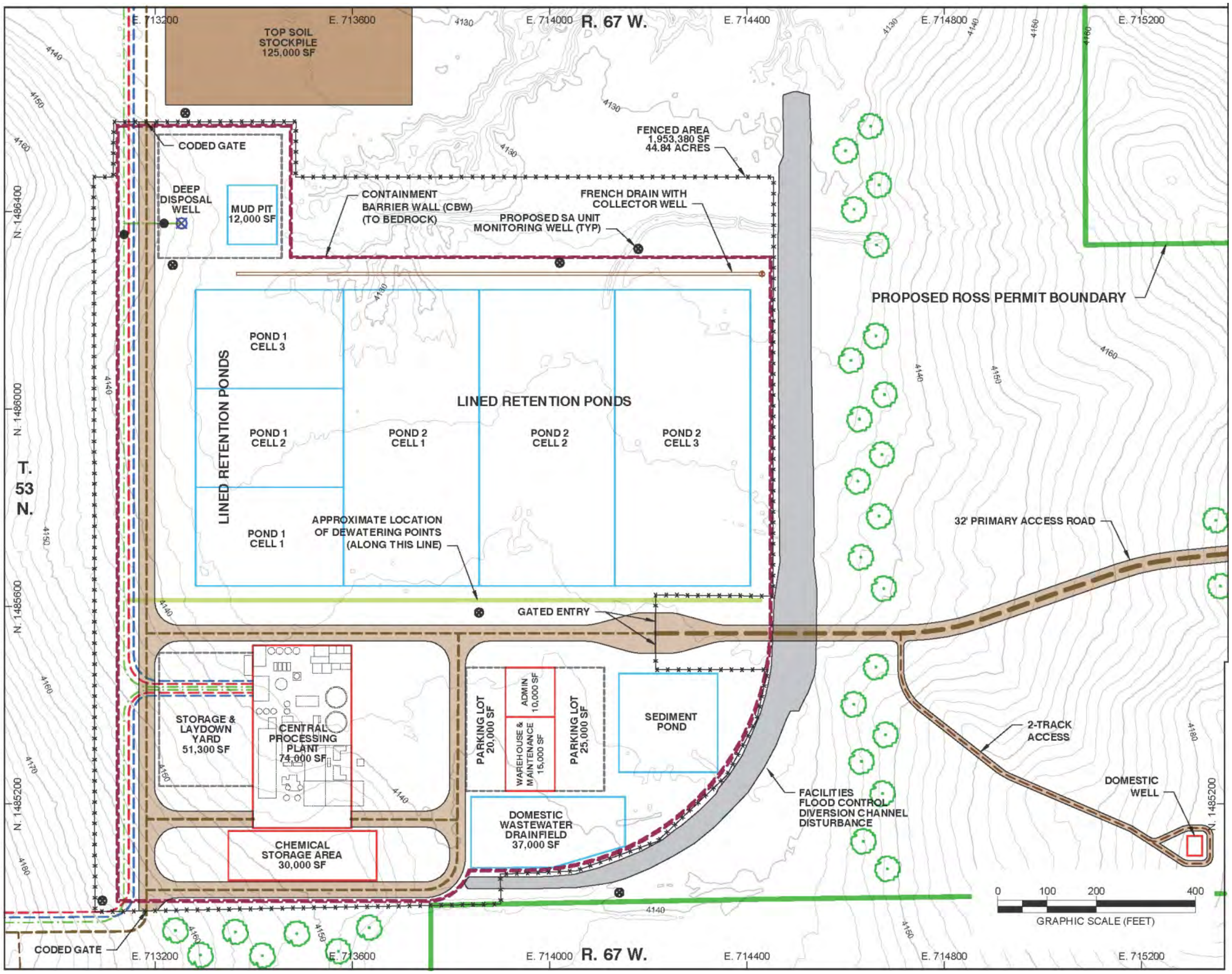
Source: Figure ER RAI GEN-1-3 (Strata, 2012a)

Figure 3.1-1 Location of Ore Bodies at the Ross Project



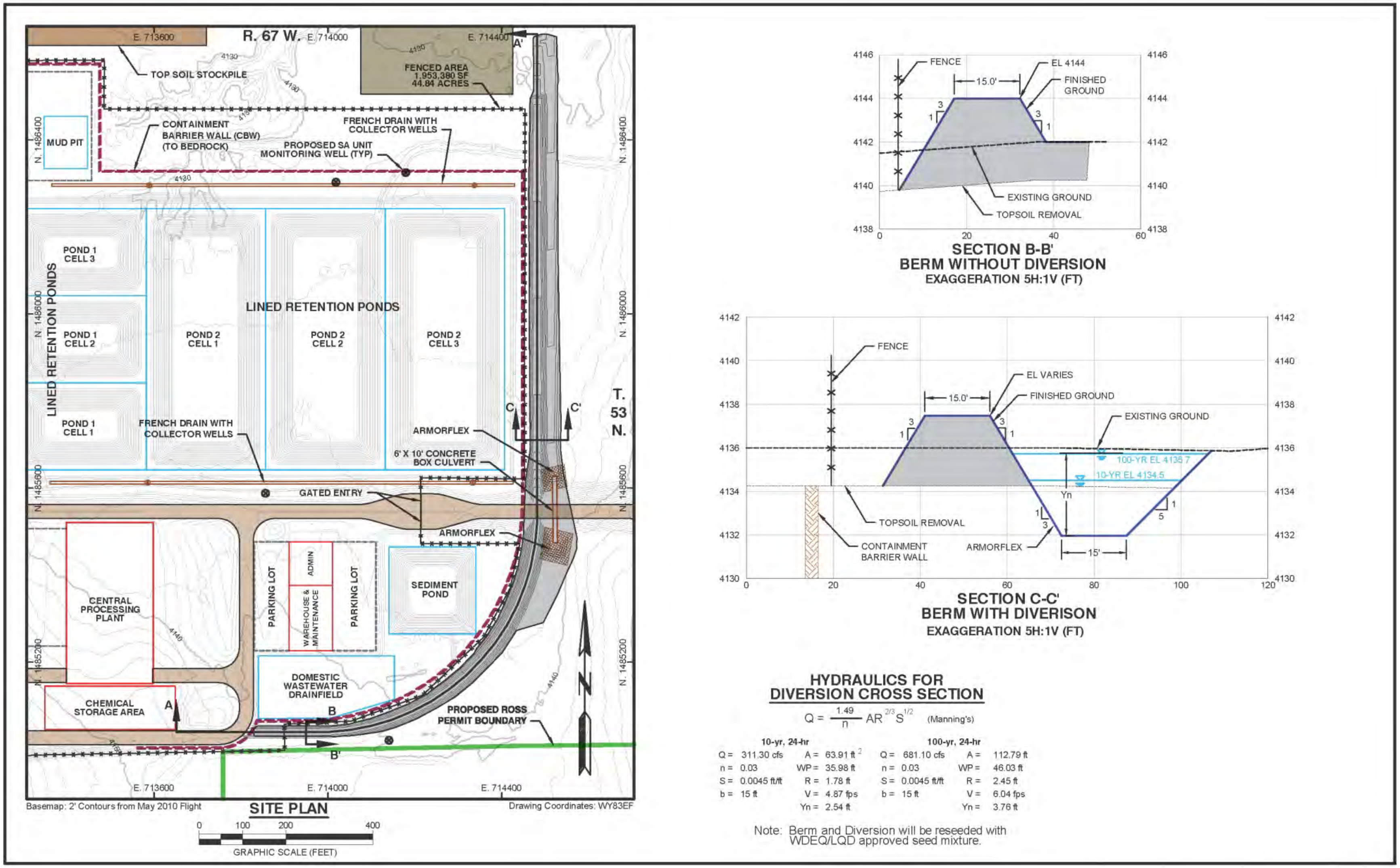
Source: Figure 1.9-1 (Strata, 2011a)

Figure 3.1-2 Ross Project Proposed Schedule



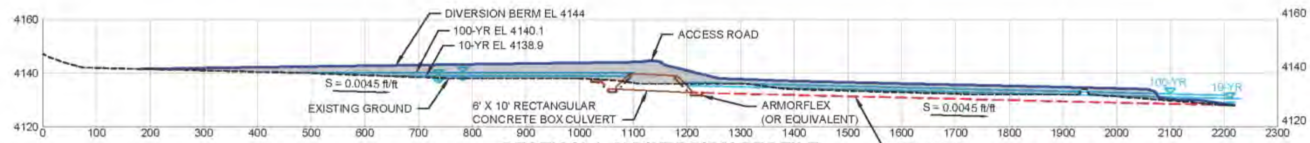
Source: Figure 3.1-16 (Strata, 2011a)

Figure 3.2-1 Central Processing Plant Area Layout



Source: Figure 3.1-18 (Strata, 2011a)

Figure 3.2-2 Diversion Component Layout and Designs (1 of 2)

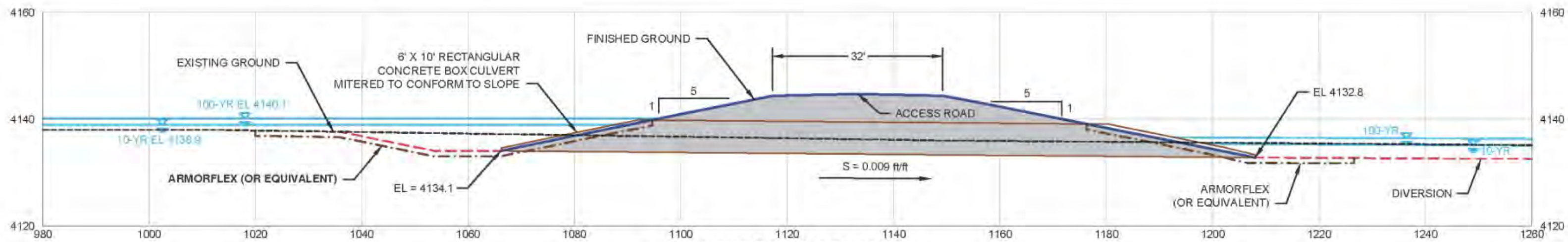


SECTION A-A' DIVERSION PROFILE
EXAGGERATION 5H:1V (FT)

HYDROLOGIC DESIGN STORM CALCULATIONS[1,2,3] (HEC-HMS)

DRAINAGE BASIN PARAMETERS			10-YR, 24-HR STORM			100-YR, 24-HR STORM		
DRAINAGE AREA (sq-mi)	CURVE NO. (CN)	WATERSHED LAG TIME (hrs)	10-YR, 24-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)	100-YR, 24-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)
1.65	78	1.26	2.8	311.3	87.0	4.2	681.1	180.2

NOTES: 1. RUNOFF VOLUMES AND PEAK INFLOWS WERE COMPUTED BY THE HEC-HMS COMPUTER PROGRAM USING THE SCS TYPE II RAINFALL DISTRIBUTION
2. SEE FIGURE 2.7-3 FOR DRAIN
3. SEE TR SECTION 2.7 FOR METHODOLOGY



CULVERT ROAD CROSSING

HYDRAULICS FOR
CULVERT ROAD CROSSING 10-YR

DISCHARGE GOVERNED BY WEIR FLOW

$$Q = C_d A(2g(H_W - Y_C))^{1/2}$$

$Q_{10,24}$ = 311.3 cfs g = 32.2 ft/s^2
Cd = 0.95 H_W = 4.83 ft
A = 31.11 ft^2 Y_C = 3.11 ft

Note: Hydraulic calculations according to Brater & King, 1976.

HYDRAULICS FOR[1,2]
CULVERT ROAD CROSSING 100-YR

DISCHARGE GOVERNED BY ORIFICE FLOW CONDITIONS

$$Q = C_d A(2g\Delta h)^{1/2}$$

$Q_{100,24}$ = 681.1 cfs
g = 32.2 ft/s^2 Δh = 3.54 ft
A = 50.47 ft^2 C_d = 0.894
T_w = 3.76 ft

Notes: 1. Hydraulic calculations according to Brater & King, 1976
2. Water surface elevation determined by adding the Δh and T_w to outlet elevation

Source: Figure 3.1-18 (Strata, 2011a)

Figure 3.2-2 Diversion Component Layout and Designs (2 of 2)

4.0 EFFLUENT CONTROL SYSTEMS

4.1 GASEOUS AND AIRBORNE PARTICULATES

This section discusses the basic design and operation of the gaseous and airborne particulates effluent control systems for ISR facilities. Effluent control systems serve to (a) prevent and minimize the spread of gaseous and airborne particulate contamination to the atmosphere using emission controls, and (b) ensure compliance for radiation dose limits to the public.

4.1.1 REGULATORY REQUIREMENTS

For gaseous and airborne particulates generated at the Ross ISR Project, the staff determines if Strata Energy, Inc. (Strata or the applicant) has demonstrated compliance with 10 CFR Part 40, Appendix A, Criterion 8, which requires milling operations to be conducted so that all airborne effluent releases are reduced to levels as low as reasonably achievable (ALARA). The applicant must also demonstrate that 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

The staff reviewed the application for compliance with the applicable requirements in 10 CFR Parts 20 and 40 using the acceptance criteria in Standard Review Plan (SRP) Sections 4.1.3 and 5.7.1.3 (NRC, 2003) that apply to effluent controls. Effluent monitoring is addressed in SER Section 5.7.7, Effluent and Environmental Monitoring.

4.1.3 STAFF REVIEW AND ANALYSIS

The following sections present the staff's review and analysis of various aspects of the gaseous and airborne particulates that the applicant will generate at the Ross ISR Project, as well as the equipment and systems that the applicant proposed to use to control the release of these radioactive materials to the atmosphere. Review areas addressed in this section include identification of (a) major discharge release points; (b) ventilation, filtration, and confinement systems to be used to control the release of radioactive materials to the atmosphere; and (c) airborne radioactive effluents.

4.1.3.1 General

The applicant states in Section 4.1 of the technical report (Strata, 2011a) that the expected airborne radioactive materials released during normal operations will be principally radon-222. The applicant states it expects only minor, incidental releases of radioactive airborne particulates from yellowcake and minor, incidental releases of airborne particulates from non-radioactive effluents, such as fumes from laboratory chemicals, gases from the operation of internal combustion engines, and particulates from wind erosion and earth disturbing activities, during normal operations (Strata, 2011a). NRC staff notes that a dryer is not the only source of radioactive airborne particulates. Radon-222, a radioactive gas with a 3.8-day half-life, decays to several solid particles that tend to be electrically charged and can deposit on surfaces or attach to dust particles (Mohamed et al., 2008). Radon progeny can build-up in buildings, such as the module buildings, if the ventilation is not adequate to ensure complete air exchange.

NUREG/CR-6733 also states that spills of radioactive liquids can be a source of air particulates and pose an inhalation hazard if the spills dry before they are cleaned (Mackin et al., 2001).

4.1.3.1.1 Ventilation Systems

The applicant provides information in Sections 4.1.2, Radioactive Gaseous Emissions and Control Measures, and 5.7.1, Effluent Control Techniques, of the technical report (Strata, 2011a) that described the modes of ventilation to control radon effluents in the plant, module buildings, and wellfields. The staff concludes that the applicant's description of the ventilation system is consistent with acceptance Criterion (3) in SRP Section 4.1.3 and acceptance Criterion (1) in SRP Section 5.7.1.3 (NRC, 2003) by providing sufficient detail describing the ventilation systems intended to control radon effluents and by following Section 3.3 of Regulatory Guide 8.31, as described below. The applicant provided the following details in its technical report (Strata, 2011a):

- Plant
  - o Passive ventilation or natural ventilation includes doors and overhead doors to reduce radon levels;
  - o General area ventilation or wall and area fans to provide an adequate exchange of air in the plant where radon is likely to gather; and
  - o Point source ventilation from tanks and process equipments or direct ventilation to the roof or outside of the plant using a stack and, in some cases fans, to increase ventilation flow rate.

- Module Buildings (Header Houses)
  - o Area ventilation consists of a roof or wall fan drawing from the basement of the module building and exhausting out of the roof of the module building; and
  - o Passive ventilation includes opening doors that allows cross-ventilation with fans to reduce radon levels.

The applicant states that wellfields would rely on passive or natural ventilation to control radon effluents at the wellheads, but wellhead enclosures may be vented (Strata, 2011a).

The staff finds that the description of the natural and engineered ventilation systems provided by the applicant, and discussed in more detail in SER Sections 4.1.3.2 and 4.1.3.3, is consistent with the guidance for ventilation and exhaust fans in Section 3.3 of Regulatory Guide 8.31 (NRC, 2002b). The staff finds that the description follows the Regulatory Guide's recommendations for limiting airborne concentrations in buildings. The staff also finds that the applicant located discharge stacks away from building ventilation intakes, as recommended in Regulatory Guide 8.31 (NRC, 2002b), to minimize exposures in accordance with 10 CFR 20.1101(b).

4.1.3.1.2 Control Systems for Airborne Effluents

The applicant describes the operating capacity, air exchange rates, and specifications of the ventilation systems in Section 4.1.2 of the application and provides the layout of the system in Technical Report Figure 5.7-1 (Strata, 2011a). The applicant states that the ventilation system will circulate air in the CPP by replacing air within the building with fresh air by expelling air outside of the building, which forces fresh air from outside into the building. The applicant states that it will design the CPP HVAC to provide a minimum of six air changes per hour with

an intake flow rate of 141.6 m^3/s (300,000 cfm). The applicant will exhaust air through ducts to a wet scrubber before it discharges air to the atmosphere in a stack above the roof. Strata will duct and filter all releases from vented equipment before it discharges the air outside of the building. The applicant plans to monitor fan performance at the point of discharge from the filtration equipment (wet scrubber). The applicant will use two exhaust fans, one serving the negative pressure system area, and one serving the CPP system scrubber area as illustrated in Technical Report Figure 5.7-1. The applicant will monitor air quality within the plant to determine if the emission controls are operating sufficiently to maintain ALARA (Strata, 2011a).

The staff finds that:

(1) the applicant's proposed effluent control systems are appropriate for the types of effluents generated;
(2) the applicant's performance specifications for the operation of the effluent controls are consistent with those recommended in Regulatory Guide 3.56, Section 1 (NRC, 1986a); and
(3) similar control systems are employed at existing ISR facilities that have been shown to be effective in minimizing exposures to workers, public and the environment.

Based on the above, staff finds that the control systems for airborne effluents are consistent with acceptance Criterion (2) of SRP Section 4.1.3 and Criterion (4) of SRP Section 5.7.1.3. Furthermore, with that finding and the inclusion of license conditions in SER Section 5.7.7.4, staff has reasonable assurance that the applicant will implement its airborne effluent and environmental monitoring program as designed.

4.1.3.2 Airborne Uranium

In Section 4.1.3 of the technical report (Strata, 2011a), the applicant states that a vacuum-paddle dryer will process its dry yellowcake and describes its operation in Section 3.2.4 of the technical report. A vacuum-paddle dryer dries yellowcake at a temperature of 422ºK (149ºC or 300ºF) or less (Strata, 2011a). The applicant states that the yellowcake dryer and packaging system will operate on a batch basis (Strata, 2011a). The applicant will discharge the sufficiently dried yellowcake through a bottom feed port of the dryer into 55-gallon drums. The applicant states that the feed port will be fitted with a rotary air lock valve, which creates a sealed and pressurized system to guard against contaminating the surrounding area with uranium particulates, as illustrated in Technical Report Figure 5.7-3. The applicant describes a local ventilation system consisting of a yellowcake-packaging hood that fits on the top of the drum and rotary airlock valve. The operator visually monitors filling the drum with yellowcake during the drying process through a viewport in the hood.

The applicant states that it will inspect seals once per shift to identify possible ruptures that could potentially release yellowcake particulates into the drying room atmosphere. The applicant states that if a seal rupture occurs, Strata will change the applicable process parameters immediately. The applicant states that although the likelihood of an unnoticed seal rupture is low, Strata addressed the potential ramifications of this situation in Technical Report Section 7.5 (Strata, 2011a).

The applicant will vent off-gas from the dryer to the atmosphere after filtering the off-gas for airborne uranium particulates through a bag house filter system. Uranium solids collected on the bag filter surfaces within that system will be periodically returned to the drying chamber. The system also includes a condenser located downstream of the bag house filters, which will be water cooled. Uranium particulates that pass through the bag filters will be wetted and

entrained in the condensing moisture within this unit. Lastly, a vacuum pump will capture the entrained uranium particulates from the condensing fluids into a gas that is captured by the vacuum pump and discharged back to the dryer room (Strata, 2011a).

In Technical Report Section 5.7.1.1.2 (Strata, 2011a), the applicant states that the dryer off-gas system will have instrumentation to provide an audible and/or visual alarm if the vacuum level is outside specifications. These instruments will operate automatically and cause the dryer to shut down if breakdowns, such as vacuum system failure, occur. The applicant states that it will inspect ventilation and effluent control equipment as recommended in R.G. 3.56 (NRC, 1986a). The applicant states the operator will perform and document inspections of the differential pressure or vacuum every operating shift. The applicant also states that if the system alarms because of off normal conditions in the emission control system, the operator will follow SOPs to recover from the alarm condition, and the dryer will not be unloaded or reloaded until the emission control system is returned to normal service (Strata, 2011a).

The applicant states that, by design, vacuum dryers discharge no airborne uranium particulates during normal operations (Strata, 2011a).

In technical report Section 3.2.4 (Strata, 2011), the applicant commits to develop SOPs for the handling of the full yellowcake drum after the drying operations. The SOPs will include procedures to ensure that the yellowcake is sufficiently cool to prevent pressure build up in the drum and accidental explosive release of airborne uranium particulates, sealing of the drums after the cooling period and storing the drums for future shipment. During the loading process for shipment, the applicant states that no airborne uranium particulates will be released.

The staff's evaluation determined that airborne uranium particulate releases from vacuum dryer operations are very low (NRC, 2003); however, based on SRP acceptance Criterion (3), staff is required to review uranium particulate emissions resulting from drying and packaging operations and spills. Staff reviewed the applicant's control and monitoring system for the drying and packaging operations, as described above, and finds that the bag house air filtration unit mounted directly above the drying chamber maintains a negative pressure that minimizes airborne uranium particulate emissions. The water-cooled condenser downstream of the bag house ensures that uranium particulates that pass through the bag filters will be wetted and entrained in the condensing moisture within this unit. Lastly, the staff finds that the vacuum pump will capture entrained uranium particulates. The staff finds from the applicant's description that when the process dries the yellowcake sufficiently, it will be discharged from the drying chamber through a chute into drums below.

The staff finds that the applicant's design of the ventilation system and controls, if operated as designed, will be sufficient to maintain airborne concentrations of natural uranium and its daughters in the workplace to less than 25% of the Derived Air Concentration (DAC) given in Table 1 of Appendix B to 10 CFR Part 20, as recommended in Regulatory Guide 8.31 (NRC, 2002b). Furthermore, the staff finds that the applicant's design for the dryer emissions control equipment, which consists of a bag house, condenser, and a vacuum pump, also provides local ventilation for the yellowcake-packaging hood. The staff finds the dryer emission control equipment and associated alarm systems are (1) state of the art and (2) consistent with equipment, controls and alarms employed at existing ISR facilities that the NRC staff finds achieve radioactive releases that are within 10 CFR Part 20 limits and exposures that are ALARA.

The staff finds that the applicant's commitment to use SOPs for loading and packaging yellowcake drums acceptable. Staff acknowledges that insufficient cooling of the yellowcake prior to sealing a drum has occurred at uranium recovery facilities in the past (NRC, 1999a;2012a).[37] The applicant's proposed procedures includes sufficient cooling time which is consistent with or exceeds procedure requirements as described in NRC (1999).

Criterion 8 of 10 CFR 40, Appendix A requires that licensees conduct checks of all parameters that determine the yellowcake emission control efficiency and that licensees log these checks hourly. The licensee shall determine if equipment is operating consistently near peak efficiency and take corrective action when performance is outside of prescribed ranges. Further, the applicant must ensure that effluent control devices are operative at all times during drying and packaging operations and whenever air exhausts from the yellowcake stack. The staff concludes that the applicant has operating procedures and instrumentation to ensure that the yellowcake dryer emissions control equipment will be operational during yellowcake drying operations. The staff concludes that this is consistent with the 10 CFR Part 40, Appendix A, Criterion 8 requirements for checks of emissions control system operability and is acceptable to protect public health and safety from airborne uranium particulate releases.

In Section 5.7.7 of the technical report (Strata, 2011a), the applicant describes its monitoring program for radioactive materials and effluents. The descriptions include monitors to assess workers exposure, adequacy of the monitors for the expected radioactive materials in the effluent, and the locations of the monitors based on airflow patterns. In SER Section 5.7.7, staff finds the applicant's monitoring program meets the acceptance criteria in Section 5.7.7.3 of the SRP (NRC, 2003), as supplement with license conditions noted in SER Section 5.7.7.4.

Staff finds that the applicant did not commit to not resuming packaging operations until the vacuum system is operational to draw air into the system, which the staff finds is a safety precaution used in the uranium industry to ensure the system is operating to prevent inadvertent release of uranium particulates outside of the dryer. Although the applicant did commit to shutting down the dryer if the vacuum system fails, staff includes a license condition in SER Section 4.1.4 that requires the vacuum system to be operational prior to startup of the dryer operations, which is consistent with uranium industry practices.

Staff evaluated the applicant's (a) emergency procedures to be followed in the event of equipment failures or spills, (b) the health and safety impacts of system failures, and (c) contingencies for such occurrences in SER Sections 5.7.1.3 and 7.3, and has found them acceptable. Consequently, staff finds that the applicant's procedures for accident conditions that may potentially release airborne uranium particulate releases is consistent with acceptance Criterion (4) in SRP Section 4.1.3 (NRC, 2003). Based on staff's review, and supplemented with the noted license condition, staff finds that the proposed controls on and monitoring for airborne uranium particulate release are consistent with those used at existing facilities, which have demonstrated adequate controls on personnel exposures.

4.1.3.3 Radon

In Sections 3.2.9, 4.1.2 and 5.7.1.1.1 of the technical report (Strata, 2011a), the applicant states that radon-222 gas is the primary radioactive effluent at the proposed project. Sources of the

[37] In the 1990s and 2012, newly filled yellowcake drums were sealed without sufficient cooling time. As a result, pressure built up in the drum which, upon opening at the next phase of processing (at a conversion facility), was rapidly released and spread yellowcake over a wide area.

radon-222 gas is off-gassing of radon from radon dissolved in the production (lixiviant) and restoration solutions extracted from the wellfields and piped to the CPP. Consequently, the applicant states that potential radon releases may occur within the CPP and wellfields (Strata, 2011a).

Within the CPP, the applicant states that the areas of potential radon gas releases are solution spills, filter changes, IX resin transfer operations and maintenance and areas of concern for potential radon exposure include the IX vessels, desanding system, resin transfer area and fluid collection sumps (Strata, 2011a). The IX vessels will be equipped with the vents to the CPP venting system. The desanding system, shaker screens in the resin transfer area and sumps will be equipped with exhaust hoods and redundant exhaust fans (Strata, 2011a). The ventilation for these areas will create negative pressure ensuring that air flows from the process area to the vent.

The applicant states that the general area ventilation systems will exhaust radon-222 released inside to outside the building to minimize occupational exposures. The applicant states in Section 4.1.2 of the technical report (Strata, 2011a) that it will reduce and eliminate potential radon exposures to workers using general area ventilation that directs radon outside the buildings using high-volume exhaust fans. According to the applicant, general area ventilation exhaust fans are expected to provide six air changes per hour (300000 cubic feet per minute) (Strata, 2011a).

Within the wellfields, the applicant states that minimal amounts of radon gas may be released from the wellheads, module buildings and lined retention ponds. The applicant commits to fitting the wellhead with vents or developing SOPs for accessing the wellheads to ensure radon exposures to personnel who are performing inspection or maintenance activities are minimized. The module buildings will be fitted with ventilation specifically for radon gas.

From the CPP or wellfields, the radon gas will ultimately be directed to the atmosphere. The applicant included all potential radon sources in the MILDOS calculation for the off-site public dose. Routine monitoring of radon and its progeny within the CPP will form the basis of worker dose assessment for internal dose (Strata, 2011a).

The staff finds that the applicant's design of the ventilation system and controls will be sufficient to maintain airborne concentrations of radon and its progeny in the workplace to less than 25% of the Derived Air Concentration (DAC) listed in Table 1 of Appendix B to 10 CFR Part 20. Regulatory Guide 8.31 (NRC, 2002b), Section 3.3 recommends that ISR facilities use ventilation systems and controls in an effort to prevent the existence of airborne radioactivity areas, as defined in 10 CFR 20.1003. Maintaining airborne concentrations of radon and its progeny at less than 25% of DAC will ensure that a facility complies with § 20.1701, which requires "the use, to the extent practical, process or other engineering controls (e.g., containment or ventilation) to control the concentration of radioactive material in air." The staff finds that the applicant's operational monitoring and control systems for radon in the buildings are consistent with acceptance Criteria (1) and (2) of SRP Section 4.1.3 and Criterion (1) of Section 5.7.1.3 of the SRP (NRC, 2003). The proposed systems are, thus, acceptable to the staff.

4.1.3.4 Non-Radioactive Effluents

The applicant states in TR Section 4.1.2 that internal combustion engine emissions would be the primary source of non-radioactive gaseous effluent (Strata, 2011a). Strata anticipates small

releases from drilling and construction equipment, wellfield utility trucks, and vehicles supporting wellfield operations and transportation of staff to/from the site. The applicant states that these emissions would include carbon monoxide and dioxide (CO, CO2), sulfur dioxide (SO2), mono-nitrogen oxides (NOx), particulate matter with a diameter of 10 µm or less (PM10), and total hydrocarbon (THC). Strata states that it would generate fugitive dust during all operation phases from events such as, wind erosion of disturbed land and stockpiles, heavy equipment disturbance of soil, and transport vehicles traveling on access roads. The applicant describes fugitive dust mitigation plans in Section 5.6 of the environmental report that include immediate revegetation of disturbed areas, using speed limits, and chemical dust suppressants to minimize dust.

The applicant also states that the vanadium dryer might emit vanadium oxides and ammonia in the vanadium precipitation, drying and packaging circuits. Similarly, to a uranium dryer, the vanadium dryer operates under a vacuum that contains most emissions. Filtration treats condensed off gas to remove water vapor ammonia. A wet scrubber removes ammonia and ammonium sulfate from the vented fumes from the vanadium tanks, which are then recycled to the vanadium precipitation system (Strata, 2011a). The NRC staff finds that the applicant adequately described anticipated non-radiological emission sources and methods to minimize or mitigate adverse impacts from these sources. The NRC concludes that the applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life and property from the effects of the non-radioactive airborne effluents.

4.1.4 Evaluation Findings

The staff reviewed the proposed effluent control systems for gaseous and airborne releases of radioactive materials for the Ross ISR Project in accordance with Sections 4.1.3 and 5.7.1.3 of the SRP (NRC, 2003). The applicant described the release points and sources of both uranium and radon at the Ross ISR Project. In Sections 4.1.1 and 7.5 of the technical report (Strata, 2011a), the applicant provides information on the radiological impacts from normal and accidental releases, and commits to providing worker training and spill control procedures to ensure that the personnel are adequately trained to respond to all potential accidents. The applicant has committed to meeting 10 CFR Part 20 occupational and public dose limits, and maintaining these doses ALARA.

The applicant, however, did not commit to not resuming packaging operations until the vacuum system is operational to draw air into the system. Therefore, staff will include the following facility specific license condition to ensure compliance with this requirement in 10 CFR 40, Appendix A, Criterion 8:

Facility Specific License Condition 10.21:

> Emission Controls (Dryer). The licensee shall maintain effluent control systems as specified in Sections 3.3.1, 4.1, and 5.7.1 of the approved license application, with the following exception:
>
> If any of the yellowcake emission control equipment fails to operate within specifications set forth in the standard operating procedures, the drying and packaging room shall immediately be closed-in as an airborne radiation area and heating operations shall be switched to cooldown, or packaging operations shall be temporarily suspended. Packaging operations shall not be resumed until the vacuum system is operational to draw air into the system.

All these cessations, corrective actions, and restarts must be reported to the appropriate NRC regional office as indicated in Criterion 8A, in writing, within ten days of the subsequent restart.

Staff finds that the information provided in the application, as supplemented by the license condition above, is consistent with the acceptance criteria in SRP Sections 4.1.3 and 5.7.1.3, and meets the requirements of 10 CFR Parts 20 and 40.

4.2 LIQUIDS AND SOLIDS

In this section, the staff reviews the applicant's estimates of the quantities and composition of waste residuals expected during construction and operation, procedures for management of the waste residuals, design specifications for effluent control systems and plans to obtain necessary permits. The staff addresses radiological impacts from the effluent control systems for liquid and solid radiological waste in SER Section 5.0.

4.2.1 REGULATORY REQUIREMENTS

General requirements for contents of an application for a specific material license issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(h) specifies that an application must clearly demonstrate how requirements and objectives set forth in 10 CFR Part 40 Appendix A are addressed. Technical Criterion 2 of 10 CFR Part 40 Appendix A sets forth requirements and objectives to avoid the proliferation of small waste disposal sites by offsite disposal of byproduct material unless offsite disposal is demonstrated to be impracticable or the advantages of onsite disposal outweighs the disadvantages, and Technical Criterion 6(7) sets forth requirements that licensees address non-radiological hazards associated with wastes in planning and implementing closure.[38] Furthermore, 10 CFR 20.2001 sets forth the requirements for disposal of licensed material. Section 10 CFR 20.2002 sets forth methods for a licensee to request disposal of licensed material not otherwise authorized by NRC regulations, and 10 CFR 20.1101(b) requires that a licensee use procedures and engineering controls based on sound radiation protection principles to achieve occupational doses and doses to the members of the public that are as low as reasonably achievable.

For liquid byproduct material, the regulatory requirements for its disposal through deep well injection depend upon whether or not the material is considered a waste or effluent discharge. Historically, and consistent with the SRP (NRC, 2003), liquid byproduct material disposed of into a deep injection well is considered to be waste. Consequently, the regulatory requirements are found in Section 10 CFR 20.2002, which specifies information needed for NRC to approve procedures, which are not otherwise authorized by 10 CFR Part 20, to dispose of byproduct material.

[38] Criteria in Appendix A are written for conventional mill setting. The conventional mill setting differs from an ISR setting in that (1) at a conventional mill, all activities conducted under the license are performed above ground whereas at ISR settings, the uranium extraction from the ore is performed in situ (or in the subsurface), and (2) at a conventional mill, a solid byproduct material, the mill tailings, is stored above ground in a tailing pile whereas at ISR settings, no mill tailings are generated. Staff is applying these criteria to ISR facilities because 10 CFR 40.31(h) specifies that the application must clearly demonstrate how both the requirements and objectives set forth in appendix A are met.

On the other hand, guidance for a discharge of byproduct material to a deep injection well at a nuclear power plant is considered an effluent discharge. The definitions for effluent and effluent discharge are found in the Glossary for Regulatory Guide 4.1 (NRC, 2009b) as follows:

> *Effluent* means liquid or gaseous waste containing plant-related, licensed radioactive material, emitted at the boundary of the facility (e.g., buildings, end-of-pipe, stack, or container) as described in the [SER].
>
> Effluent discharge (radioactive) means any evolution in which plant-related, licensed radioactive material is released from a system, structure, or component and enters the unrestricted area.

For this classification, the regulatory requirements are found in 10 CFR 20.2001(a)(1), which specifies that the byproduct material may be released as an effluent provided the limits specified in 10 CFR 20.1301 are met.

Staff will follow the guidance in the SRP (NRC, 2003) and treat the disposal of byproduct material as waste.

Regulatory Guide (RG) 3.11 (NRC, 2008) provides guidance for licensees to demonstrate that its design, construction and inspection of embankment retention systems at uranium recovery facilities achieve information collection requirements for 10 CFR Part 20 and Part 40. SRP Section 2.6 (NRC, 2003) provides guidance on areas of review, review procedures and acceptance criteria for staff in reviewing liquid and solid waste control systems in a license application for an ISR facility.

4.2.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria in Section 4.2.3 of the SRP (NRC, 2003), which incorporates guidance in RG 3.11. Additionally, the staff reviewed the application for compliance with the requirements of 10 CFR Part 20 using acceptance criteria 13 in Section 6.1.3 of the SRP.

4.2.3 STAFF REVIEW AND ANALYSIS

Information in SER Section 4.2.3, unless otherwise stated, is from Sections 4.2 and 4.3 of the Technical Report (Strata, 2011a), or Addendum 3.1-A of the Technical Report (Strata, 2011a;2012b)**.**

4.2.3.1 Liquids

The applicant describes the types and quantities of liquid wastes that would be generated at the facility (Strata, 2011a). The applicant divides the liquid waste expected to be generated at the Ross Project into two general categories: AEA-regulated liquid wastes and non-AEA-regulated liquid wastes. AEA-regulated liquid wastes include wastes meeting the definition of 11e.(2) byproduct material as defined by 10 CFR Part 40.4. AEA-regulated liquid wastes (liquid byproduct material) include brine and excess permeate from the treatment of production bleed and aquifer restoration water, decontamination waste water, spent eluate and other process liquids, and “affected” groundwater generated during well enhancement and maintenance

activities (Strata, 2011a).[39] Non-AEA-regulated liquid wastes would include TENORM (technologically enhanced naturally occurring radioactive materials); storm water runoff; hazardous waste such as petroleum products and chemicals; and domestic sewage (Strata, 2011a). TENORM liquid waste includes drilling fluid and "native" groundwater generated during construction and development of monitoring, recovery and injection wells, and groundwater generated during sample collection and aquifer testing of wells.

The staff finds that the types of liquid wastes as identified by the applicant for the Ross Project are consistent with staff's experience at operating ISR facilities. Furthermore, because effluent control systems at those facilities for those types of liquid wastes have been shown to be protective of human health and the environment, staff has reasonable assurance that the applicant will design, construct, and operate similarly effective systems. Therefore, the applicant's descriptions meet acceptance Criterion (1) of Section 4.2.3 and Criterion (13) of Section 6.1.3 of the SRP.

4.2.3.1.1 Liquid Byproduct Material Handling

As described above, the applicant identifies several types of liquid byproduct material that it will generate at the facility. The applicant plans to manage handling of these materials within the process piping as plant makeup water, a system of open retention ponds for storage and ultimately disposal of a portion of waste in underground injection control (UIC) Class I wells, also referred to as deep disposal wells. For the excess permeate byproduct material, the applicant states that disposal of excess permeate liquid byproduct waste may occur through surface discharge.[40]

4.2.3.1.2 Excess Permeate

In Section 3.1.3 of the Technical Report (Strata, 2011a), the applicant proposes treatment of portion of the operational and restoration fluids by a two-phase reverse osmosis (RO) treatment system. The RO treatment system will be housed in the CPP and its purpose is to produce one portion of the fluid that is relatively clean water (permeate) with the other portion with the concentrated salts and other impurities (brine) (Strata, 2011a). The design for the RO system is to produce a permeate:brine at a ratio of 83:17 (the first RO phase is 67:33 permeate:brine and the second phase takes the brine from the first phase and produces 50:50 permeate:brine) (Strata, 2011a). The applicant will discharge to the lined retention ponds excess permeate which is not recycled back to operation or restoration activities (Strata, 2011a). From the ponds, the applicant states that excess permeate may be used as plant makeup water, surface discharged, or injected with brine in the deep disposal wells.

The applicant states that the permeate would be high quality water (i.e., low salt content) and would generally be put to beneficial use (i.e., recycled with reinjected lixiviant to reduce the buildup of salts and other dissolve constituents, or used as a water supply for other operations).

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[39] The terms permeate and brine refer to the two waste streams following treatment of the process fluids through reverse osmosis. The term brine refers to the highly saline waste stream that is often referred to as reject. The applicant anticipates using (recycle) the permeate, or the clean water stream from the RO treatment, onsite in other areas (e.g., plant makeup water). The excess permeate refers to the applicant's expected excess permeate requiring disposal after fulfilling the onsite uses.

[40] Although the applicant proposes a surface water discharge for excess permeate, the NSPS in 40 CFR 40.34 prohibits such a discharge. However, for completeness, the staff identifies the disposal options as proposed by the applicant.

Due to the limited surface area of the lined retention ponds planned for excess permeate storage, evaporation is considered by the applicant to not be a significant permeate disposal option and did not used it in its material mass balances or storage calculations (Strata, 2011a). However, the applicant estimates that excess permeate would evaporate at an average annual rate of 1.5 gpm per acre of exposed surface area.

The applicant estimates that it will produce permeate at the proposed Ross Project throughout the uranium recovery and aquifer restoration activities. During most of the operation, the amount of permeate produced can be used in the operations, which will result in no excess permeate.

Of the three major phases of production (i.e., only active wellfields recovering uranium, active wellfields either recovering uranium or in aquifer restoration, or only active wellfields in aquifer restoration) as discussed in TR Sections 3.1 and 4.2 (Strata, 2011a), the applicant states that it will produce no excess permeate due to high permeate demand in the injection streams for most periods. However, operations without a concurrent wellfield in aquifer restoration (i.e., the active wellfields are recovering uranium), or, the beginning of a concurrent operation (i.e., wellfield undergoing uranium recovery and others in aquifer restoration) would produce excess permeate (Strata, 2011a).

During the operation only phase (Strata, 2011a), the applicant estimates excess permeate flow rate would be approximately 57 gallons per minute (gpm). Excess permeate generated during the concurrent operation or aquifer restoration phases would occur only during the beginning of these phases when the first modules are in groundwater sweep and no modules have begun RO treatment with permeate reinjection. During this time, excess permeate of up to approximately 184.5 gpm would be produced (Strata, 2011a). The applicant proposes surface water discharge, use as plant make-up water, and disposal in Class I deep disposal wells for the final effluent control system to manage excess permeate (Strata, 2011a).

4.2.3.1.3 Brine

As discussed in SER Section 4.2.3.1.2, the applicant will generate brine from the Reverse Osmosis (RO) treatment of the production bleed and treatment of groundwater from aquifer restoration (Strata, 2011a). The applicant proposes two stages of RO treatment for both the production bleed and restoration fluids (for a description of the two stages, see SER Section 4.2.3.1.2) .   The applicant indicates that it will discharge the second phase RO brine into lined retention ponds for storage with eventual disposal in the deep disposal (deep injection) wells. The applicant has selected deep well disposal as the preferred method of brine disposal due to the minimal potential impacts to human health and the environment, and reduced costs compared to other brine disposal alternatives such as evaporation ponds or off-site brine transport (Strata, 2011a). In addition to deep well injection, the applicant considers the effects of brine evaporation in the lined retention ponds in the brine water balance and gaseous effluents.

4.2.3.1.4 Other Byproduct Liquid Waste

Other byproduct liquid waste expected at the Ross Project includes spent eluate, liquid from process drains in the CPP (including spills within the containment barrier), contaminated reagents, resin transfer wash water, filter backwash water, plant wash down water, decontamination water (e.g., employee showers), and fluids generated from work over and enhancement operations on injection and recovery wells (Strata, 2011a). The applicant states that liquid wastes generated in the CPP is to be discharged into the lined retention ponds

through the wastewater collection system, while water collected from swabbing or other work over activities on injection and recovery wells is to be collected in dedicated tanks and transported to the lined retention ponds. The applicant will transport any water captured from leaking pipelines or equipment to lined retention ponds in dedicated portable tanks or tanker trucks. The applicant will combine and dispose other byproduct liquid wastes with brine primarily through deep well injection, with lesser amounts evaporated in the lined retention ponds prior to disposal. The applicant estimates that the generation rate for the other byproduct waste is 25 gpm throughout the life the project (Strata, 2011a)

4.2.3.1.5 Liquid Non-byproduct material

The applicant lists TENORM among its non-byproduct material liquid wastes. TENORM liquid waste includes drilling fluids and drill cuttings from monitoring wells and from the construction and development of recovery and injection wells prior to using the wells for ISR uranium recovery. Strata had discharged TENORM groundwater produced during its baseline activities under a temporary WYPDES permit (Strata, 2011a). The applicant expects that it will discharge other TENORM groundwater generated during the operation and decommissioning phases in a similar manner.

The applicant expects to control storm water management under a WYPDES permit issued by the WDEQ/WQD, and it will design facility drainage to route storm water runoff away from or around the CPP, parking areas, and other associated structures. The applicant will collect any storm water runoff from the paved area around the CPP in a storm drain system and route it to a sediment pond for disposal (Strata, 2011a).

Small quantities of used oil would be generated from equipment and vehicles used at the project. The applicant will temporarily store waste petroleum products on site before transporting the waste to a nearby recycling or disposal facility. Strata anticipates that the proposed Ross Project would be classified as a conditionally exempt small quantity generator (CESQG) by WDEQ/SHWD (Strata, 2011a). A CESQG designation means that a facility generates less than 220 pounds (100 kg) of hazardous waste in any calendar month and stores less than 2,200 pounds (1,000 kg) of hazardous waste at any one time.

Domestic sewage generation would vary throughout the phases of the project based on the number of workers on site (Strata, 2011a). The applicant estimates the peak daily domestic wastewater generation rate to be up to about 6,000 gpd during construction and 800 gpd during normal operations. Domestic waste would be disposed in an on-site wastewater treatment or disposal system. Strata indicates that the system would be designed according to WDEQ/WQD standards and would likely include one or more septic tanks for primary treatment. Septic tank effluent would likely be disposed in a gravity or pressure-dosed drain-field. Based on the anticipated peak daily flow rate greater than 2,000 gpd, Strata anticipates that the drain-field would be permitted as a Class V UIC facility through WDEQ/WQD.

The staff considers the applicant's approaches to liquid non-byproduct material management described above acceptable as the applicant has identified plans for surface discharge, septic system, recycling, or disposal of these materials that are consistent with acceptance Criterion (1) in SRP Section 4.2.3 (NRC, 2003), and consistent with the waste streams that are generated and managed satisfactorily at existing ISR facilities. Additionally, the applicant has identified State permits that are required for disposal of liquid non-byproduct material. By identifying the State permits required, the staff finds that the applicant has addressed acceptance Criterion (7) in SRP Section 4.2.3.

4.2.3.1.6 Surface Water Discharge

The applicant proposes to discharge excess permeate to surface waters. For such a discharge, the applicant states that it will obtain a permit to discharge through the Wyoming Pollutant Discharge Elimination System (WYPDES). Based on existing ISR facilities, the applicant anticipates that any WYPDES permit will include radiological effluent limits that are equal to or less than the established limits for discharge of radionuclides to the environment in 10 CFR Part 20, Appendix B, Table 2, Column 2. These limits are based on Annual Limits of Intake (ALI) of radionuclides for occupational exposure.

The applicant discusses several treatment alternatives for the excess permeate prior to any surface water treatment (Strata, 2011a). The excess permeate would be treated to achieve uranium effluent limits in the IX columns. The applicant states it does not anticipate thorium-230 and lead-210 levels at concentrations above the limits; however, if concentrations were above the limits, the applicant will treat the effluent as necessary to satisfy the WYPDES effluent limits. The applicant will treat radium-226 in the lined retention ponds by adding barium chloride to the liquid waste to co-precipitate radium-226 with barium sulfate. The technology for radium removal by barium chloride is well established (Strata, 2011a).

WDEQ/WQD would establish effluent limits designed to protect the receiving water(s), including effluent limits for radionuclides and other constituents. The actual WYPDES effluent limits likely would be less than the 10 CFR Part 20, Appendix B, Table 2, Column 2 standards (Strata, 2011a). Therefore, adherence to these effluent limits would ensure that doses from surface discharge of excess permeate are ALARA (Strata, 2011a).

Staff finds that treatment of the excess permeate to levels that meet the standards in 10 CFR Part 20 is ALARA and protective of human health and the environment if released as an effluent to the environment. However, a license condition will require the applicant to obtain all necessary permits, including the WYPDES permit, for a surface water discharge. As discussed below, staff anticipates that the applicant will not be able to obtain a WYPDES permit for a surface water discharge for a new ISR facility and thus staff did not include the surface water discharge option for disposal of byproduct material in its evaluation of the wastewater mass balance.

Under authority of the Clean Water Act, the EPA promulgated regulations in 40 CFR Part 440 to address limitations on direct discharges from the ore mining and dressing point source category. The New Source Performance Standards in 40 CFR 440.34 prohibit new discharges of “process wastewater” from ISR facilities. Therefore, the applicant would not be able to obtain a WYPDES for “process wastewater” from mills using “in situ leach methods.” Based on 40 CFR 440.132, the definition of in-situ leach methods means “the purposeful introduction of suitable leaching solutions into a uranium ore body to dissolve the valuable minerals in place” but the definition specifically excludes “the rehabilitation of aquifers.” The Statement of considerations for 40 CFR Part 440 further elaborates the basis for this definition by explaining that EPA considers ISR operations during recovery of uranium as an “active mine” subject to requirements of 40 CFR Part 440 whereas aquifer restoration operations as an “inactive mine” not subject to requirements of 40 CFR Part 440.

Surface water discharge through a temporary, storm water or construction permit may be possible for the applicant to pursue for non-byproduct material.

4.2.3.1.7 Plant Make-Up Water

The applicant proposes that excess permeate may be used for various processes in the CPP, including elution and precipitation (Strata, 2011a). The required flow rate for plant make up water would range from 10 to 40 gpm depending on the production rate of the uranium elution and precipitation circuits. Use of excess permeate for the plant make-up water would not require additional treatment or handling equipment or procedures.

4.2.3.1.8 Class I Deep Disposal Wells

The applicant proposes disposal of brine and excess permeate through injection to five on-site Class I deep disposal wells (Strata, 2011a). Where possible, the applicant states it would employ one of the other methods discussed in its application to maximize beneficial uses of the relatively high quality permeate. However, this disposal method is the only option proposed by the applicant for disposal of brine.

The applicant has received Class I UIC permits for five deep wells from WDEQ (WDEQ, 2011). The receiving formations for the fluid injections are the Cambrian-age Deadwood and Flathead formations, both of which are at least 500 feet below the lowermost potential USDW, the Madison Formation (Strata, 2011a). The estimated depths for the target formations range from 8,160 to 8,560 feet below ground surface. The receiving Cambrian formations are confined above by the Ice Box Shale member of the Winnipeg Group, which is overlain by the Red River Formation. The Red River Formation also separates the Deadwood and Flathead Formations from the Madison Formation. Granitic and metamorphic rocks of the Precambrian basement provide the lower confining interval for the Deadwood and Flathead Formations. Based on the anticipated porosity, thickness, lateral extent, and permeability of the receiving formations, the applicant estimates that it expects the injection capacity for each Class I deep disposal well to range from 35 to 80 gpm.

The applicant indicates that the deep disposal wells would be constructed according to WDEQ/WQD Class I disposal well construction standards, including a casing from ground surface to a distance of at least 100 feet below the base of the lowermost potential USDW (Strata, 2011a). Strata also would perform regular monitoring and perform internal and external MITs in accordance with WDEQ regulations and conditions of the UIC permit. The applicant will constantly monitor pressures and flow rates for the piping and the disposal well at the CPP. The applicant will use the brine tank along with the lined retention ponds for any necessary brine surge capacity.

To issue the UIC permit, WDEQ verifies that the injected fluids are isolated from the accessible environment, including potential sources of drinking water. Use of deep disposal wells also requires an NRC finding that the applicant meets the requirements in 10 CFR 20.1301 and 20.2002. As identified in 10 CFR 20.2002, an application seeking approval for a waste disposal method under this regulation shall 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.
- 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.

The applicant provides the anticipated material characteristics of the excess permeate and brine in Tables 4.2-2 and 4.2-5 of the technical report, respectively (Strata, 2011a). By providing details on the characteristics of liquid byproduct material, the applicant has met acceptance Criterion (13) in Section 6.1.3 (NRC, 2003). Therefore, the staff finds these descriptive tables to be acceptable.

The applicant will route liquid wastes that would be disposed of in the deep disposal wells from various sources throughout the project, into the lined retention ponds. The ponds would be equipped with double liners and leak detection system. The applicant will pump liquid waste from the lined retention ponds to brine tanks at the CPP and then distribute the liquid waste to the deep disposal well locations. Surface equipment at the deep disposal well locations would consist of pumps, filters, meters, valves, recording devices, wellhead monitoring instrumentation, and control valves.

As stated above, Strata's proposed Class I deep disposal wells would target the Cambrian-age Deadwood and Flathead formations. The estimated depths of these formations range from 8,160 to 8,560 feet below ground surface within the project area. The Deadwood Formation is described as a very fine- to fine-grained sandstone with low to fair porosity. The applicant describes the Flathead Formation as a medium to coarse-grained sandstone with good porosity. Additional geologic discussion of the Deadwood and Flathead formations is included in Attachment A of TR Addendum 4.2-A.

According to Chapter 8 of the WDEQ Water Quality Rules and Regulations, the WDEQ classifies groundwater from the Deadwood/Flathead interval as Class VI water and is most likely unsuitable for use. The applicant projects groundwater within this formation to contain TDS concentrations in excess of 10,000 mg/L, which would require extensive treatment for any beneficial use (Strata, 2011a).

The applicant indicates that the closest public water supply wells are the City of Gillette water supply wells approximately 10 to 12 miles from the project area (TR Section 7.4.2). The next closest public water supplies are for Pine Haven at 17 miles away, Hulett at 19 miles away, and Moorcroft at 22 miles away. The wells that supply water for Gillette, Pine Haven, and Hulett are completed in the Madison Limestone formation. The Moorcroft public water supply receives water from the Madison and Lance/Fox Hills formations. The potential to impact these public water supplies would be extremely small due to the geologic separation of these formations from the disposal well injection zone by more than 500 feet.

Strata states that the liquid waste disposal via deep well injection would not involve any foreseeable public radiation exposure because no credible pathway exists by which members of the public could come into contact (via ingestion in particular) with water from these aquifers. The environment within which this waste would be disposed would never be available as a source of domestic water. Accordingly, Strata concludes that the public dose limits in 10 CFR § 20.1301 would be met.

The applicant addresses the potential for public and occupational doses as follows: Regarding the contribution of the deep well injection system surface facilities to the off-site dose to the public, water that would be moved to the disposal wells would have originated from process streams or purge (over-recovery) water. Strata assumes in its source term MILDOS calculation

that 100 percent of the radon entrained in these fluids would be released at these locations. Accordingly, the water entering the waste stream would have had all radon effluent accounted for in the source term. The only radon in the liquid waste sent to deep well injection would be a result of in-growth from radium-226 over the very brief period of time it was stored prior to injection. Staff finds that this amount of radon would be trivial and have no impact as a significant pathway for public exposure.

In regard to potential occupational dose (e.g., relative to the limits of 10 CFR § 20.1201), the exposure potential would be associated with external exposure from the gamma photons coming out of the piping, primarily from the radium-226. There would be very little addition to the gamma ray flux associated with radon progeny (e.g., bismuth-214) in the fluids since the applicant would have released the vast majority of entrained radon earlier in the process (see above).

The excess permeate and brine would have a maximum radium-226 concentration of less than 10,000 pCi/liter. Gamma ray absorption by the piping and the very limited time personnel would be in close proximity to the wells, in combination with the relatively low concentrations of gamma emitting radionuclides in the fluid ensures that occupational exposure associated with this activity would be trivial. Staff finds this evaluation acceptable.

For its deep well disposal plans, the applicant has shown that it would be in compliance with the NRC regulations for the alternate disposal of byproduct material in 10 CFR 20.2002, as well as the dose limits in 10 CFR 20.1301. By providing information on the methods that would be used to control liquid effluents and obtaining a permit from WDEQ for Class I deep disposal wells, the staff finds that the applicant has described liquid waste effluents and disposal methods in accordance with acceptance criteria (1), (2), (7), and (8) in SRP Section 4.2.3 (NRC, 2003). Therefore, Strata's plans are acceptable to the NRC staff.

4.2.3.1.9 Lined Retention Pond Design

The applicant states that it plans two lined retention ponds as part of the waste storage infrastructure at the Ross Project. The primary purposes of the retention ponds are to manage permeate and brine inflows, to optimize disposal techniques and to provide for waste storage in the event of accident conditions (Strata, 2011a).

Strata indicates that each pond consists of three cells that would be built utilizing common containment berms. Interconnected piping within the ponds would allow the transfer of liquids between cells (Strata, 2011a). The ponds would include double liners and leak detection systems and the applicant would design the ponds to meet the recommendations in NRC Regulatory Guide 3.11 for embankment retention systems. Pond cells would be trapezoidal, with maximum interior slopes of 3H:1V. Ponds would be approximately 17 feet deep and mostly incised to minimize embankment fill and the volume of water that could be released during an embankment failure. Pond embankment crest widths would be 25 feet with 3H:1V maximum exterior slopes. The applicant would place road surfacing on pond embankments to allow access to pond infrastructure and monitoring/inspection. The applicant would also install a system to deter avian wildlife from landing in the retention ponds (Strata, 2011a).

Strata's preliminary evaluations of the surficial aquifer at the CPP site indicate that shallow groundwater is present at depths ranging from 8-12 feet below grade. Current proposed pond depths extend up to 14 feet below grade. In order to mitigate the effects of the surficial aquifer on the ponds, Strata proposes to install a containment barrier wall (CBW) around the perimeter

of the CPP area. The applicant would dewater groundwater levels in the area inside the CBW by a series of wells/French drains located within the CBW boundary see SER Section 4.2.3.1.9.7).

Strata provides a report including designs and site geotechnical investigation for facilities within the proposed Central Processing Plant (CPP) area at the proposed Ross Project, particularly the retention ponds and their associated analyses. Staff's review includes an assessment of: (a) information related to the site of the retention ponds, including the soil conditions; (b) design and construction details of the ponds; operation; and (c) closure and decommissioning of the ponds. The remainder of this section addresses specific retention pond design components (Strata, 2011a).

4.2.3.1.9.1 Retention Pond Site Characterization

The applicant completed a subsurface investigation to support the construction of the ponds and other site features (Strata, 2012b). The drilling program during 2011 consisted of drilling and sampling 78 shallow boreholes aimed at obtaining specific geotechnical and groundwater information at the locations of the various facilities and components associated with the CPP.

The surficial, unconsolidated, Quaternary-age deposits consist of a sequence of very fine-grained, locally derived, sediments deposited by alluvial, colluvial, and eolian processes. These deposits, collectively referred to as valley fill, are generally soft, brown and often mottled, predominantly sandy and silty clay with occasional thin to very thin lenticular layers of poorly to moderately well-sorted, fine- to coarse-grained sands and secondary pebbly, clay-rich sands. The soft, cohesive clays near the ground surface often display visible salt crystals, which is indicative of upward transport and precipitation of dissolved saline minerals from shallow groundwater (Strata, 2011a). In the CPP area, the valley fill deposits range from just a few feet to over 30 feet thick.

Bedrock materials underlying the valley fill consist of very fine-grained terrestrial sandstone, siltstone, mudstone, claystone, and occasional thin lenses of carbonaceous mudstone and coal. Based on all the available borehole logs, the applicant developed seven geologic cross sections depicting the valley fill and shallow bedrock in the CPP area.

Soil specimens were collected during Strata's 2011 geotechnical investigations from each of the test holes using various means, including California tube samplers, SPT split spoon samplers, Shelby tubes, a CME hollow stem continuous sampler, and bulk samples. For all the samples submitted for testing, Atterberg Limits and minus #200 sieve grain size tests were performed in order to classify the soils. Additional testing performed on selected samples included Standard Proctor density testing, permeability testing, triaxial strength testing, pH tests, water soluble sulfate tests, resistivity testing, chloride percent tests, swell and consolidation tests, and unconfined compressive strength tests.

Strata used open-hole water level measurements in conjunction with water level measurements from the observation wells to develop a water table map in the CPP area. The water table contours illustrate that shallow groundwater moves from the highland areas west and south of the CPP area via saturated Lance Formation bedrock strata and discharges to the overlying valley fill deposits.

Staff's review of the boring logs indicates that there has been adequate coverage of the site, the applicant has conducted appropriate testing, and the subsurface soil properties are relatively consistent near the retention ponds.

4.2.3.1.9.2 Slope Stability

The applicant states that the proposed retention pond designs will not be covered under the National Dam Safety Program because the proposed impoundments do not meet the criteria listed in RG 3.11 (NRC, 2008).

The applicant performed two slope stability analyses on embankments surrounding the lined retention ponds at critical pond cross sections ((Strata, 2011a;2012b). The first slope stability analysis evaluates the ponds' interior slope at Pond 2, Cell 3, and the second analysis evaluates the ponds' exterior slope at the maximum fill section that is located in Pond 2, Cell 1. The applicant obtained material properties for the slope stability analyses from drilling samples. The computer program GeoStudio 2007 Slope/W© module was used to generate the slope stability analyses. The program uses Morgenstern-Price general method of slices to determine minimum factors of safety. The analyses are based on the maximum loading, which is comprised of the weight of the water at the high water level, weight of the embankment, seepage and earthquake forces (NRC, 2008). The computer program output is in the form of a factor of safety. Factor of safety is the ratio of the available shear strength to the developed maximum shear stress and it is used by staff to evaluate potential failures (NRC, 2008).

For the interior slope analysis, the applicant assumed that the pond contained no water and that the phreatic surface had been drawn down to a level below the floor of the pond. The presumption that the phreatic surface was below the floor of the pond appears to be contradictory to requirements of Criterion 5A(5) of Appendix A to 10 CFR Part 40 which states that it must not be presumed that the liner system will function without leakage. The applicant states that it designed the embankments with the presumption that the liner system could leak during the active life of the impoundment (Strata, 2012d). The applicant concludes that a steady-state phreatic surface through the embankment would not develop during a leak for the following reasons: First, Strata proposes a compacted clay liner below the geo-synthetic liner with permeability less than 1.0×10^{-5} cm/s that would extend to the top of the embankment. Second, the normal or operating water level in the ponds would be primarily below the existing ground surface. The applicant would incise ponds to the greatest depth possible in order to reduce the potential for impounded volumes acting upon the embankment (i.e., the extent of the embankment above grade (*i.e*., dike) is minimal). Third, Strata would install a leak detection system in the pond to alert operations personnel to any upset condition. In accordance with NRC Regulatory Guide 3.11 and as the applicant indicates in TR section 5.3.2, daily inspections of the ponds that include pond water elevation, signs of leakage, erosion, cracking and liner damage would be conducted. In the event of liner perforation and subsequent leakage, corrective action would occur quickly. Fourth, as discussed in SER Section 4.2.3.1.9.7, the dewatering system for the CPP area will be designed and monitored to ensure the water table (phreatic surface) is below the bottom of the pond during operations. The staff agrees that these measures prevent the possibility of a steady-state phreatic surface developing within the embankment. For the exterior slope analysis, the applicant assumed that the pond was in an emergency situation and the water level was at the high water level (i.e, maximum loading) (Strata, 2012b).

The applicant performed a static and pseudo-static analysis of the long-term stability condition for the ponds. The pseudo-static analysis uses a seismic coefficient of 0.05, which is

recommended for this seismic zone and verified by staff. Results of the analyses indicate that the minimum factor of safety for the analyses exceeds the 1.5 and 1.0 minimum values for static and pseudo-static analyses recommended in RG 3.11 (NRC, 2008).

The staff concludes that Strata has demonstrated that the storage ponds would be stable under anticipated loading conditions.. By demonstrating the stability of the retention ponds, the staff finds the applicant has shown that this approach is consistent with acceptance Criterion (4) in SRP Section 4.2.3, which 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 with Regulatory Guide 3.11, Section 2 (NRC, 2008), which outlines acceptable methods for slope stability and settlement analyses

4.2.3.1.9.3 Settlement

The applicant indicates that the foundation for the ponds is comprised of predominantly sand and silty clay (Strata, 2012b). According to laboratory testing of a sample collected by the applicant, its bearing strength is approximately 15,000 lb/ft^2. The applicant design for the ponds is to have a maximum water depth of approximately 14 feet (HWL) that would result in an application of approximately 873.6 lbs/ft^2 to the pond foundation material (Strata, 2012b). The applicant concludes that, considering the bearing strength of the foundation material, settlement of the pond is not anticipated. The staff reviewed Strata's evaluation of settlement of the storage ponds. The staff observes that applicant's evaluation considered the loading conditions near the storage ponds and that the applicant based the evaluation on the soil conditions identified during the site characterization. For these reasons, Strata's approach meets acceptance Criterion (4) in SRP Section 4.2.3 (NRC, 2003) and is consistent with the settlement analyses guidance in Section 2 of Regulatory Guide 3.11. Therefore, the applicant's methods are acceptable to the NRC staff.

4.2.3.1.9.4 Liquefaction Potential

Liquefaction occurs principally in uncompacted cohesionless saturated clean sands and silty sands. The applicant states that the soils in this area have a relative density of 20%-30% and are not clean sands or silty sands. The materials in the CPP area are predominantly CL (clean clays) and CH (fat clays). In addition, the applicant would maintain the phreatic surface elevation at a minimum of one foot below the floor of the pond. Therefore, it is unlikely that liquefaction would occur due to the material types. The staff determined that soils with these characteristics are typically not susceptible to liquefaction; therefore, no further analysis is warranted. Because the applicant submitted information documenting that liquefaction is not a concern, the staff finds this aspect of the storage pond design meets the acceptance Criterion (3) in SRP Section 4.2.3 (NRC, 2003). Therefore, this approach is acceptable to NRC staff.

4.2.3.1.9.5 Freeboard and Capacity

The freeboard analysis for the lined retention ponds considers the highest water level at which the applicant would operate the ponds, which is the High Water Level (HWL). NRC Regulatory Guide 3.11 states that if the applicant designs the impoundments to contain only direct precipitation, the applicant may use a single occurrence of the 6-hour Probable Maximum Precipitation (PMP) in determining the storage capacity and freeboard requirements. Strata's grading plan for the storage ponds showed that it would divert surface water runoff around the ponds (Strata, 2011a). Based on Strata's design, the staff finds that the only water that would enter the storage ponds would be either process water, or precipitation that falls directly into the

ponds. The applicant acceptably calculated the 6-hour PMP to be 22 inches at the proposed project area. The HWL is the maximum operating water level in the ponds and would provide a minimum of 3 feet of freeboard. Therefore, the HWL freeboard would be sufficient to contain the 6-hour PMP of 22 inches. Under HWL conditions, the freeboard is also sufficient to contain the calculated wave run up of 2.98 feet (calculated assuming 80 mph winds). Under normal operating conditions, the applicant would operate the ponds at the Normal Water Level (NWL), which would provide sufficient storage capacity in the event that brine or permeate from a leaking pond cell needs to be transferred into other cells within a pond. The normal water levels for Pond 1 and Pond 2 provide ample freeboard for containment of the 6-hour PMP and wave action combined. The applicant would rarely operate the ponds at the HWL, and the probability of this occurring during the 6-hour PMP event combined with 80 mph winds is low. Therefore, the staff finds that the applicant meets acceptance Criterion (2) of SRP Section 4.2.3, and this aspect of the pond design is acceptable to the staff.

The applicant commits to maintaining sufficient capacity between the cells such that the applicant can transfer the contents of an entire pond cell into the other two cells within the same pond in the event of a leak. The pond sizes and capacities reflect the need to store brine and excess permeate from ISR operations for varying lengths of time at the maximum design flow rates. Excess permeate would only be present during two operational periods: operation without concurrent aquifer restoration, and groundwater sweep in the first wellfield module(s) undergoing aquifer restoration. The maximum brine flow rate would occur during the concurrent operation and restoration phase, when the applicant would discharge up to 227 gpm of brine into the ponds.

4.2.3.1.9.6 Liner and Leak Detection

The applicant proposes that each pond would be equipped with a double liner system with a primary and secondary geosynthetic liner. Primary liners would be high density polyethylene (HDPE) or polypropylene (PP) with a minimum thickness of 36 mils. Secondary liners, if a geosythetic liner, would have a minimum thickness of 36 mils; however, the applicant states it is considering using the native clays found in the subsurface as the secondary liner (Strata, 2011a;2012b). The applicant further states that, based on site-specific tests, the permeability of the native material compact to 95 percent of the Standard Proctor will meet the maximum permeability requirements of WDEQ (Strata, 2012b), and if the material does not meet the requirements, additional compaction, soil amendments or replacement of soils will result in the native soils meeting the WDEQ requirements for the secondary liner.

The applicant proposes a leak detection system that would consist of a permeable drainage layer and a collection piping system. The permeable drainage layer directly underlies the primary liner and overlies the secondary liner. This permeable drainage layer provides support for the overlying primary liner and transmits any leakage through the primary liner to collection piping system. The applicant states that the primary drainage layer will be constructed of suitable material (sand) under the floor and a geosynthetic drainage material or Geonet under the sidewalls of the ponds. The collection piping system would convey leakage to riser pipes located on the corners of each pond cell. Pond bottoms and the primary drainage layer would be contoured to slope to the corners in order help identify the quadrant of a leak if one were to occur.

The applicant states that tests will be performed to demonstrate liner resistance to chemicals and any other pertinent analysis required to establish that the structures meet all necessary regulatory requirements (Strata, 2011a).

The staff finds that the applicant's design for the storage ponds to prevent migration of wastes to the subsurface is consistent with acceptance Criteria (2), (3) and (4) of Section 4.2.3 of the SRP (NRC, 2003). The staff finds that the proposed liner system components are acceptable because the components and designs meet the applicable requirements of Criterion 5A(1), Criterion 5A(2), Criterion 5A(4), Criterion 5A(5), Criterion 5E(1) and Criterion 5E(2) in 10 CFR Part 40, Appendix A. In SER Section 4.2.4, the staff includes a license condition to memorialize the applicant's commitments for an inspection program for the impoundment embankments during the life of the facility

Staff acknowledges that Criterion 5E(1) allows the use of native clay but tests of a sufficient duration must be performed to confirm no significant deterioration of the permeability or stability properties of the clay material from exposure to the byproduct material. The applicant commits to constructing the retention pond liners and leak detection systems to meet recommendations in RG 3.11 (NRC, 2008). Under the basic design criteria, RG 3.11 states:

> "*liners and leak detection systems need to be included in the design of retention systems per 10 CFR Part 40, Appendix A, Criteria 5A(1), 5A(2), and 5E(1), and considering EPA requirements in 40 CFR 264.221".*

Under construction considerations, RG 3.11 states:

> *"Much additional information on the characteristics of foundations is obtained during clearing and stripping operations, which may confirm or contradict design assumptions based on earlier geotechnical investigations. Weather and ground-water conditions during construction may significantly alter water contents of proposed fill material or create seepage and/or hydraulic conditions, necessitating modifications in design. Projects must be evaluated and "reengineered" continuously during construction to ensure that the final design is compatible with conditions encountered during construction".*

Under engineering data complication, RG 3.11 states that the data should include the following:

> *"general project data, including regional vicinity maps showing the project location and the upstream and downstream drainage areas, and as-built drawings and photographs of the retention system."*

In SER Section 5.2.4, staff includes a license condition requiring a preoperational inspection by NRC staff prior to operations. During that inspection, NRC staff will verify that the Pond 1 is constructed as designed. As discussed below, staff includes a license condition prohibiting construction of Pond 2 until the dewatering system operations are verified by staff.

4.2.3.1.9.7 Hydrostatic Uplift and Dewatering System

The applicant indicates that a containment barrier wall (CBW) and dewatering infrastructure would be necessary to reduce the potential for hydrostatic uplift of the retention ponds liner system ((Strata, 2011a;2012b). The location of the CPP resides in an area of shallow groundwater in valley fill sediments. The applicant states that groundwater laterally enters the CPP area shallow groundwater through the upgradient valley fill or vertically from underlying bedrock. Based on slug tests at selected wells, the applicant determined that the valley fill has low permeabilities (Strata, 2012b). This determination is consistent with the boring logs which

record significant thicknesses of clay and very fine sediments. However, the valley fill has lenses of sand-rich horizons primarily at depth immediately above the top of bedrock. Although the sand lenses are thought to be discontinuous, the applicant designed the CBW to eliminate lateral flow through "sand channel" conduits that may contribute to the high groundwater in the CPP Area. The applicant states that the top of the bedrock in the CPP area is dominantly a claystone which would minimize flow from bedrock (Strata, 2012b).

The CBW consists of a highly impermeable in-situ mixture of soil and bentonite that forms a continuous barrier around three (northern, eastern and southern) sides of the CPP area. The applicant does not plan alignment along the entire west side of the CPP area because boreholes indicated that bedrock is generally shallow (within 3-5 feet of the existing ground). Thus, the applicant expects very little flow from the west side. The CBW would be approximately 2 feet wide and would extend from the ground surface through the soil and unconsolidated surficial material to a point at least 2 feet into bedrock (Strata, 2012b). The applicant expects the maximum depth for the CBW to be approximately 35 feet. The location of the CBW is shown on SER Figure 4.2-1.

Strata designed a system of three French drains to dewater and maintain a depressed water table principally within the area of the ponds within the CPP area throughout the operational life of the project (Strata, 2012b). The French drains consist of approximately 1.5-foot wide drainage trenches constructed to a depth of 5 to 7 feet below the bottom of the ponds, the bottom elevation of the ponds is at 4121 ft-MSL. The French drainage trenches will be backfilled with clean (permeable) sand or fine gravel with piping to convey water collected through the trench to a collector well. The piping consists of 5-inch diameter perforated HDPE pipe, which would slope at a minimum of 0.5 percent toward the collector wells. The applicant's design for the collector wells is a 2-foot diameter corrugated steel pipe extending from the French drain to the ground surface (Strata, 2012b). The applicant would install a submersible pump inside each collector well. The collector wells would be fitted with pressure transducers to monitor water level and to control submersible pumps. The buried pump discharge piping would provide flexibility to convey the groundwater to an outfall structure within the facilities flood control diversion (assuming the water meets effluent limits) or to the lined retention ponds (if contaminated) (Strata, 2012b). In the application (Strata, 2011a), the applicant states that maintenance dewatering efforts would be minimal after the area is initially dewatered and that water generated during the dewatering effort most likely meets surface water discharge limits and thus would be discharged through a temporary WDEQ WYPDES permit. The location of the French drains is shown on SER Figure 4.2-1.

The applicant would operate French drains and the dewatering system to maintain the water level in the CPP area at an elevation of one foot below the elevation of the bottom of the ponds. The applicant estimates that daily volume of water removed by the dewatering system after the CPP area is dewatered is 28 gpd.

Staff finds that the applicant presented its conceptual model for the dewatering system based on a sufficient number of samples and that the sampling, evaluations and designs were conducted using sound engineering practices. However, because of the elaborate design, staff will require license conditions that ensure:

1) the system is tested for sufficient time to determine its successful dewatering before using the ponds; and
2) a strong inspection and monitoring program is in place to determine continued successful dewatering is occurring.

The volume of water generated by the dewatering system and disposition of that water will have to be clearly defined after the system is installed and prior to its operation. Staff finds that the volume of water the applicant predicts is low at 28 gpds; if that is the volume of water generated, then that volume can be readily discharged to the ponds and ultimately injected into the deep disposal well without affecting the water budget mass balance and without discharging to the nearby surface water. If the volume of water produced by normal operations of the dewatering system is higher than predicted by the applicant, then the applicant has proposed several options including discharge to the nearby surface water (if the water is clean) or discharged to the retention pond with ultimate injection into the deep disposal well (if the water has a poor quality). Staff has reasonable assurance that even at higher volumes (up to 2 orders of magnitude above the estimated volume) and with fluids that have poor water quality, the volume of water from the dewatering system will be sufficiently below the 25 gpm, the estimate of "other waste" category that the applicant included in its water mass balance for the deep disposal well. Therefore, even at higher dewatering rates and poor water quality, the operation of the dewatering system will be conducted in a manner that is protective of human health and safety and the environment.

4.2.3.1.9.8 Facilities Flood Control Diversion Design

In Section 3.1.9 of the Technical Report (Strata, 2011a) and Addendum 3.1-A of the Technical Report (Strata, 2012b), the applicant presents the designs and plans for a diversion of the ephemeral stream around the proposed CPP area. The existing stream channel drains Larson Flat. The channel historically bisected the area proposed for the CPP but the existing channel has been modified in the recent past in order to optimize irrigation efforts (Strata, 2011a).

The proposed diversion will include a constructed channel east of the CPP area (SER Figure 3.2-2). The diversion channel will be an approximately 1700 feet long, trapezoidal channel with a 15-foot wide bottom (Strata, 2012b). The slope to the sidewalls are 3H:1V (left side) or 5H:1H (right side (Strata, 2011a). The channel will be partially excavated in the existing surface on its left side (towards the CPP area), and fully excavated on the right sight. The left side will include a 15-foot wide berm 2 to 3 feet above the existing ground surface (Strata, 2011a).

Due to the anticipated low water velocities, the applicant proposes that the constructed channel will consist of vegetative cover except in the area of a proposed 6-foot high by 10-foot wide box culvert (Strata, 2012b). The box culvert is needed because the primary access road to the CPP area is over the proposed diversion channel. In the area of the proposed box culvert, the applicant proposes erosion controls such as an Armoflex® cellular concrete mat (Strata, 2011a).

The design for the channel and culvert is the 24-hour,100-year storm event (Strata, 2011a). The applicant states that this storm event is appropriate for the design based on the 25-year life expectancy of the facility (Strata, 2011a). The peak flow during the 24-hour, 100-year storm event is 680 cfs (velocities less than 5 feet per second), and was based on results of the applicant's HEC-HMS surface water flow modeling for the watershed at the point downstream of the diversion (see SER section 2.4.3). The applicant estimates that the design includes a 1-foot freeboard above the stage during the design peak flow (Strata, 2011a;2012b).

As discussed in SER Section 4.2.3.1.9.5, a design criterion for the retention ponds is that outside sources of water be limited to direct precipitation. If the proposed diversion were to overlflow, the overflow would flood the CPP area including the retention ponds, presenting a safety issue necessitating staff's review. Staff reviewed the applicant's design for the diversion

and finds that the applicant used proper methods for its design and finds it acceptable because the design is conservative leading to velocities that would minimize erosion potential, and volumes that adequately handle the estimated volume of flood water without flooding the nearby facility. Staff accepts the applicant's argument that the 24-hour,100-year storm event is appropriate for the design criteria given the anticipate life expectancy of the facility. Therefore, staff finds that the diversion channel is protective of human health and the environment.

4.2.3.1.9.9 Construction Considerations

The applicant provides a set of construction specifications and drawings that provide details of the construction aspects of the storage ponds (Strata, 2011a;2012b). The staff finds the drawings provide an acceptable representation of the pond layout and design details, including cross sections and details of the liner, leak detection system, and dewatering system.

The staff acknowledges that the applicant's construction specifications provide appropriate details regarding the manner in which the applicant would construct the retention ponds and clearly identify performance requirements during construction (Strata, 2012b). The applicant includes specifications for site preparation, placement of compacted fill, installation of liners and leak detection systems, construction of flood control measures, and construction of the CBW. The staff finds that these specifications follow the construction guidance in Section 3 of NRC Regulatory Guide 3.11 (NRC, 2008), are consistent with standard engineering practices in the geosynthetics industry, and are protective of public health. Therefore, the staff finds these specifications acceptable.

Additionally, an engineer would be on-site to conduct construction inspection and materials testing during installation of the lined retention ponds, flood control diversion, and containment barrier wall.

4.2.3.1.9.10 Operational Inspection

The applicant proposes an inspection plan for the retention ponds consisting of daily, weekly, quarterly, and annual inspections (Strata, 2012b). The applicant commits to inspecting the lined retention ponds at the proposed Ross ISR Project in accordance with NRC Regulatory Guide 3.11. The daily inspection would include checks of the leak detection system, the pond levels, and the condition of the embankments. The applicant commits to retaining engineering data related to the design, construction, and operation of the lined retention ponds on-site and available for reference and inclusion in inspection reports.

The applicant proposes to sample the pond leak detection system if at least 6 inches of fluid height is detected in any of the leak detection riser pipes (Strata, 2011a). If the fluid levels exceed 6 inches, fluid from the riser pipe would be collected, tested and compared to the water quality of the contents of the ponds. The applicant proposes to use common constituents such as conductivity and chloride to determine if fluids are leaking from the pond. If the applicant verifies that the pond has leaked fluid, the applicant would notify the NRC within 48 hours and transfer the contents of the pond cell with the identified leak to the other two pond cells or into the deep disposal well (Strata, 2011a).

The applicant proposes to conduct visual inspections of the condition of the diversion structure and box culvert monthly as well as immediately following large storm events (Strata, 2011a;2012b). Personnel competent in the evaluation of these structures would conduct the inspections based on a standard checklist. Personnel would visually inspect the embankment

top, side slopes, and toe for settlement, surface cracks, erosion, and changes in alignment. The box culvert would be inspected for structural integrity, obstructions, and scouring. The applicant would inspect the erosion protection for scouring, and the condition of anchoring. If the applicant observes unusual conditions, the applicant would survey the area to assess the extent of the problem. The applicant would keep inspection records on site and retained until termination of the project (Strata, 2011a).

The applicant proposes to accomplish monitoring for the containment barrier wall by monitoring the hydraulic gradient across the wall through a network of wells. Visual inspection of the CBW would be limited due to its lack of surface expression. However, the applicant would inspect instruments installed to demonstrate the effectiveness of the structure on a monthly basis. Key features proposed for the monthly inspection include the French drain/collector well system, monitoring wells on both sides of the CBW and the dewatering well points. Inspections could include the following: measuring water levels by other means to confirm pressure transducer readings, testing of the pumping system installed in the collector well, testing of the dewatering well point system and a check of the monitoring wells surface condition. Testing of the dewatering systems would ensure that in an upset condition, the infrastructure would be in an operational state necessary to mitigate any impacts from the upset. The applicant may increase monitoring frequency to confirm the necessary contrast in water levels across the CBW during periods of heavy precipitation or to account for seasonal fluctuations. In the event of an alarm in the collector well, an immediate inspection would occur to verify functionality of the pumping system. The applicant would keep records on site and retained until termination of the project.

The staff reviewed Strata's retention pond inspection plan and observes that Strata proposed appropriate daily, weekly, quarterly, and annual inspections, and notification requirements in the event of a leak. Strata has proposed inspection activities that are consistent with acceptance Criterion (2) of SRP Section 4.2.3. Staff finds that the applicant's inspection plan is acceptable because the plan is consistent with programs being conducted at other ISR facilities with surface impoundments containing liquid byproduct material where the programs have been shown to provide early detection of a release thus minimizing impacts to the environment and human health and safety. Retention of records for the operational inspections until license termination fulfills the requirement in 10 CFR 40.61 for this program. Staff will include a license condition that memorializes the applicant commitments to the inspection program.

4.2.3.1.9.11 Closure

The primary surface disturbance area at the Ross Project is the CPP area (Strata, 2011a). Surface disturbance associated with the CPP, including the lined retention ponds and facilities flood control diversion, would remain for the life of the project. Prior to final decommissioning and surface reclamation of any area, the applicant plans to submit a detailed decommissioning and reclamation plan to the NRC at least 12 months prior to the commencement of the activities (Strata, 2011a).

The applicant anticipates that the storage ponds would be in use over the life of the facility (Strata, 2011a). After completion of uranium recovery operations and groundwater remediation activities, the applicant would close and decommission the storage ponds. The closure activities would include moving remaining sediments, pond liners, and other contaminated materials to a licensed byproduct material facility for final disposal. After the applicant has removed the pond liner, the applicant would survey the soils beneath the storage pond to ensure that the area is suitable for unrestricted release. Finally, the applicant would re-contour

the footprint of the storage ponds, cover the area with topsoil, and re-vegetate the area (Strata, 2011a).

The staff reviewed the components of the design for the storage ponds related to closure and decommissioning. By providing information on decommissioning aspects of the storage ponds, the staff concludes that the applicant meets acceptance Criterion (1) of SRP Section 4.2.3. Therefore, Strata's approach is acceptable to the staff.

4.2.3.1.10 System Failure

In Section 5.7.1.2.1.2 of the Technical Report (Strata, 2011a), the applicant identifies possible sources of accidental releases in the retention ponds, wellfields, and buildings. The applicant's design would contain leaks from failures of process tanks within the CPP building by having secondary confinement for the process areas within the CPP building with perimeter concrete curbs, where feasible. Drainage from the secondary containment basins would be directed to sumps that would allow the transfer of the spilled solutions to appropriate tanks, ponds or the deep well injection system (Strata, 2011a). In addition, the applicant would incorporate an overall plant containment berm into the building foundation that would contain spills during a catastrophic event or spills from areas where it is not feasible to include secondary containment berms (Strata, 2011a).

In Section 5.7.1.2.1.3 of the Technical Report (Strata, 2011a), the applicant states that the most common form of surface releases from in-situ recovery operations occurs from breaks, leaks, or separations within the piping system that transfer recovery fluids between the CPP and the wellfield. Strata indicates that instrumentation and controls would include leak detection sensors in module buildings, valve manholes, and wellheads in the wellfields, as well as pressure monitoring instrumentation on pipelines which would trigger alarms and automatic shutdown in the case of an upset condition. The applicant would hydrostatically test all pipelines prior to final burial. Prior to backfilling, the applicant would conduct a final inspection of all pipes and appurtenances.

In order to prevent spills of mining solutions, the applicant would pressure check wellfield pipelines and manifolds before placing them into operation and after significant repairs. The applicant would install automated monitoring so any significant deviations in operating parameters would signal alarms and automatic shutdown. The operations staff would inspect each operating module building at least once per week with the results documented. The applicant also identified recordkeeping efforts related to spills (Strata, 2011a).

A system failure for the retention ponds would consist of a leak in the liner system resulting in a potential release of byproduct material to the environment. As discussed in SER Sections 4.2.3.1.9.6 and 5.7.8.3, the retention pond design consists of a defense in depth strategy consisting of a double liner system, a leak detection system, routine inspection program and a detection monitoring program. For the retention ponds, the first system failure consists of a leak developing in the primary liner releasing fluids to the interval between the primary and secondary liners. The leak detection system is located in this interval and monitoring is designed to detect a collection of fluids in this interval prior to the loss of integrity of the secondary liner.

In Section 5.2.2 of the Technical Report (Strata, 2011a), the applicant states that a radiation work permit (RWP) is required for any activity that has no operating procedure but has a potential for significant exposure to radioactive materials. In addition, in Section 5.7.6.1.3 of the

Technical Report (Strata, 2011a), the applicant states that a RWP will be developed for maintenance activities for which specific radiation safety controls are not addressed in the existing SOPs.

The staff reviewed the tank volumes and volumes provided by the concrete curb and has determined that the applicant has proposed acceptable design features to provide containment in the event of a spill within the plant. The applicant's proposed pond design and associated monitoring programs are consistent with those used at existing ISR facilities and have been shown to provide early detection of the pond system failure prior to a release into the environment.

Staff finds that the applicant does not propose procedures to develop RWPs for a system failure or emergency situation. Staff includes License Condition 10.4 in SER Section 5.2.4 for the applicant to develop procedures to be implemented for a system failure or other emergency. The procedures will include development of RWPs for those situations.

Based on staff's review of information in the technical report, and supplemented with the noted license condition, the staff has reasonable assurance that the applicant has addressed acceptance criteria (4) and (5) in Section 4.2.3 of the SRP (NRC, 2003) by identifying possible sources of accidental spills or releases, and the techniques that would be used to monitor for accidental releases. The staff observes that Strata's monitoring techniques are consistent with generally accepted practices in the ISR industry, which the staff has found to be protective of public health and safety. Therefore, these approaches are acceptable to the staff.

4.2.3.2 Solids

The applicant anticipates generating solid wastes at the Ross Project, which the applicant divides into two general categories: AEA-regulated solid waste and non-AEA-regulated solid waste (Strata, 2011a). AEA-regulated solid waste includes byproduct material in the form of process solids (e.g., filter media, resins), contaminated soil, equipment and parts, debris, and personal protective equipment (PPE) that cannot be decontaminated for unrestricted use. Non-AEA-regulated solid wastes include construction debris, office trash, and decontaminated materials and equipment, solid hazardous waste, and septic system solid waste.

Strata anticipates generating approximately 100 cubic yards of solid byproduct material on an annual basis. In addition, Strata estimates generating up to 5000 cubic yards of solid byproduct material during decommissioning. Strata has described how these materials would be stored prior to disposal and has committed to disposing of this waste at a facility licensed by either the NRC or an Agreement State. Byproduct material would be placed inside of 55-gallon, lined drums within properly identified and restricted access byproduct storage and preparation areas (Strata, 2011a). When the drums are full, they would be sealed and moved into a 20-cubic yard roll-off container. The applicant would ultimately ship roll-off containers to a licensed disposal facility. The applicant would provide adequate storage for at least two roll-off containers in the CPP. One or more additional byproduct material storage areas may be designated outside of the CPP (Strata, 2011a). These areas would be fenced, locked, and posted with signs indicating restricted access. Large items such as contaminated equipment that cannot be stored in a roll-off container would be stored in one of the designated byproduct material storage areas and covered/sealed in a manner that would prevent the spread of contamination in the storage area.

The applicant commits to developing an agreement with an appropriately NRC- or Agreement-State-licensed facility for solid byproduct material disposal and lists four facilities at which an agreement could be developed. The applicant has committed to notifying the NRC if the disposal agreement expires or terminates, and to submitting a new agreement to the NRC within 90 days of the expiration or termination (Strata, 2011a).

Any hazardous waste generated at the facility would be stored in sealed containers meeting OSHA and EPA requirements (Strata, 2011a). The applicant expects the total amount of hazardous wastes generated at the Ross Project to be small and the facility classified as a Conditionally Exempt Small Quantity Generator.

Staff finds that the volume of byproduct material to be generated during operations is small and will be properly stored at the facility until off-site disposal. The volumes of byproduct material generated during operations and decommissioning are consistent with those estimated or generated at existing ISR facilities. The applicant's commitments to developing a solid byproduct waste disposal agreement and maintaining an agreement throughout the life of the project is consistent with the review procedures in Section 4.2.2 and acceptance criteria in Section 4.2.3 in the SRP (NRC, 2003), and Criterion 2 of 10 CFR Part 40 Appendix A. The applicant will not be able to perform principal activities at the Ross Project until a solid byproduct waste disposal agreement is in effect, maintained on-site and subject to NRC notification requirements. Staff will memorialize the applicant's commitments in two standard license conditions presented in SER Section 4.2.4. The first condition will require developing an agreement prior to any operations, the second license condition will require maintaining an agreement throughout the life of the facility.

4.2.4 EVALUATION FINDINGS

The staff reviewed the aspects of the solid and liquid effluents that the applicant would generate at the proposed Strata Ross Project in accordance with the procedures in Section 4.2.2 and acceptance criteria in SRP Section 4.2.3. The applicant has acceptably described the common liquid and solid byproduct waste and effluents generated at the facility. The applicant has identified the appropriate control methods for onsite storage and disposal, i.e., surface discharge, deep well injection, and surface storage ponds.

The applicant has proposed an approach to dewater the pond area and monitor the water table conditions to prevent hydrostatic uplift issues. Staff will include license conditions for the dewatering system and pond inspections that ensure the applicant: 1) tests the system for sufficient time to determine its successful dewatering before using the retention ponds; and 2) commits to a strong inspection and monitoring program to determine that continued successful dewatering is occurring. The license conditions are as follows:

Standard License Condition 10.8:

> The licensee is permitted to construct and operate lined retention pond(s) as described in Section 4.2.2 and Addendum 3.1-A of the approved license application subject to requirements of LC 10.11. The ponds will be used for retention of liquid byproduct material prior to disposal in a deep disposal well as described in Section 4.2.3 of the approved license application. Routine pond inspections will be conducted in accordance with procedures defined in Section 5.3.2 of the approved license application. The inspections include:

A) Daily Inspection. The licensee will perform daily inspections in accordance with Section 5.3.2.1 of the approved license application. The inspections will include visual inspections of the piping, berms, diversion ditches, freeboard and leak detection systems. The minimum freeboard is 3 feet. If during the daily inspections a fluid height in any of the standpipes for the pond leak detection system is found to be in excess of six (6) vertical inches, then the licensee will collect a sample of the fluid for analysis of specific conductance. If the specific conductance of the fluid in the leak detection system is in excess of 50 percent of the specific conductance of fluids in the pond, then it is concluded that a leak has occurred in the pond primary liner and the licensee will perform mitigative and corrective actions. The corrective actions include notifying the NRC Project Manager by telephone or email within 48 hours and lowering the water level in the pond sufficiently to eliminate the leak. If corrective actions are not completed within 60 days, the pond will not be used to store any byproduct material until the liner is inspected by qualified personnel as required by Subsection E (Annual Technical Inspection). The licensee will submit a report to NRC upon completion of the corrective actions including documentation of all pond repairs. Routine daily inspections reports will be maintained on-site for NRC staff to review during routine inspections.

B) Weekly Inspection. The licensee will conduct weekly inspections in accordance with Section 5.3.1.2 of the approved license application. The inspections will include visual inspection of the entire area including perimeter fencing. The inspection report will be reviewed by the RSO, Manager of Health, Safety and Environmental Affairs, and the Facility Manager. The weekly inspection reports will be maintained on-site for NRC staff to review during inspections.

C) Monthly Inspection. The licensee will conduct inspections monthly in accordance with Section 5.3.2.2 of the approved license application or following a major storm event (precipitation greater than 1-inch of water during a 24-hour period) of the condition of structures associated with the diversion of the stream around the CPP area in accordance with Section 5.3.4 of the approved license application. The reports will be maintained on-site for NRC staff to review during inspections.

D) Quarterly Inspection. The licensee will conduct quarterly inspections in accordance with Section 5.3.2.3 of the approved license application. Results of the quarterly inspections will be included in the semi-annual report submitted to NRC as required by LC 11.2. If groundwater quality in the monitoring wells indicates a release of fluids from the pond, then the licensee will immediately perform corrective actions to eliminate the leak and any appropriate remedial actions including characterization of impacts to shallow soils and water in the uppermost aquifer. Results of the quarterly inspections will be submitted to NRC for review.

E) Annual Technical Inspection. The licensee will conduct annual inspections in accordance with Section 5.3.2.4 of the approved license

application. The annual inspection will include a review of the previous year's daily, weekly, and quarterly inspections, assessment of the hydraulic and hydrologic capacities, and a survey of the embankment by qualified personnel. A copy of the report will be submitted to NRC for review.

Facility Specific License Condition 10.11:

> The licensee is prohibited from using Pond 2 for the retention of byproduct material until NRC review and verification that the field operations of the CPP dewatering system is consistent with its design as described in TR Addendum 3.1-A of the approved license application.

On the basis of the information presented in the application, and the license conditions discussed above, the NRC staff concludes that the characterization information provides an acceptable basis to enable the staff to make a finding on compliance with the applicable criteria in 10 CFR Part 40, Appendix A. The applicant has described how it would design, construct, and maintain any impoundment with sufficient structural integrity to prevent a massive failure. The design of the embankments that would be used to construct the storage ponds is consistent with Regulatory Guide 3.11, Sections 2 and 3 (NRC, 2008), and therefore meets the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

The applicant provided acceptable plans and procedures that address contingencies for all reasonably expected system failures. The applicant has demonstrated that sump capacity is sufficient to contain the volume of the largest hazardous material source.

The applicant has committed to securing an agreement for disposal of solid byproduct materials; however, the applicant does not yet have an acceptable plan for the disposal of solid byproduct materials generated by the facility. Therefore, the staff will include the following license conditions to ensure that an agreement is in place prior to and during operations:

Standard License Condition 9.9:

> The licensee shall dispose of solid byproduct material from the Ross Project at a site that is authorized by NRC or an NRC-Agreement State to receive such byproduct material. The licensee's approved solid byproduct material disposal agreement shall be maintained on site during any time the facility is in operation. In the event that the agreement expires or is terminated, the licensee shall notify the NRC within seven working days after the date of expiration or termination. A new agreement shall be submitted for NRC review within 90 days after expiration or termination, or the licensee will be prohibited from further lixiviant injection.

Standard License Condition 12.5:

> Prior to commencement of operations, the licensee shall submit a copy of the solid byproduct material disposal agreement to the NRC.

The applicant does have plans in place to obtain the appropriate water quality certification. By providing information on the health and safety impacts of system failures and identifying preventive measures and mitigation for such occurrences, the applicant has shown that effluent control systems would limit radiation exposures under both normal and accident conditions.

Staff finds the deep well disposal capacity is sufficient for routine operations and provides accommodations for on-site storage to handle any surge capacity. Staff has reasonable assurance that the radiation exposures at the deep disposal wellheads meet the 10 CFR Part 20 exposure limits as the applicant's well design and injection rates are consistent with those used at deep disposal wells at existing ISR facilities, which have been shown to be protective of workers' and public health and safety.

Based upon the review conducted by the staff as indicated above, the staff has concluded that the proposed control systems for liquid and solid effluents meet the applicable acceptance criteria in SRP Section 4.2.3 and the applicable requirements in 10 CFR Parts 20 and 40.

4.3 REFERENCES

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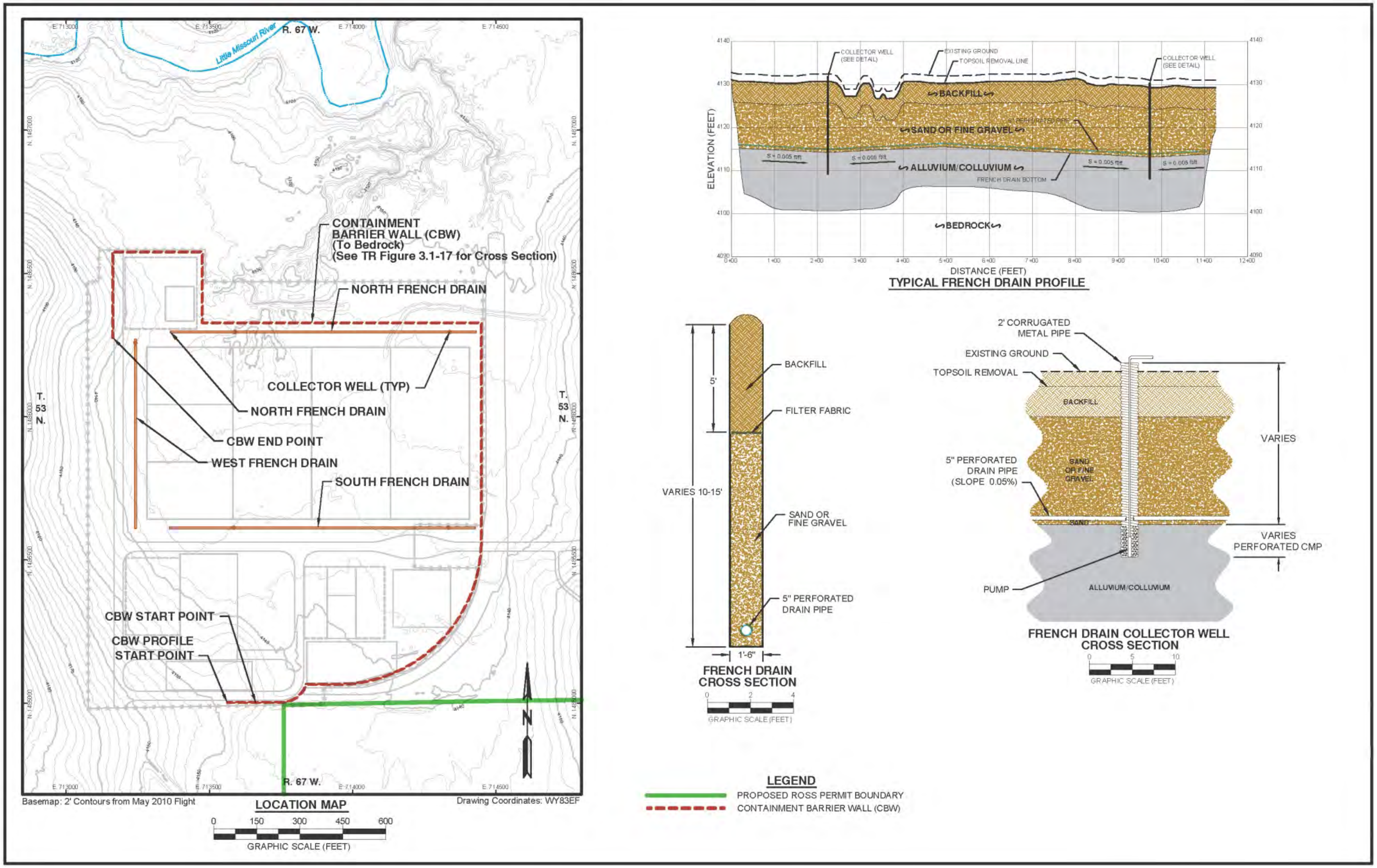
WDEQ, 2011. Letter to A. Simpson (Strata Energy, Inc) from J. Passehl (Wyoming Department of Environmental Quality/Water Quality Division (WDEQ/WQD)) forwarding the UIC Class I Permit for the Ross Project, ADAMS Accession No. ML111380015, April 13, 2011.



Source: Figure 6.1 of Addendum 3.1-A (Strata, 2012b)

Figure 4.2-1 Dewatering System Component Layout

5.0 OPERATIONS

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

5.1.1 REGULATORY REQUIREMENTS

General requirements for issuance of a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.32. Section 10 CFR 40.32(b) specifies that the applicant be qualified through training and experience to use source materials in such a manner as to protect health and minimize danger to life or property. Furthermore, 10 CFR 20.1101(b) specifies that a licensee use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles to achieve occupational doses and doses to the members of the public that are ALARA.

5.1.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviews the application for compliance with applicable requirements of 10 CFR Part 40 and Part 20 using guidance in RG 8.31 (NRC, 2002b) and acceptance criteria in Section 5.1.3 of the SRP (NRC, 2003). The staff determines if the applicant has demonstrated that the proposed corporate organization and administrative procedures for the Ross Project meets the 10 CFR 40.32(b) requirement that the applicant is qualified by reason of training and experience to use the source material for the purpose requested in such manner as to protect health and minimize danger to life or property and the 10 CFR 20.1101 requirement that the proposed procedures are ALARA by following guidance in RG 8.31 that the RSO should have the responsibility and authority to suspend, postpone, or modify any work activity that is unsafe or potentially a violation of the NRC's regulations or license conditions, including the ALARA program.

Based on guidance in RG 8.31 (NRC, 2002b) and Section 5.1.3 of the SRP (NRC, 2003), an application should provide relevant information to ensure that occupational radiation exposures at uranium recovery facilities are ALARA, and adequate descriptions of the corporate organization which defines management responsibilities and authority at each level of management, specifically those responsibilities and authorities for the radiation safety officer.

5.1.3 STAFF REVIEW AND ANALYSIS

Information referenced in SER Section 5.1.3, unless otherwise stated, is from Section 5.1 of the Technical Report (Strata, 2011a).

The applicant states that the management portion of the corporate organization for Strata[41] consists of its Chief Operating Officer (COO), General Manager, Facility Manager, Manager of Health, Safety and Environmental Affairs, Radiation Safety Officer, and Site Department Supervisors (Strata, 2011a) The corporate organization is shown in the Ross Project organizational chart (SER Figure 5.1-1). The COO is authorized by the Board of Directors to have the responsibility and authority for the radiation safety and environmental compliance

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[41] As discussed in SER Section 1.3, Strata is a wholly owned subsidiary of Peninsula Energy Limited. For this application, Strata is the applicant and the corporate organization for this SER section is solely for Strata.

programs at all Strata facilities. The COO is directly responsible for ensuring that Strata personnel comply with corporate industrial safety, radiation safety, and environmental protection programs. The COO is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements (Strata, 2011a).

The applicant states that the General Manager reports directly to the COO (Strata, 2011a). The General Manager is responsible for all uranium production activities at the various project sites. In addition to production activities, the General Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations. The General Manager is authorized to immediately implement any action to correct or prevent hazards (Strata, 2011a).

The applicant states that the Facility Manager reports directly to the General Manager (Strata, 2011a). The Facility Manager is responsible for all uranium production activity at the proposed Ross Project. All site operations, maintenance, construction, environmental health and safety, and support groups report directly to the Facility Manager. The Facility Manager is authorized to immediately implement any action to correct or prevent hazards. The Facility Manager has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations (Strata, 2011a).

The Manager of Health, Safety, and Environmental Affairs is responsible for all radiation protection, health and safety, and environmental programs and for ensuring that the applicant complies with all applicable regulatory requirements (Strata, 2011a). The Manager of Health, Safety, and Environmental Affairs reports directly to the Facility Manager and supervises the Radiation Safety Officer (RSO) to ensure that the radiation safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The Manager of Health, Safety, and Environmental Affairs has no production-related responsibilities (Strata, 2011a).

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs (Strata, 2011a). The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs, including emergency procedures, training programs for both the staff and the Radiation Safety Technician, and sampling and inspection procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to review and approve new equipment and changes in processes and procedures that may affect radiological safety and to ensure that established programs are maintained. The RSO cannot be overruled by other members of the management team on any decision involving radiation safety. The RSO has no production related responsibilities and reports directly to the Manager of Health, Safety, and Environmental Affairs (Strata, 2011a).

The Ross Project department supervisors would include the Operations Superintendent, Construction Superintendent, and Chief Geologist (Strata, 2011a). These positions are responsible for the direct supervision of site activities including construction, operation, and maintenance of the proposed Ross Project CPP, wellfields, and water disposal facilities (Strata, 2011a). These individuals report directly to the Facility Manager.

In Section 5.2.4 of the Technical Report (Strata, 2011a), the applicant describes the organization, procedures, and responsibilities of the Safety and Environmental Review Panel (SERP). The SERP would review proposed changes, tests, or experiments at the facility to verify that they do not conflict with any license requirements or NRC regulations; and that Strata maintains its commitments to safety and the environment. The SERP would consist of at least three individuals with appropriate managerial, financial, operations, environmental, and radiation safety responsibilities (i.e., RSO or equivalent) at the facility. The SERP would base its decisions on a thorough review of the proposal. Note that the applicant may add additional members to the SERP depending on the magnitude or technical issues.

The staff finds the RSO responsibilities as proposed by the applicant to be consistent with the responsibilities and authority described in Regulatory Guide 8.31, Section 1.2. This position does not have any direct production responsibilities. According to the applicant, the Facility Manager, Department Supervisors, and RSO would all be located at the project site which would allow workers to easily raise safety and environmental issues to senior managers. The staff finds that the applicant has adequately described its organization and organizational responsibilities because the information presented by the applicant is consistent with acceptance criteria (1), (4), and (5) of SRP Section 5.1.3 (NRC, 2003), and the applicant has demonstrated a strong commitment to support the development and implementation of the radiation safety and ALARA programs, as recommended in Regulatory Guide 8.31 (NRC, 2002b) to meet the regulatory requirements in 10 CFR Part 20, Subparts B, C, D, and F. The staff finds the applicant has incorporated radiation safety and ALARA programs into the design of the facility to ensure compliance with regulatory requirements in 10 CFR 20, Subparts B, C, D, and F, which demonstrates a capability to meet qualifications required in 10 CFR 40.32(b) to use source materials.

The staff finds that the proposed organizational structure provides for integration between plant management and the group responsible for plant construction consistent with acceptance Criterion (2) of SRP Section 5.1.3 (NRC, 2003) because the RSO will work closely with all supervisory personnel to review and approve new equipment and changes in processes and procedures that may affect radiological safety and to ensure that established programs are maintained. Furthermore, department supervisors would perform and document an annual review of each SOP within his or her area of responsibility to ensure continued accuracy and relevance.

The staff finds that the applicant has met acceptance Criterion (3) of SRP Section 5.1.3 and Criterion (4) of SRP Section 5.2.3 (NRC, 2003) by establishing the SERP and describing the procedures, members, and their responsibilities in sufficient detail. The staff finds the applicant’s organization of the panel follows recommendations in the SRP by requiring at least one member having expertise in operations and another in radiation safety, and thus, is acceptable because the information presented assures that the SERP can identify safety issues that arise and ensure that the actions of the applicant are protective of human health and the environment as required by 10 CFR 20.1101.

5.1.4 Evaluation Findings

The staff reviewed the corporate organization of the proposed Strata Ross Project in accordance with SRP Section 5.1.3. The applicant described its corporate organization and defined management responsibilities and authority at each level. The staff finds the organizational management structure diagram portrays the proposed integration among groups

that support operation and maintenance of the facility. The proposed management structure maintains sufficient independence for radiation safety personnel to raise safety issues to management. Therefore, the proposed management structure is acceptable to the staff. Based upon the review conducted by the staff as indicated above, the staff concludes that the proposed corporate organization and administrative procedures provided in the application are consistent with the acceptance criteria of SRP Section 5.1.3 and meet the requirements of 10 CFR 40.32(b).

Staff will include the following standard license condition to memorialize the applicant's commitment for the SERP:

Standard License Condition 9.4:

Change, Test, and Experiment License Condition

A) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition:

i Make changes in the facility as described in the license application (as updated);

ii Make changes in the procedures as described in the license application (as updated); and

iii Conduct tests or experiments not described in the license application (as updated).

B) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

i Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);

ii Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);

iii Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);

iv Result in more than a minimal increase in the consequences of a malfunction of an SEMS important to safety previously evaluated in the license application (as updated);

v Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);

vi Create a possibility for a malfunction of an SEMS important to safety with a different result than previously evaluated in the license application (as updated); or

vii Result in a departure from the method of evaluation described in the license application (as updated) used by the NRC in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA), technical evaluation reports (TERs), or other analyses and evaluations for license amendments.

For purposes of this paragraph as applied to this license, SEMS important to safety means any SEMS that has been referenced in a staff SER, TER, EA, or EIS, and supplements and amendments thereof.

C) Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and SERs, TERs, EAs, and EISs issued with amendments to this license.

D) The licensee's determinations concerning (B) and (C) of this condition, shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management (e.g., Plant Manager) and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent meeting recommendation in paragraph 2.4 of Regulatory Guide 8.31 with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate, to address technical aspects such as groundwater or surface water hydrology, specific earth sciences, and other technical disciplines. Temporary members or permanent members, other than the three above-specified individuals, may be consultants.

E) The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes are in compliance with (B) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation of each. In addition, the licensee shall annually submit to the NRC page changes, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.

In addition to documenting the changes approved by the SERP, the applicant is required to report other aspects of the operations to NRC (e.g., the annual audit of the ALARA program). The reporting requirements are discussed in SER Section 3.1.4.

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 REGULATORY REQUIREMENTS

The staff determines if Strata has demonstrated that the proposed management control program for the Strata Ross Project is consistent with requirements of Subparts L, “Records,” and M, “Reports” of 10 CFR Part 20, 10 CFR 40.61, and Criteria 8 and 8a of Appendix A to 10 CFR Part 40.

5.2.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria outlined in Section 5.2.3 of the SRP (NRC, 2003).

5.2.3 STAFF REVIEW AND ANALYSIS

Information in SER Section 5.2.3, unless otherwise stated, is from Section 5.2 of the technical report (Strata, 2011a). The applicant commits to developing written standard operating procedures (SOPs) for all routine tasks that may be a hazard to employee safety, public safety, operations, or the environment. The SOPs are to include all pertinent radiation safety practices. The Radiation Protection Program (RPP) consists of written operating procedures for all process activities including those activities involving radioactive materials. Written operating procedures would also be established for record keeping, document control, quality assurance, environmental and health physics monitoring, emergency procedures, and industrial safety. All operating procedures would be reviewed and approved in writing by the RSO prior to being implemented. In addition, review and approval of SOPs would be required by the SERP to ensure proper safety principles and practices are included and to ensure that the SOPs follow the ALARA program. All proposed changes to an operating procedure also would be reviewed and approved by the RSO and SERP. The RSO would perform a documented annual review of the operating procedures to ensure they follow currently established radiation protection practices (Strata, 2011a).

The applicant commits to issuing Radiation work permits (RWPs) for activities of a non-routine nature with potential for significant exposure to radioactive materials and for which no operating procedure exists (Strata, 2011a). The staff finds this approach acceptable because it is consistent with the recommended practices in Regulatory Guide 8.31 for maintaining worker, members of the public, and environmental exposures ALARA and complies with 10 CFR Part 20, Subparts B, C, and D.

The applicant has developed a recordkeeping program that would document the control of source and byproduct material (Strata, 2011a). The applicant would maintain the types of records identified in acceptance criteria (7) and (8) of Section 5.2.3 of the SRP (NRC, 2003; Strata, 2011a). Records would be maintained as hard copy originals or stored electronically in accordance with the requirements of 10 CFR 20 Subpart L and 10 CFR 40.61 (d) and (e), and consistent with acceptance Criterion (11) of Section 5.2.3 of the SRP (NRC, 2003). Records would be readily available for regulatory inspection, would be available for transfer to the NRC after license termination, and would be provided to a new owner or new licensee in the event that the property or license is transferred consistent with acceptance criteria (7) and (9) of Section 5.2.3 of the SRP (NRC, 2003).

In accordance with SRP Section 5.2.3, Criterion 12 (NRC, 2003), Strata would report all spills, lined retention pond leaks, excursions of recovery solutions, or process chemicals to the NRC Headquarters Project Manager by telephone or electronic mail within 48 hours of the event. This notification would be followed by submittal of a written report to the NRC Headquarters Project Manager detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved within 30 days of the notification. In accordance with SRP Section 5.2.3, Criterion 13, Strata also would submit an annual report to the NRC that includes the ALARA audit report, land use survey, monitoring data, corrective action program report, one of the semiannual effluent and environmental monitoring reports, and the SERP information (Strata, 2011a).

The staff finds the applicant's proposed recordkeeping and reporting comply with 10 CFR 40.61 and 10 CFR Part 20, Subparts L and M. The staff finds the applicant's description of the SERP process to be consistent with acceptance criteria (2), (4), and (13) of SRP Section 5.2.3 and meets regulatory requirements in 10 CFR Part 20, Subparts B, C, and F, as well as those described above.

In accordance with SRP Section 5.2.3, Criterion (6), Strata would administer a historic and cultural resources inventory before engaging in any development activity not previously assessed by NRC or any cooperating agency. Any disturbances to be associated with such development would be addressed in compliance with the National Historic Preservation Act (NHPA), the Archeological Resources Protection Act, and the guidelines discussed in Section 3.8 of the ER. Strata would cease immediately any work resulting in the discovery of previously unknown cultural artifacts to ensure that no unapproved disturbance occurs. Strata would notify appropriate authorities per any license conditions and would not go forward without appropriate approvals from NRC or other agencies as appropriate. Any such artifacts would be inventoried and evaluated, and no further disturbance would occur until authorization to proceed has been received.

5.2.4 EVALUATION FINDINGS

The staff reviewed the management control program of the proposed Strata Ross Project in accordance with SRP Section 5.2.3 (NRC, 2003). The applicant has proposed acceptable record keeping and retention and reporting programs that would be adequate to ensure that the applicant 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 until license termination. Record keeping and retention plans would assist the applicant in ensuring that it keeps both on-site and off-site exposures within regulatory limits and in documenting compliance with NRC regulations. The applicant has demonstrated an acceptable program to maintain records of spills, likely contamination events, and unusual occurrences for use in calculating annual surety amounts and to ensure acceptable decommissioning. The applicant would 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 would be transferred to any new owner or applicant, and ultimately to NRC, before license termination. Strata would make reports to the NRC, as required by regulations. The staff notes that spills, excursions, and other contamination events at ISR facilities may not be captured by Part 20 and Part 40 reporting requirements, but such events nonetheless need to be tracked to adequately ensure that the health and safety requirements of 10 CFR 40.32(c) would be met.

Therefore, the staff is adding the following standard license conditions to ensure that the applicant reports and documents these activities during operation of the facility:

Standard License Condition 9.8:

> Cultural Resources. 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 be completed in compliance with the National Historic Preservation Act (as amended) and its implementing regulations (36 CFR Part 800), and the Archaeological Resources Protection Act (as amended) and its implementing regulations (43 CFR Part 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 to proceed from the NRC, Wyoming State Historic Preservation Officer or the Bureau of Land Management, as appropriate.

Standard License Condition 9.10:

> The results of the following activities, operations, or actions shall be documented: sampling; analyses; surveys or monitoring; survey/ monitoring equipment calibrations; audits and inspections; all meetings and training courses; and any subsequent reviews, investigations, or corrective actions required by NRC regulation or this license. Unless otherwise specified in a license condition or applicable NRC regulation, all documentation required by this license shall be maintained until license termination, and is subject to NRC review and inspection.

Standard License Condition 10.4:

> The licensee shall develop and implement written standard operating procedures (SOPs) prior to operation for:
>
> A) All routine operational activities involving radioactive and non-radioactive materials associated with licensed activities that are handled, processed, stored, or transported by employees;
>
> B) All routine non-operational activities involving radioactive materials including in-plant radiation protection and environmental monitoring; and
>
> C) Emergency procedures for potential accident/unusual occurrences including significant equipment or facility damage, pipe breaks and spills, loss or theft of yellowcake or sealed sources, significant fires, and other natural disasters.
>
> The SOPs shall include appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. A copy of the

current written procedures shall be kept in the area(s) of the production facility where they are utilized. Should an activity be deemed ‘non-routine’, its procedures will be documented in a specific Radiation Work Permit for that non-routine activity.

Standard License Condition 11.6:

Until license termination, the licensee shall maintain documentation on spills of source or byproduct materials (including process solutions) and process chemicals. Documented information shall include, but not be limited to: date, spill volume, total activity of each radionuclide released, radiological survey results, soil sample results (if taken), corrective actions, results of post remediation surveys (if taken), a map showing the spill location and the impacted area, and an evaluation of NRC reporting criteria.

The licensee shall have procedures used to evaluate the consequences of the spill or incident/event against 10 CFR Part 20 Subpart M and 10 CFR 40.60 reporting criteria. If the criteria are met, then the licensee will report the spill or incident/event to the NRC Operations Center, as required.

If the licensee is required to report to a State or other Federal agency incidents/events that may have an impact on the environment, including wellfield excursions or spills of source, byproduct material, and/or process chemicals, the licensee shall submit a report to the NRC Headquarters Project Manager (PM) by telephone or electronic mail (e-mail) within 24 hours. This notification shall be followed, within 30 days of the notification, by submittal of a written report to NRC Headquarters in accordance with LC 9.3, detailing conditions leading to the spill or incident/event, corrective actions taken, and results achieved.

Standard License Condition 12.6:

The licensee shall not commence operations until the NRC performs a preoperational inspection to confirm, in part, that operating procedures and approved radiation safety and environmental monitoring programs are in place, and that preoperational testing is complete.

The licensee should inform the NRC, at least 90 days prior to the expected commencement of operations, to allow for sufficient time for NRC to plan and perform the preoperational inspection.

Furthermore, staff acknowledges the license condition requiring the applicant to prepare SOPs prior to the pre-operational inspection as documented in SER Section 3.1.4.

Based on the information provided in the application, the information required by the license condition above, and the detailed review conducted of the management control program for the Strata Ross Project, the staff concludes that the proposed management control program is acceptable and is in compliance with 10 CFR Part 20 Subpart L and 10 CFR 40.62.

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

5.3.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed management audit and inspection program for the Strata Ross Project meets the requirements of 10 CFR 40.32(b) and (c).

5.3.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in Section 5.3.3 of the SRP (NRC, 2003).

5.3.3 STAFF REVIEW AND ANALYSIS

Information in SER Section 5.3.3, unless otherwise stated, is from Section 5.3 of the technical report (Strata, 2011a). Inspections and audits would be performed periodically at the proposed Ross ISR Project to ensure compliance with radiological health, operational, and environmental standards.

Radiation Health Inspections: A daily walk through inspection would be conducted by the RSO or RST of all work and storage areas. The purpose of the inspection is to determine if proper radiation safety procedures and good housekeeping practices are being used in order to minimize contamination. Specifically, the inspection would focus on the effluent control systems, security features, instrumentation and alarm systems, and radiation monitoring devices. The RSO along with the Production Supervisor would conduct weekly inspections of all facility areas to observe general radiation control practices and to review required changes in procedures or equipment. A minimum of once monthly, the RSO would review the results of the daily and weekly inspections, including a review of all monitoring and exposure data for the month. The RSO would then provide the Mine Manager and Department Supervisors a written report. The report would specifically address the trends and any deviations from the radiation and ALARA programs, including a review of the adequacy of the implementation of license conditions regarding radiation protection and ALARA.

Lined Retention Pond Inspections: The applicant states (Strata, 2011a;2012b) that lined retention ponds at the proposed Ross ISR Project would be inspected in accordance with NRC Regulatory Guide 3.11 (NRC, 2002b). Engineering data related to the design, construction, and operation of the lined retention ponds would be kept on-site and available for reference and inclusion in inspection reports. A trained employee who has knowledge of the pond construction and safety features would conduct daily, monthly and quarterly inspections of each lined retention pond would be conducted by daily inspections would include water levels, piping, inlet and outlet structures, instrumentation, embankment condition, liner and leak detection system, and signs of animal damage. Monthly inspections would include inspection of runoff diversion channels and berms for erosion and flow obstructions, and the perimeter fence and associated signage to ensure adequate protection and warning from unauthorized entry. Quarterly inspections would include more detailed assessment of the embankments and liners, and sampling of groundwater monitoring wells and surface water. A technical evaluation of the ponds would be done annually to evaluate the hydraulic and hydrologic capacities of the ponds and diversion ditches and the structural stability of the embankments. A trained employee or an independent expert would conduct the annual evaluation.

Other Inspections: Strata would implement a continuous wellfield monitoring program based on roving wellfield personnel. Wellfield personnel would be trained, and intimately familiar with the functions and normal operating characteristics of equipment in these areas. Inspections of the module buildings, wellheads, and valve vaults would be conducted on a weekly basis. A visual inspection of the condition of the diversion structure and box culvert would be conducted monthly as well as immediately following large storm events. Visual inspection of the Containment Barrier Wall is limited due to the lack of surface expression of the wall. However, instrumentation installed to demonstrate the effectiveness of the structure would be inspected on a monthly basis.

Annual ALARA Audit: The applicant would conduct annual audits of the radiation safety and ALARA programs to provide assurance that all radiation protection procedures and license condition requirements are being conducted properly (Strata, 2011a). The audit would be conducted by a team of members who are knowledgeable of the RPP with at least one member who is experienced in the operational aspects of the radiation protection practices at the facility. The RSO would accompany the audit team to provide information when needed but would not be allowed to participate in the audit conclusions. Strata may also elect to use qualified personnel from another uranium facility or an independent radiation protection consultant to conduct the audit. Based on the findings of the audit, an audit report would be compiled and kept on record at the facility until project termination. The Manager of Health, Safety, and Environmental Affairs, the Facility Manager, and the RSO would review the audit conclusions and recommendations and ensure that the proper corrective actions are implemented.

The staff finds that the inspections and monitoring described by the applicant are acceptable because they follow the recommendations of Regulatory Guides 8.31 and 3.11 (NRC, 2002b;2008), and meet the regulatory requirements of 10 CFR Part 20 Subparts B, F and L.

5.3.4 EVALUATION FINDINGS

The staff reviewed the management audit and inspection program of the proposed Strata Ross Project in accordance with review procedures in Section 5.3.2 and acceptance criteria in Section 5.3.3 of the SRP (NRC, 2003). The applicant described the various aspects of daily and weekly inspections that its staff would perform within the facilities and at the storage ponds. The applicant described the personnel that would perform these inspections. Staff acknowledges that license conditions for (a) pond inspections in SER Section in 4.2.4, (b) wellfield inspections in SER Section 3.1.4, (c) documentation preparation in SER Section 5.2.4, (d) annual reviews of the radiation protection programs in SER Section 5.7.7.4 and (e) reports and notifications to NRC in SER Section 3.1.4 compliment the review of the management audit and inspection program.

Based upon the review conducted by the staff as indicated above and the referenced license conditions as presented in other SER sections, staff finds the information provided in the application meets the applicable acceptance criteria requirements of 10 CFR 40.32(b) and 10 CFR 40.32(c) because the management audit and inspection program is consistent with the programs used at existing ISR facilities which have been shown to provide adequate documentation for ensuring that the training, experience, equipment, facilities and procedures are adequate to protect the public and workers health and safety and the environment.

5.4 QUALIFICATIONS OF RADIATION SAFETY PERSONNEL

5.4.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the qualifications of the personnel conducting the radiation safety program satisfy 10 CFR 20.1101, which defines the radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for applicant qualifications.

5.4.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the review procedures in Section 5.4.2 and acceptance criteria in Section 5.4.3 of the SRP (NRC, 2003) and recommendations for technical qualifications of radiation safety staff in Regulatory Guide 8.31 (NRC, 2002b).

5.4.3 STAFF REVIEW AND ANALYSIS

5.4.3.1 Radiation Safety Officer (RSO)

Information in SER Section 5.4.3, unless otherwise stated, is from Section 5.4 of the technical report (Strata, 2011a). The applicant identifies educational, training and experience requirements for an RSO. The RSO educational requirements includes a bachelor's degree in physical science, industrial hygiene, or engineering from an accredited college or university, or an equivalent combination of training and relevant experience in radiation protection related to uranium recovery (Strata, 2011a). The staff notes that Regulatory Guide 8.31, Section 2.4.1, states that two years of relevant experience are generally considered equivalent to one year of academic study (NRC, 2002b).

Other minimum qualifications for the RSO identified by the applicant include health physics experience (Strata, 2011a). Specifically, the RSO qualifications include at least one year of work experience relevant to uranium recovery operations in applied health physics, radiation protection, industrial hygiene, or similar work. The applicant identifies specialized training for the RSO, which would include at least four weeks of specialized classroom training in health physics specifically applicable to uranium recovery. Lastly, the applicant identifies specialized knowledge requirements that include a thorough knowledge of the proper application and use of all health physics equipment used during uranium recovery activities (Strata, 2011a).

The staff finds that the RSO qualifications identified by the applicant are consistent with guidance and recommendations in Regulatory Guide 8.31 (NRC, 2002b) and finds them acceptable because they meet the acceptance criteria in Section 5.4.3 of the SRP (NRC, 2003), and are consistent with the education, training and experience requirements for an RSO at existing ISR facilities, which have been shown to be provide qualified personnel to protect the health of workers and public and minimize danger to life or property. Therefore, the information provided by the applicant meets the requirements of 10 CFR 40.32(b).

5.4.3.2 Radiation Safety Technician (RST)

The applicant identifies the minimum qualifications for the RST as one of the following two combinations of education, training, and experience in Section 5.4.2 of the technical report (Strata, 2011a). Qualifications Option 1 includes the following:

- an associate degree or two or more years of study in the physical sciences, engineering, or a health related field;
- at least a total of four weeks of generalized training in radiation protection applicable to uranium recovery facilities; and
- one year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene or industrial safety measures to be applied in a uranium recovery facility (Strata, 2011a).

Qualifications Option 2 as proposed by the applicant includes the following:

- a high school diploma;
- at least three months of specialized training in radiation protection relevant to uranium recovery facilities of which up to one month may be on-the-job training; and
- two years of relevant work experience in applied radiation protection (Strata, 2011a).

NRC staff has determined that the RST qualifications identified by the applicant are consistent with the training and experience recommended in Section 2.4 of Regulatory Guide 8.31 (NRC, 2002b) and acceptance criteria in Section 5.4.3 of the SRP (NRC, 2003), and are consistent with the education, training and experience requirements for an RSO at existing ISR facilities, which have been shown to be provide qualified personnel to protect the health of workers and public and minimize danger to life or property. Therefore, the information provided by the applicant meets the requirements of 10 CFR 40.32(b).

5.4.3.3 Designee

The applicant states in Section 6.4.5 of the technical Report (Strata, 2011a) that a designee may replace the RSO or RST during decommissioning activities where a potential radiation exposure hazard exists. The applicant identifies the minimum qualifications for the designee to perform certain functions in the absence of the RSO and RST in Section 5.4.3 of the Technical Report (Strata, 2011a;2012b). The applicant states that the designee's training would be commensurate with their level of responsibility and magnitude of potential hazards he or she is attempting to recognize and mitigate. The applicant states that the designee's duties should be limited to completing and documenting the daily radiation safety inspections during decommissioning activities, which include daily function checks of radiological survey instruments and performing routine release and personnel radiological contamination surveys during the absence of both the RSO and RST. Moreover, the applicant states that the designee shall not perform these duties without the presence of the RSO or RST on site for more than three consecutive days. The applicant states that the designee should not perform any other radiation safety duties (Strata, 2012b).

The applicant lists the following as a minimum as the designee's qualifications and training requirements (Strata, 2012b):

- A high school diploma;
- A minimum of three months experience working at the Ross ISR Project as a radiation worker;
- Annual radiation worker training in compliance with Section 2.5 of Regulatory Guide 8.31 (NRC, 2002b);

- A line-by-line review of the daily Inspection and applicable radiological survey SOPs with the RSO or RST; and
- On-the-job training performing daily inspections, and release and personnel surveys under the direct supervision of the RSO or RST.

Additionally, the applicant states that prior to becoming qualified as a designee and annually thereafter an individual will perform activities a minimum of five days under direct supervision of the RSO or RST (Strata, 2011a;2012b). The supervised activities include inspections and performance of release and personnel contamination surveys (Strata, 2011a). Strata states that the designee's on-the-job training in conducting the daily radiation safety inspections will prepare the designee to be cognizant of circumstances suggesting off-normal conditions (Strata, 2011a). The applicant states that the designee will not act as an RSO or RST, nor serve as a radiation expert in the event of an emergency or upset condition (Strata, 2011a). The applicant states that employees working at the Ross ISR Project during the decommissioning activities will be trained as radiation workers and, as such, will have daily responsibilities for recognizing, reporting, and correcting radiation hazards (Strata, 2011a).

In Section 5.4.3 of the technical report (Strata, 2011a), the applicant limits the designee to performing daily inspections during decommissioning activities to no more than three consecutive days when both the RSO and RST are absent. In Section 5.7.6.5 "Routine Daily Inspections and Qualifications of Personnel Performing Contamination Surveys" of the Technical Report (Strata, 2011a), the applicant states that it has been industry practice to train selected individuals, usually the plant operators, to perform the weekend daily inspections, and perform contamination surveys of areas and for release of material and equipment from a restricted area during operations. The applicant states that the selected individuals will receive specific training that includes specific procedural requirements contained in SOPs and related documentation for inspections. The applicant commits to preparing a checklist that the designated worker will use for consistency (Strata, 2011a).

Staff finds that the designee's qualifications, as described by the applicant in Section 5.4.3 of the technical report (Strata, 2011a), do not meet the training and experience requirements of an RSO or RST as suggested by Regulatory Guide 8.31. Although not meeting requirements for an RSO or RST as recommended in Regulatory Guide 8.31, the staff acknowledges that regulatory guides provide examples of methods for satisfying the NRC's regulatory requirements and applicants have the opportunity to include other methods in their programs as long as those methods satisfy the applicable regulatory requirements. Under certain circumstances, NRC staff has allowed the use of "qualified designees" for specific limited activities such as: (1) conducting daily inspections for a short defined period in the temporary absence of the RSO or RST; (2) surveying equipment, materials or packages moving from one licensed restricted area or controlled area to another licensed restricted or controlled area associated with an NRC-verified contamination control program and (3) surveys of resin trucks leaving a restricted area and traveling to another restricted area of the applicant's site. For these limited circumstances, the staff has reasonable assurance that use of qualified designees for the above tasks provides sufficient protection of worker's and public health and safety provided specific conditions are met.

For operational activities, NRC staff finds that the applicant has not defined the qualifications of "selected individuals" or "qualified designee" in sufficient detail to allow use for the specific limited activities during operations, nor are they consistent with qualifications of personnel as suggested in Regulatory Guide 8.31 (NRC, 2002b) or with the "Inspection and Enforcement Circular 81-07, Control of Radioactively Contaminated Material" (NRC, 1981), which

recommends that only qualified radiation safety individuals perform surveys releasing radioactive contamination to unrestricted areas.   Therefore, the staff will include a standard license condition that requires the applicant to comply with recommendations in Regulatory Guide 8.31(NRC, 2002b), which requires that either an RSO or a RST perform the daily inspections and release materials to unrestricted areas. Both of these positions require specific specialized training beyond a high school education and work experience, including a demonstration of knowledge and refresher training. The license condition will permit the applicant's use of a designee that does not meet the education and experience of an RST as defined by RG 8.31, for the limited circumstances discussed above, provided the applicant submits for NRC review and verification details on the specific qualifications of the “selected individual” or “qualified designee” for staff to have reasonable assurance of an equivalent level of protection to that recommended in Regulatory Guide 8.31. The staff finds that Regulatory Guide 8.31 provides academic and experience requirements for radiation safety staff, and as such, the designee training should be a subset of the academic training, facility-specific training, and experience required by full radiation staff. The license condition will not permit a designee to perform contamination surveys for unconditional release of material to unrestricted areas.

For decommissioning activities, the staff finds that the use of a designee as proposed by the applicant for a period not to exceed three days acceptable but the minimum work experience as proposed by the applicant unacceptable. The staff finds that three months experience as a radiation worker is too limited for an individual to be surveying material for release to unrestricted areas. The limited experience, as described by the applicant, has been acceptable by NRC staff for other licensees with the requirement that the designee can be in telephone contact with the RSO or RST during unsupervised periods. Therefore, the staff’s approval of the proposed designee during decommissioning activities is contingent upon the NRC’s review and verification of the designee’s training requirements, as documented in license conditions in SER Section 5.4.4 and 5.5.4, and the requirement for a designee to be in telephone contact with the RSO or RST during unsupervised periods, as documented in a license condition in SER Section 6.3.4.

5.4.4 EVALUATION FINDINGS

The staff reviewed the qualification requirements of the personnel conducting the radiation safety program at the proposed Ross ISR Project in accordance with SRP Section 5.4.3. The applicant described qualifications of the RSO and RST that are consistent with Regulatory Guide 8.31 (NRC, 2002b).   Staff will include a standard license condition to document the applicant’s commitments to follow guidance for elements in a radiation safety program in RG 8.31 as well as those in RG 8.30 and RG 8.11 as follows:

Standard License Condition 9.7:

> The licensee shall follow the guidance set forth in NRC Regulatory Guides 8.22, “Bioassay at Uranium Recovery Facilities” (as revised), 8.30, “Health Physics Surveys in Uranium Recovery Facilities” (as revised) and 8.31, “Information Relevant to Ensuring that Occupational Radiation Exposure at Uranium Recovery Facilities will be As Low As Is Reasonably Achievable (ALARA),” (as revised) or NRC-approved equivalent with the following exception:
>
> The licensee may identify qualified designee(s) to perform daily inspections in the occasional absence of the RSO and radiation safety technician(s) (RST). The qualified designee(s) will have health physics training, and the licensee will

> specify the training program to qualify a designee and submit it to the NRC staff for review and written verification. A qualified designee may perform daily inspections on weekends, holidays, or times when both the RSO and RST(s) must both be absent (e.g., illness or offsite training). A designee shall not perform daily inspections for more than two consecutive days except in the event of a Federal or company holiday, whereby the designee will not exceed more than three consecutive days. Reports generated by the designee will be reviewed by the RSO or RST as soon as practical, but no later than 3 hours from the beginning of the next workday following an absence, weekend, or holiday. The licensee will also have the RSO or RST available by telephone while the qualified designee is performing the daily inspections.
>
> Notwithstanding the License Condition (LC) 9.4 change process, no additional exceptions to the guidance will be implemented without written NRC verification that the criteria in LC 9.4 do not require a license amendment.

In addition, staff will include the following license condition for the applicant to submit, for NRC review and verification prior to operations, the qualifications for the radiation staff, including those qualifications and responsibilities for a designee:

Standard License Condition 12.4:

> Prior to commencement of operations, the licensee shall submit the qualifications of radiation safety staff members, including the qualifications and responsibilities of a designee, and the policy on the work situations for a declared pregnant worker, for NRC review and verification.

The staff reviewed the applicant's proposed alternative to allow a designee to perform daily inspections and personnel/material release surveys during decommissioning activities. The above license conditions will require the licensee to document the qualifications of all radiation safety staff and ensure that a qualified designee has telephone contact capabilities with the RSO or RST during unsupervised periods.

For personnel responsibilities for releasing material to unrestricted areas, staff will include a license condition documenting requirements for those personnel in SER Section 6.3.4.

Based upon the review conducted by the staff as indicated above, the information provided in the application as supplemented with the noted license conditions meets the applicable requirements of 10 CFR 40.32(b) and 10 CFR 40.32(c) for qualifications of the radiation safety personnel.

5.5 RADIATION SAFETY TRAINING

5.5.1 REGULATORY REQUIREMENTS

The staff determines if Strata has demonstrated that the proposed radiation safety training program for the Ross ISR Project complies with 10 CFR 19.12, which provides requirements for instructions to workers; 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR 19.11, which requires posting of notices to workers; 10 CFR 19.12, which addresses requirements for instructions to workers; 10 CFR 19.13, which addresses requirements for notifications and reports to individuals; 10 CFR 19.15, which addresses

consultation with workers during inspections; 10 CFR 19.16, which defines requests by workers for inspections, and 10 CFR 40.32(b), as it relates to the applicant qualifications through training.

5.5.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with applicable requirements of 10 CFR Parts 19, 20, and 40 using the review procedures in Section 5.5.2 and acceptance criteria in Section 5.5.3 of the SRP (NRC, 2003) and guidance on (1) protecting the fetus, (2) a basis for training employees on the risks from radiation exposure in the work place, and (3) the fundamentals of protection against exposure to uranium and its progeny as provided in Regulatory Guide 8.13 (NRC, 1999b), RG 8.29 (NRC, 1996), and RG 8.31 (NRC, 2002b), respectively.

5.5.3 STAFF REVIEW AND ANALYSIS

Information in SER Section 5.5.3, unless otherwise stated, is from Section 5.5 of the technical report (Strata, 2011a).

In Section 5.5.3 of the Technical Report (Strata, 2011a), the applicant states that its radiation safety training will follow guidance for training as provided in Regulatory Guides 8.13 (NRC, 1999b), 8.29 (NRC, 1996), and 8.31 (NRC, 2002b). The applicant states that specific, detailed worker radiation training materials would be presented in the Radiation Safety Manual, which will be managed by the RSO. Initial radiation safety training will include, among other topics, the following: fundamentals of health protection, personal hygiene at ISR facilities, facility provided protection (i.e., engineering controls, cleanliness of the work place), health protection measurements, radiation protection regulations, and emergency procedures (Strata, 2011a). The applicant will conduct a written or oral test following initial radiation safety training for all employees. The instructor will discuss any incorrect answers to test questions to ensure a correct understanding of the material by all workers. If an employee fails to pass the test (less than 70 percent of the answers being correct), additional training will be provided prior to re-testing. Training will also include refresher training that will occur on an annual basis for each employee (Strata, 2011a).

The applicant states that the RSO will receive a minimum of 40 hours of refresher training in health physics or related courses at least biennially (Strata, 2011a). In regard to the designee's training, the applicant states that the RSO shall determine if an individual is qualified to be a designee by documenting that the qualification and training requirements outlined in Section 5.4.3 in the technical report have been satisfactorily completed (Strata, 2011a). The RSO will administer a written and functional test to determine if the individual is capable of performing inspections, personnel/material release surveys according to SOPs, recognize hazards, and report hazards to individuals responsible for implementing corrective action. The RSO shall maintain a file for each designee containing his/her education, training and testing qualifications as described above. The applicant states that the file shall be maintained and available for review by the NRC during inspections (Strata, 2011a).

The applicant states that each employee will receive annual refresher training (Strata, 2011a). This training course will provide a brief review of topics from the initial training, as well as the following: safety issues that have arisen, changes in regulations and license conditions, and employee exposure trends. The applicant will maintain tests and results until license termination (Strata, 2011a).

In addition, radiation safety training for female employees and supervisors of female employees will address risks associated with prenatal exposure, regulations concerning exposure limits and dose monitoring for pregnant women, and the applicant's policy for declared pregnant workers (Strata, 2011a).

For radiation safety training for visitors, the applicant states that all visitors will be instructed on hazard prevention and avoidance specific to the areas of visitation (Strata, 2011a). In addition, contractors who handle contaminated equipment will receive the same training and radiation safety instruction required of permanent employees. Contractors, who have previously completed the full training for the Ross ISR Project or who have evidence of recent and relevant training elsewhere will receive job-specific radiation safety instruction. An employee with proper training and knowledge of potential hazards must escort all visitors and contractors that have not received proper training (Strata, 2011a).

The staff acknowledges that Regulatory Guides 8.13, 8,29, and 8.31 provide methods acceptable to the NRC staff for implementing the regulatory requirements in 10 CFR 19.12, 10 CFR 19.13, 10 CFR 19.15, 10 CFR 19.16, and 10 CFR Part 20, Subpart C. The staff finds that the radiation safety training program as proposed by the applicant is acceptable with regard to the following:

- The applicant's initial training and testing for all personnel is consistent with the recommendations in Section 2.5 of Regulatory Guide 8.31 and therefore, is consistent with acceptance Criterion (1) of SRP Section 5.5.3 (NRC, 2003).

- Except as noted below, the applicant's plan for retraining and testing for all personnel is consistent with the recommendations in Section 2.5 of Regulatory Guide 8.31 and therefore, is consistent with acceptance Criterion (1) of SRP Section 5.5.3 (NRC, 2003).

- The applicant's plan for training visitors and contractors consistent with the recommendations in Section 2.5 of Regulatory Guide 8.31.

Staff finds that the radiation safety training program as proposed by the applicant is not acceptable with regard to the following:

- The applicant did not provide its policy affecting a woman's work situation after she has filed a written declaration of pregnancy as recommended in Regulatory Guide 8.13 (NRC, 1999b).

- The applicant did not provide an adequate description of the training for a designee to meet the education and experience of an RST or equivalent level of protection as recommended in Regulatory Guide 8.31.

As discussed in SER Sections 5.4.3 and 5.7.6.3.3, staff evaluates the applicant's proposed program for a designee. In SER Section 5.4.4, staff presents license conditions 9.7 and 12.4 requiring documentation on the qualifications of a designee that provide reasonable assurance to staff that the applicant's use of a designee is protective of workers and public health and safety.

In SER Section 5.7.4.3.3, staff evaluates the applicant's dose equivalent calculations for an embryo/fetus of a declared pregnant female employee. In SER Section 5.4.4, staff presents license condition 12.4 requiring the applicant submit for NRC review and verification, the policy on the work situation for a declared pregnant worker. Staff will include a license condition, as described in SER Section 5.5.4 below, that will require the applicant to administer a training program consistent with Regulatory Guides 8.13, 8.29, and Section 2.5 of Regulatory Guide 8.31, or an NRC-approved equivalent.

The staff has reasonable assurance that the applicant's proposed radiation safety training program is sufficient to ensure compliance with 10 CFR Parts 19 and 20, specifically the requirements in 10 CFR 20.1101, and to ensure compliance with 10 CFR 40.32(b), because the radiation safety program follows the recommendations for an acceptable radiation safety program in the noted regulatory guides. The reasonable assurance finding is contingent upon the fulfillment of the noted license conditions.

5.5.4 EVALUATION FINDINGS

The staff reviewed the radiation safety training aspects of the proposed Ross ISR Project. As discussed above, the applicant's radiation safety training program is primarily complete, and the staff is reasonably assured that the applicant's program will ensure the applicant's compliance with 10 CFR 19.12, Part 20, Subpart C, and 10 CFR 40.32(b). However, because certain items, discussed above, were omitted from the training program, the staff's reasonable assurance determination is contingent upon the license conditions presented in SER Section 5.4.3 and 5.4.4 on qualifications for the designee and review of the policy on work situations for declared pregnant workers and on the fulfillment of the following facility specific license condition:

Facility Specific License Condition 10.18:

> The licensee shall ensure radiation safety training is consistent with Regulatory Guides 8.13, "Instruction Concerning Prenatal Radiation Exposure," (as revised) and 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," (as revised) in addition to the requirements in Section 2.5 of Regulatory Guide 8.31 (as revised), as described in Section 5.5 of the approved application, or NRC-approved equivalent.

Based upon the review conducted by the staff as indicated above, the information provided in the application as supplemented by the noted license conditions, is consistent with the applicable acceptance criteria of SRP Section 5.5.3 and meets the requirements of 10 CFR 19.12, 10 CFR Part 20, Subpart C, and 10 CFR 40.40.32(b).

5.6 SECURITY

5.6.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed security measures for the Strata Ross Project meet the requirements of 10 CFR 20, Subpart I.

5.6.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20 using the review procedures in Section 5.6.2 and acceptance criteria in Section 5.6.3 of the SRP (NRC, 2003).

5.6.3 STAFF REVIEW AND ANALYSIS

Information in SER Section 5.6.3, unless otherwise stated, is from Section 5.6 of the technical report (Strata, 2011a).

The applicant commits to securing all licensed material that is stored in controlled or unrestricted areas from unauthorized removal or access as part of the security program in accordance with requirements of 10 CFR Part 20, Subpart I. Areas where licensed material is located or stored, such as wellfields, lined retention ponds and the CPP, will be fenced. Gates or doors for access to areas where licensed material is located or stored will have appropriate signage and be locked when facility personnel are not within the area to prevent unauthorized access (Strata, 2011a).

The main access gate to the project will be locked with coded and remote-activated entry. The gate would be equipped with an intercom and video surveillance so that plant or administrative personnel can identify contractors and other site visitors who wish to gain access. During normal working hours, personnel in the administration building will control the gate. During night shifts, personnel in the Central Control Room will control the gate. Contractors and visitors would be required to sign in and would be given applicable safety training. Staff would be on-site 24-hours per day, 7-days a week to monitor unauthorized access. Facility operators would conduct daily inspections of access controls and signage (Strata, 2011a).

Also, as required in 10 CFR Part 20, Subpart I, the applicant commits to controlling and maintaining constant surveillance of any licensed material that is in a controlled or unrestricted area and that is not in storage. This includes transportation of loaded ion exchange resin from future satellite facilities or other resin generators to the CPP. Transportation security risks would be documented and SOPs concerning these risks would be strictly followed. All access to containers and vehicles where license material is located when not in storage would be locked, if possible, and under surveillance. Transporting shipments of licensed material off-site would be done by appropriately licensed and qualified transporters in accordance with packaging and shipping requirements in U.S. DOT Hazardous Materials Regulations and may qualify for requirements of 49 CFR Part 172, Subpart I (see SER Section 7.3).

The staff finds that the applicant's transportation and security procedures are acceptable because the transportation procedures comply with the requirements in 49 CFR Parts 172 and 173 and 10 CFR 71.5(a)(1); and security procedures comply with 10 CFR Part 20, Subpart I, "Storage and Control of Licensed Material." The staff concludes that Strata has described the security measures that would be used at the Strata Ross Project in sufficient detail to meet the acceptance criteria in SRP Section 5.6.3 because it has acceptable passive controls, such as fencing for well fields, and active controls, such as daily inspections and locks for plant buildings (NRC, 2003).

5.6.4 Evaluation Findings

The applicant has described the security measures that would be used for stored material and control measures for material not in storage. The security measures at the Strata Ross Project, as discussed above, demonstrate that the applicant has acceptable active and passive constraints on entry to the licensed and restricted areas. The applicant has identified acceptable passive controls, for example, fencing, locked gates, and warning signage for site control and active security systems for buildings.

Based on the information provided in the application and the detailed review conducted of the security measures for the Strata Ross Project, the staff concludes that the security measures are acceptable and are in compliance with 10 CFR Part 20, Subpart I, which provides requirements for the security of stored material and control of material not in storage.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

This section discusses radiation safety controls and monitoring techniques used to ensure the applicant maintains radiation exposures and releases of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable (ALARA).

5.7.1 Effluent Control Techniques

The areas of review, review procedures and acceptance criteria listed in SRP Section 5.7.1 (NRC, 2003), which addresses effluent control techniques, are duplicative of the areas of review, review procedures and acceptance criteria in other sections of the SRP, specifically Section 4.1 *Gaseous and Airborne Particulates* and Section 5.7.7 *Airborne Effluent and Environmental Monitoring Program*. The staff describes and evaluates the applicant’s proposed effluent control techniques and monitoring in SER Sections 4.1 and 5.7.7, respectively.

5.7.2 External Radiation Exposure Monitoring Program

5.7.2.1 Regulatory Requirements

The staff determines if Strata has demonstrated that the proposed external radiation exposure monitoring program for the Ross ISR Project meets the requirements of 10 CFR Part 20, Subparts B, C, F, J, L, and M, and 10 CFR 40.61.

5.7.2.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria in Section 5.7.2.3 of the SRP (NRC, 2003). Regulatory Guides 4.14 (NRC, 1980a), 8.7 (NRC, 2005), 8.10 (NRC, 1977), 8.30 (NRC, 2002a), 8.31 (NRC, 2002b), and 8.34 (NRC, 1992b) provide guidance on how compliance with the regulations can be demonstrated.

5.7.2.3 Staff Review and Analysis

The following sections present the staff’s review and analysis of various aspects of the external radiation exposure monitoring program for the Ross ISR Project. Review areas addressed in this section include radiation surveys, personnel monitoring, records, and reporting.

5.7.2.3.1 Surveys

In Section 5.7.2.1 of the technical report (Strata, 2011a), the applicant states that direct gamma exposure rate surveys in the process area will be conducted at least once a month by a radiation safety technician (RST) meeting the training and experience requirements described in Technical Report Section 5.4.2. The RST will conduct surveys using hand held instrumentation. The applicant provides examples of survey instrumentation and the associated instrument specifications in Table TR RAI 32-1 submitted in its response to RAIs (Strata, 2012b).

The applicant states that initial comprehensive gamma exposure rate surveys will be performed at start up to verify assumptions regarding where external exposure rates will be highest and during operations at process areas of potentially elevated gamma radiation areas where radium may concentrate or precipitate, and in areas where uranium concentrates are processed and/or stored (Strata, 2011a). The applicant states these areas for the gamma exposure rate surveys include the wellfield module buildings within which precipitates from dried leaks could from, loaded ion exchange (IX) and elution tanks, resin transfer system, RO unit, yellowcake precipitation, thickening, drying/packaging and storage areas, and other areas where byproduct material accumulates and stored. Technical Report Figure 5.7-5 (Strata, 2011a) illustrates areas of potential external exposure within the CPP where the applicant states that it will perform at a minimum, regular gamma surveys. The applicant states that it may adjust the survey locations and frequencies should conditions change affecting the external exposure profile of the plant and wellfields.

In addition to the surveys, the applicant will place area TLDs at locations that initial surveys indicate highest potential for gamma exposure, as well as in non-uranium process areas, such as offices, change rooms, and lunchroom. The applicant states that it will exchange personnel dosimeters on a quarterly basis or more frequently based on survey results or at the discretion of the RSO (Strata, 2011a).

The applicant states that because elevated gamma radiation measurements can be an indication of surface contamination, it will assess areas for surface contamination in which elevated gamma radiation measurements are made during routine surveys but which elevated gamma exposure rates are not typically observed or expected. The applicant will designate and post an area as “Radiation Area” if an employee could receive an exposure greater than 5 mrems (0.05 mSv) in one hour at 30 cm from the source external radiation levels. The applicant will investigate and document the cause for any radiation areas (Strata, 2011a). In accordance with the ALARA principle, the applicant states that it will implement controls to reduce gamma exposure rates in all radiation areas if the applicant cannot otherwise reduce exposure rates during operations (Strata, 2011a).

The applicant states that it will perform beta exposure rate surveys at specific operations that involve direct handling of large quantities of aged yellowcake (Strata, 2011a;2012b). The operations consist of those in the plant areas associated with precipitation, dewatering (filter press) and drying/packaging. The applicant states that it will perform these surveys near the surface of the material (e.g., within 10 cm) so that the measurements are representative of beta exposure rates to workers’ hands and skin while handling the material or it may perform beta exposure rate evaluations for these operations, in lieu of instrument surveys, using information provided in Regulatory Guide 8.30 Figures 1 and 2 (Strata, 2011a;2012b). The initial beta contamination surveys will be performed in the described plant areas, and whenever a procedural and/or equipment change may increase the risk of beta contamination. The applicant states that these instances may occur when performing maintenance on tanks/pipes

that may accumulate materials over time. The accumulation of material could present a potential for in growth of beta emitting progeny (Strata, 2011a;2012b). As stated above, Strata provides examples of survey instrumentation and the associated instrument specifications in Table TR RAI 32-1 (Strata, 2012b).

The applicant states it is unlikely under routine operations that beta exposure rates could result in shallow dose equivalents to the skin or the skin of extremities greater than 10% of the limits in § 20.1201(a)(2), which would require individual beta monitoring as described in § 20.1502 (Strata, 2011a;2012b). The applicant states it will prepare a radiation work permit (RWP) that will define specific radiological monitoring and controls for tasks that are typically not covered by existing SOPs. The applicant states that if circumstances identify the potential for beta exposures, it will perform an ALARA analysis to evaluate needs for additional surveys and controls, including provisions for personnel beta monitoring (e.g., ring and/or wrist badges) (Strata, 2011a;2012b).

The applicant states it will perform gamma and beta exposure rate surveys in accordance with standard operating procedures (SOP) that it will develop in accordance with NRC guidance in Regulatory Guides 8.30 (NRC, 2002a) and 8.31 (NRC, 2002b), and NUREG-1575, Revision 1, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000; Strata, 2011a). The applicant will calibrate gamma survey instruments at the manufacturer's suggested interval or semi–annually, whichever is more frequent, operate the instruments in accordance with the manufacturer's recommendations and will use check sources to verify instrument consistency of operation prior to each use. The applicant will remove instruments from use and re-calibrate them if performance checks result in variations from reference readings greater than 20 percent. The applicant commits to maintaining calibration records of gamma survey equipment on-site (Strata, 2011a).

The staff finds that the applicant's commitment to conduct gamma surveys and maintain exposures ALARA is consistent with those recommendations in Regulatory Guides 8.10 (NRC, 1977) and 8.31 (NRC, 2002b), and with acceptance Criterion (7) in SRP Section 5.7.2.3, which recommends keeping radiation doses ALARA by following these two regulatory guides. The applicant includes a drawing, as recommended in Regulatory Guide 4.14, Sections 1.1.5 and 2.1.6 (NRC, 1980a), that depicts the facility layout and location of external radiation monitors and, therefore, is consistent with acceptance Criterion (1) in SRP Section 5.7.2.3. However, 10 CFR 20.1301(a)(2) does not allow dose rates from external radiation sources to exceed 2 mrem in any one hour in unrestricted areas. The applicant did not address what actions will be taken if employee work areas in an unrestricted area exceed 2 mrem/hr. The staff has reasonable assurance that the applicant will ensure that exposures in unrestricted areas are limited because in Section 5.7.2 of the technical report (Strata, 2011a), the applicant commits to preventing visitors or other unmonitored individuals from entering into areas where the exposure rate exceeds 2 mrem/hr in accordance with requirements of 10 CFR 20.1301(a)(2). Because the applicant has not addressed those actions it will take if exposure dose rates exceed 2 mrem/hr in unrestricted areas, the staff will include a license condition to ensure exposure dose rates do not exceed 2 mrem/hr in unrestricted areas and comply with 10 CFR 20.1301(a)(2). This license condition is discussed in SER Section 5.7.2.4.

The staff concurs with the applicant that the types of survey instruments required depend on the exposures and doses expected (Strata, 2011a;2012b). The applicant describes the survey instrumentation that it plans to use in Technical Report Section 5.7.2 and Table TR RAI 32-1 in its response to the NRC staff's RAIs (Strata, 2011a;2012b). The applicant commits to calibrating the instruments at least semi-annually by the manufacturer. The applicant will use

check sources to perform instrument response validation and will perform background checks each day that the instrument is used (Strata, 2011a). The staff finds the applicant's description of instrument use and calibration is consistent with the recommendations in Section 8, Calibration of Survey Instruments, in Regulatory Guide 8.30, and in compliance with 10 CFR 20.1501(b) and 20.2103(a). The applicant's commitments are also consistent with acceptance Criterion (3) of SRP Section 5.7.2.3 by (a) identifying the monitoring equipment by type, (b) describing the use of the monitoring equipment to protect health and safety, and (c) describing the calibration methods, frequency, and sensitivity.

Figure 1 of Regulatory Guide 8.30 (NRC, 2002a) shows that the surface beta dose rate changes as a function of time after separation from the ore as the short-lived uranium progeny increase. The applicant states in Section 5.7.2.2 of the technical report that it will conduct beta exposure rate surveys at the specific operations that involve direct handling of large quantities of aged yellowcake (Strata, 2011a;2012b). The applicant describes these areas in the CPP to include areas associated with precipitation, dewatering (filter press) and drying/packaging of yellowcake. The applicant states that it will conduct these surveys near the surface of the material (e.g., within 10 cm) to be representative of beta exposure rates to workers' hands and skin during the handling of the material. The applicant states that it will use the information provided in Regulatory Guide 8.30 Figures 1 and 2 for any beta exposure rate evaluations that it performs in lieu of instrument surveys (Strata, 2012b).

The applicant states that it does it does not expect beta radiation to be a problem given that storage periods for dried yellowcake will be brief (Strata, 2011a;2012b); and therefore, no significant in growth of beta emitting progeny (i.e., Pa-234, Th-234) is produced. The applicant states that small amounts of precipitates that could contain aged yellowcake as scale in pipes and/or tanks are not accessible to workers except for very brief periods during maintenance activities. Because the workers would not be exposed to the scale for periods longer than a few minutes at a time, the applicant does not expect personnel beta exposures. The applicant commits to characterize the radionuclide composition of the yellowcake product relative to (1) isotopic composition and (2) total alpha vs. beta activity during the initial yellowcake operations (Strata, 2012b).

The applicant further commits in application Section 5.7.2.2 to conduct beta surveys during initial operations in yellowcake areas to evaluate the beta component and to use this evaluation to establish alpha vs. beta ratios for ISR products (Strata, 2012b). The applicant plans to use the data to (1) define instrument selection and measurement protocols to establish the static and scan MDCs for alpha and (2) establish the ratios of alpha vs. beta activity to determine if separate beta measurements are required. The applicant anticipates that alpha vs. beta relationships can be established such that it may use a gross alpha-only measured value below which there is no significant beta component and/or that the beta/gamma unrestricted releases limits are met (Strata, 2011a;2012b). However, to ensure that the applicant complies with 10 CFR 20.1501(a), which requires each licensee to conduct surveys that evaluate the magnitude and extent of radiation levels, quantities of radioactive material, and the potential radiological hazards, staff will include a license condition (presented in SER Section 5.7.6.4) to ensure that the applicant meets its commitment to evaluate the relationship between alpha and beta radiation at the Ross ISR Project. SER Section 5.7.6.4 discusses this license condition as it evaluates the applicant's contamination survey program in application Section 5.7.6.

The applicant commits to specify requirements in standing SOPs or ad hoc RWPs for performing beta surveys of "aged yellowcake" to which workers may be exposed during maintenance activities (e.g., scale in pipes, pumps, tanks, etc.) (Strata, 2011a). The applicant

states that it may modify these requirements over time as it collects and evaluates the study data (Strata, 2011a;2012b). The staff finds that the applicant's plans to conduct beta exposure surveys are consistent with acceptance Criterion (8) of SRP Section 5.7.2.3 and are consistent with recommendations to conduct surveys and re-evaluate the radiation safety program to minimize exposures in Regulatory Guides 8.10, 8.30, and 8.31. The staff finds the applicant's commitment to evaluate beta dose rates acceptable to comply with 10 CFR 20.1501(a). Based on the information presented above and the additional data requested in the aforementioned license condition, the staff has reasonable assurance that the applicant's radiation monitoring program is in compliance with 10 CFR 20.1101 and 20.1501(a)(2)(i).

5.7.2.3.2 Personnel Monitoring

The applicant identifies its criteria to provide employees personnel dosimetry in Section 5.7.2.3 of the technical report (Strata, 2011a;2012b). The proposed criteria are that the applicant will provide all full-time employees with personnel monitoring devices. Strata states that it finds it unlikely that any personnel will receive 10 percent of the 10 CFR 20.1201(a) dose limit from external sources during a single year. The applicant acknowledges that 10 CFR 20.1502(a)(1) requires personnel monitoring if the expected dose is in excess of the 10 percent level; however the applicant commits to monitoring all employees though not required by regulations.

The applicant states that it will administer the external dosimetry program in accordance with Regulatory Guides 8.30 (NRC, 2002a), 8.34 (NRC, 1992b), and 8.36 (NRC, 1992c). The applicant intends to use a commercial personnel dosimetry service accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) to monitor beta and gamma exposure with a minimum range of 1 mrem to 1000 mrem, which will be exchanged them quarterly. Strata will use personnel dosimetry to measure the deep dose equivalent (DDE), which will be used to determine the total effective dose equivalent (TEDE). Strata will maintain a permanent dose record for each employee. Results from the external dosimetry program will be entered into each employee's personal exposure record and integrated into the overall dose assessment program as the applicant describes in technical report Section 5.7.4 (Strata, 2011a;2012b).

According to Table TR RAI 34-1, *Summary of Ross Personnel Dosimetry Program Requirements* (Strata, 2012b), which the applicant provided in response to the NRC staff's request for additional information (NRC, 2012b), Strata will provide dosimetry to part time employees, personnel occasionally on site, contractors, and visitors that enter any area where the exposure rate could exceed 2 mrem/hr. The applicant states in application Section 5.1.9.2 that the RSO will investigate any dosimetry result greater than 25 percent of the limits of 10 CFR 20.1201 and will determine cause and/or institute corrective actions as may be necessary to maintain exposures ALARA (Strata, 2012b). Therefore, the staff finds that the applicant's personnel monitoring program for employees, contractors, and visitors complies with 10 CFR 19.13 and 10 CFR Part 20, Subparts C, D, F, and L. The applicant's description of the personnel monitoring program meets SRP Section 5.7.2.3 acceptance criteria (2) and (10) because the application provides criteria to be used in establishing which employees are to receive external exposure monitoring and follows recommendations in Regulatory Guide 8.34, Section C (NRC, 1992b). The applicant meets SRP Section 5.7.2.3 acceptance Criterion (6) by including a description of radiation dose levels for corrective action that are consistent with the 10 CFR Part 20 regulatory requirements.

5.7.2.3.3 Records and Reporting

The applicant addresses records and reporting in Sections 5.7.2.1, 5.7.2.2, and 5.7.2.3 of the technical report (Strata, 2011a). The applicant states that it would maintain survey, calibration, and permanent dose records for each employee as required by 10 CFR 20.2102(a)(1), § 20.2103(a) and (b)(1), and § 20.1501.

Staff finds that the applicant's commitments to maintain records and reporting acceptable because the applicant's proposed methods for record keeping and reporting are those used by existing NRC and agreement-state licensees and have been shown to provide records and reporting that are protective of human health and safety and the environment. If issued a license, during routine compliance inspections, recording keeping and reporting are scrutinized by NRC staff. Non-compliance with the personnel and survey record keeping and reporting requirements will result in a violation. Therefore, staff has reasonable assurance that the applicant will adhere to its commitments.

5.7.2.4 Evaluation Findings

The staff reviewed the radiation safety controls and monitoring aspects of the proposed Ross ISR Project in accordance with the acceptance criteria in SRP Section 5.7.2.3. The applicant has provided a drawing that depicts the facility layout and the location of external radiation monitors. The applicant has identified radiation instrumentation that it will use to conduct gamma radiation surveys and has described the frequency of these surveys. The applicant has committed to conduct beta dose rate surveys in accordance with Regulatory Guide 8.30 when needed. The applicant will provide dosimetry to all process plant employees and measure the DDE and shallow-dose equivalent, if applicable. Although the staff has reasonable assurance that Strata will comply with radiation exposure limits in 10 CFR Part 20 by ensuring that unrestricted areas do not exceed 2 mrem/hr and that surveys will be conducted with the appropriate survey instruments, the staff is including two standard license conditions to ensure that these requirements are met. The first condition addresses the treatment of restricted area:

Standard License Condition 10.17

> Any area with exposure rates that exceed 2 millirem in any one hour must be immediately treated as a restricted area in accordance with 10 CFR 20.1301(a)(2).

The second license condition addresses the requirement in 10 CFR 20.1501(a)(2)(i) to conduct surveys to evaluate the magnitude and extent of radiation levels. The range of one of the gamma radiation survey meters proposed by the applicant will not meet requirements for radiation exposure readings above 5 mR/hr, which the applicant stated may occur within the facility. Therefore, the staff includes the following standard license condition:

Standard License Condition 10.15

> The licensee will use calibrated radiation instruments that can measure the full range of radiation exposure rates or dose rates for radiological parameters that are reasonably expected at an ISR facility to ensure the magnitude and extent of radiation levels are measured in accordance with 10 CFR 20.1501(a)(2)(i). The instruments used to measure airborne concentrations of radioactive materials will allow for a lower limit of detection (LLD), as described in Regulatory Guide 8.30

(as revised), to provide a 95 percent confidence that measurements are in conformance with 10 CFR 20.1201, 20.1204, 20.1301, 20.1501, and 20.1502.

In addition to the above license conditions, staff acknowledges two other pre-operational license conditions presented in other SER sections that compliment the radiation safety program. The first license condition, as discussed in SER Section 7.7.4.4, requires the applicant to establish procedures to ensure unmonitored employees will not exceed the established dose limits. The second license condition, as discussed in SER Section 7.7.6.4, requires the applicant to establish a survey program for radiological material.

Based upon the review conducted by the staff as indicated above, the staff is reasonably assured that the applicant's external radiation monitoring program will be consistent with the applicable acceptance criteria in standard review plan Section 5.7.2.3. This reasonable assurance determination is based on the information presented in the approved application, as supplemented by the information discussed in the aforementioned license condition. Therefore, the external radiation monitoring program meets the applicable requirements of 10 CFR 20.1101, 20.1201(a), 20.1501 and 20.1502, and 10 CFR Part 20, Subparts L and M.

5.7.3 In-Plant Airborne Radiation Monitoring Program

5.7.3.1 Regulatory Requirements

The staff determines if Strata has demonstrated that the proposed in-plant radiation monitoring program for the Ross ISR 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

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria in Section 5.7.3.3 of the SRP (NRC, 2003). Regulatory Guide 8.30 provides guidance on how the applicant can demonstrate compliance with the regulations.

5.7.3.3 Staff Review and Analysis

This section describes the in-plant airborne radiation-monitoring program. In-plant airborne radiation monitoring includes the airborne uranium particulate monitoring, radon progeny concentration monitoring, and respiratory protection program. In-plant airborne radiation monitoring measures airborne concentrations at various locations in the processing plant to determine necessary posting requirements, respiratory protection needs, and dose assessments. In demonstrating compliance with these requirements, the applicant must provide acceptable methods for determining internal radiation dose including accounting for the presence of mixtures of contaminants as described in 10 CFR Part 20, Subpart C. Table 1 in Appendix B to 10 CFR Part 20 specifies the Derived Air Concentrations (DACs) for each contaminant. Each DAC identifies the concentration for that radionuclide that, if breathed over a course of 2000 hours by a worker, would result in an Annual Limit of Intake (ALI), which equates to the annual occupational dose limit.

5.7.3.3.1 General Program Description

The staff acknowledges that while the primary operations at Ross ISR Project will be wet operations and the lixiviant will be contained within its primary boundary, airborne radioactivity could result from spills, leaks, and maintenance activities. The in-plant airborne radiation monitoring program is designed to detect these contaminants if they escape the primary boundary and become airborne.

The applicant states in Section 5.7.3 of the application (Strata, 2011a) that the proposed locations of routine airborne particulate and radon progeny sampling are depicted in Figure 5.7-5 of the technical report. The applicant states that it will conduct weekly area air sampling initially, but the frequency may be changed based on results at the discretion of the RSO.

5.7.3.3.2 Airborne Particulate Uranium Monitoring

The applicant states in Section 5.7.3.1 of the application (Strata, 2011a) that it will measure airborne uranium particulates by gross alpha counting of the glass fiber filters using a Ludlum Model 2929 alpha/beta sample counting system or equivalent. Samples will be collected monthly using Staplex TFIA Series High Volume Air Sampler or equivalent that it will calibrate according to manufacturer specifications following guidance in Regulatory Guide 8.25 (NRC, 1992a). The applicant states that it will analyze samples within 2 days of sampling, but no less than a delay of 4 to 8-hours. Strata will recount samples 24 hours to verify the measured long-lived alpha concentration (Strata, 2011a;2012b).

Additionally, the applicant commits to using breathing zone samplers, worn on the upper torso, as determined appropriate by the RSO during use of a radiation work permit (RWP), in the drying/packaging area or anytime a worker may be exposed to 12 DAC-hours in any single week. The applicant will use Staplex model PST-2X Personal Air Sampler or equivalent as breathing zone samplers, which Strata will calibrate according to the manufacturer's qualifications or semi-annually, whichever is more frequent (Strata, 2011a).

The staff acknowledges that radium-226 and lead-210 (from the decay of radon-222 and its short-lived progeny) might also be present in the air, and thus a mixture of radionuclides might be present on the air filters. Although the applicant (Strata, 2011a) states that analysis of samples would be delayed 4 to 8 hours to allow short-lived radon progeny to decay, the staff notes that gross alpha counting of the air filters will not be able to differentiate specific radionuclides. Consequently, the applicant might not be able to determine accurately if the action level for uranium or other alpha emitting radionuclides, such as radium-226, has been reached by relying on gross alpha counting of the air filters.

To confirm that natural uranium is the primary radionuclide of concern in airborne particulate samples, the applicant states in Section 5.7.3.1.1 of the technical report (Strata, 2012b) that Strata will conduct isotopic airborne sampling to establish that natural uranium isotopes are the exclusive alpha emitting radionuclides of concern in air. Strata will collect composite samples with sampling times long enough to maximize collected material, from several representative air particulate monitoring locations, such as lixiviant, precipitation, and drying/packaging areas. The applicant will analyze samples for U-natural, Th-230, and Ra-226 and will compare results with the mixture exclusion conditions defined in 10 CFR 20.1204(g) to ensure that Strata uses the appropriate DAC limits from 10 CFR Part 20 Appendix B, Table 1. The applicant commits to using the "sum of fractions rule" if a mixture is present greater than the 10 CFR 20.1204(g) exclusion to determine the appropriate DAC. The applicant also commits to characterize

yellowcake product to verify the radiological composition of fresh yellowcake is essentially exclusively uranium (Strata, 2012b).

The applicant states that it will use a DAC value for inhalation Class W natural uranium for occupational airborne concentrations, and stated the LLD for natural uranium, Class W, will be less than 3.0 x 10^{-11} µCi/mL (Strata, 2011a). The staff acknowledges that 3.0 x 10^{-11} µCi/mL of air represents 10 percent of the DAC for natural uranium, Class W, for inhalation in Table 1 of Appendix B to 10 CFR Part 20. Therefore, the staff has determined that the applicant has established the LLD for uranium in air within the processing plant consistent with Regulatory Guide 8.30 and acceptance Criterion (3) of SRP Section 5.7.3.3. However, to ensure that the appropriate DAC is used to limit and determine personnel exposures, as described in Section 5.7.4 of the technical report (Strata, 2011a), staff will include a pre-operational license condition (presented in SER Section 5.7.7.4) that will ensure the applicant conducts the isotopic analyses as stated in the technical report. The analyses to identify the isotopes and concentrations of each isotope present are required to ensure the appropriate DAC is selected from Table 1 in Appendix B of 10 CFR Part 20 and exposures are in compliance with 10 CFR 20.1201 and 20.1204. Additionally, the analyses are required to ensure that the sum of all nuclides are considered in accordance with 10 CFR 20.1204(e)(1) or meet the requirements to be disregarded as described in 10 CFR 20.1204(g) and measured in accordance with 10 CFR 20.1502(b).

5.7.3.3.3 Radon Progeny Concentration Monitoring

The applicant stated in Section 5.7.3.2 of the technical report (Strata, 2011a) that it will collect radon-222 progeny samples on a monthly basis at all locations in the CPP. After collecting sufficient background data, the applicant will collect monthly samples in areas where radon-222 progeny routinely exceed 10% of the regulatory limit or 0.03 working levels (WL) above background and quarterly samples at locations that usually measure below 0.03 WL (Strata, 2011a). Figure 5.7-5 of the application illustrates these locations. The applicant will analyze filter paper samples using standard alpha counting equipment, such a Ludlum Model 2929 alpha/beta sample counting system or equivalent, using the modified Kusnetz method. Furthermore, the LLD for radon-222 with progeny will be no greater than 0.03 working level (WL) (Strata, 2011a). The staff acknowledges that 0.03 WL represents 10 percent of the DAC for radon-222 with progeny for inhalation in Table 1 of Appendix B to 10 CFR Part 20. Regulatory Guide 8.30 recommends that the quantity of the air sampled and the method of analysis should be 10 percent of the Appendix B to 10 CFR Part 20 limit for radon; therefore, the staff determined that the LLD for radon in air is consistent with Regulatory Guide 8.30 and Appendix B to 10 CFR Part 20, and is, therefore, acceptable.

The applicant states that if at any time the levels of Rn-222 progeny exceed 0.08 WL, the applicant will immediately investigate circumstances or mitigate the situation (Strata, 2011a). The applicant will collect samples weekly at these locations until four consecutive samples measure concentrations below 0.08 WL. The applicant will collect additional samples in areas where upset conditions, maintenance, or an operational change that could result in the release of radon and/or as may be required by an RWP. The applicant states that it will require radon progeny samples collected before an RWP can be issued for work in confined spaces likely to contain radon and progeny (Strata, 2011a).

The staff acknowledges that the purpose of the modified Kusnetz method is to reduce the magnitude of the counting error by use of a time factor to back-calculate the true concentration during sampling if nonequilibrium conditions exist (NRC, 2002a). Considering the nature of the

operational process and activities that could occur in the plant and that radon will be the predominant radionuclide in the plant, the staff notes that a potential exists for nonequilibrium conditions to occur during operations. The applicant states that it will express results of radon progeny sampling in WLs (Strata, 2011a) in accordance with 10 CFR Part 20, where 1 WL is defined as any combination of short-lived radon-222 progeny in 1 liter of air, without regard to equilibrium, that emits 1.3 x 10^5 million electron volts of alpha energy. The staff has reviewed the proposed modified Kusnetz method for the radon progeny monitoring program and determined that the method is consistent with recommendations in Regulatory Guide 8.30 and complies with exposure calculations in 10 CFR 20.1201 and 20.1204. However, as discussed in SER Section 5.7.3.3.2, the applicant must verify that alpha radiation measured is actually radon progeny. By conducting isotopic analyses of air samples and including longer lived radon progeny Po-210 and Pb-210 in the analyses, the staff finds that the applicant can obtain data to support the applicant's assumptions (a) that radon will be the primary airborne radioactive material present and (b) that natural uranium will be the primary air particulate present to be used in dose calculations. Staff has reasonable assurance that fulfillment of the License Condition 10.16, as presented in SER Section 5.7.3.4, and pre-operation License Condition 12.7, as presented in SER Section 5.7.7.4, would provide representative data to verify the applicant's assumptions and confirm that the exposure levels do not pose a hazard to workers or public health and safety.

5.7.3.3.4 Action Levels

Regulatory Position 3.3, "Ventilation Systems," of Regulatory Guide 8.31 states that the facility should establish a facility-specific operational ALARA goal for concentrations of natural uranium and its progeny at less than 25 percent of the DAC values (NRC, 2002b). In application Section 5.7.4.7, the applicant sets an action level of 25 percent of the DAC for natural uranium in the plant (Strata, 2011a;2012b). Due to the lack of actual operational data, the applicant will assume the natural solubility is Class W for purposes of establishing the initial DAC upon plant startup (Strata, 2011a). The staff acknowledges that the DAC for (inhalation Class W) natural uranium is 3 x 10^{-10} µCi/mL. The applicant states that it will estimate and assign the DAC-hrs of exposure to employees when it measures concentrations of 10% of the DAC (Strata, 2011a). The applicant states the RSO will initiate an investigation to determine if corrective actions are necessary when it measures 25% of the DAC, which it has established as an internal administrative limit (Strata, 2011a;2012b). The staff notes that if after operations commence the applicant would like to change the inhalation class, it will be required to submit samples demonstrating that such a change is warranted.

The DAC in Table 1 of Appendix B to 10 CFR Part 20 for radon-222 with its progeny present is 0.33 WL. The applicant proposes an action level of 25 percent of the DAC or 0.08 WL (Strata, 2011a). The applicant indicates that air sample results that exceed the action level would result in an investigation of the cause of the elevated concentrations (Strata, 2011a). The staff has determined that the proposed action level of 25 percent of the DAC for radon-222 with progeny is consistent with Regulatory Guide 8.31 and that the action levels for natural uranium and radon will adequately protect the Ross ISR Project workers and comply with 10 CFR Part 20.

5.7.3.3.5 Respiratory Protection

The applicant commits in application Section 5.7.3.3 (Strata, 2011a) that it will use respiratory protection where engineering controls may not be adequate to maintain acceptable levels of airborne radioactive materials and that this respiratory protection program will be implemented in accordance with 10 CFR 20, Subpart H. The applicant states that workers in the yellowcake

drying and packaging may be required to wear respirators as standard PPE in the unlikely event that process upsets and spills occur. In other circumstances, the applicant will only use respirators in the event that it cannot maintain exposures ALARA with engineering and/or administrative controls. The applicant states that following guidance in Regulatory Guide 8.31 (NRC, 2002b), the RSO will determine when respirators are needed, and that all respirators used on the site will be certified by the National Institute for Occupational Safety and Health (NIOSH) and will be used in accordance with 10 CFR 20.1703 (Strata, 2011a;2012b).

Staff finds the applicant's respiratory protection program to be consistent with the recommendations in Regulatory Guides 8.15 and 8.25 and in compliance with the regulatory requirements in 10 CFR Part 20, Subpart H, Respiratory Protection, with the exception of a quality assurance program. The staff notes that § 20.1703(c)(4)(vii) requires written procedures that address the quality assurance (QA) of respiratory protection equipment in addition to the use and maintenance described by the applicant. The applicant's proposed Quality Assurance Plan (QAP), which is described in application Section 5.7.9 (Strata, 2011a), is planned for environmental and effluent monitoring following guidance in Regulatory Guides 4.14 (NRC, 1980a) and 4.15 (NRC, 2007) . Although the applicant did not specifically address a QA program for the respirator program, the applicant commits to developing and administering a respiratory protection program consistent with requirements in 10 CFR Part 20, Subpart H (Strata, 2011a). In SER Section 5.7.9, the staff includes a pre-operational license condition for the applicant to submit its QAP for staff review and verification, including the QA elements for the respiratory protection program. Therefore, the staff finds the applicant's proposed respiratory protection program to be in compliance with 10 CFR Part 20, Subparts B, C, F, and H, and thus, acceptable.

5.7.2.3.6 Records and Reporting

The applicant states that calibrations and air sampling records will be documented on a form compliant with NRC Regulatory Guide 8.7, Instructions for Recording and Reporting Occupational Radiation Exposure, Revision 1 (NRC, 2005), and maintained by the RSO on-site until the license is terminated. The staff finds the applicant meets SRP acceptance Criterion (5) by describing plans for exposure that are consistent with the requirements 10 CFR Part 20, Subpart L.

5.7.3.4 Evaluation Findings

The staff reviewed the in-plant airborne radiation monitoring program of the proposed Ross Project in accordance with SRP Section 5.7.3.3. The applicant plans to conduct in-plant airborne monitoring consistent with Subpart B, "Radiation Protection Programs," of 10 CFR Part 20 (10 CFR 20.1101), which defines the radiation protection program. This program includes monitoring for the two primary contaminants and the instruments that the applicant will use to collect and analyze the results of the air samples. The applicant has demonstrated that adequate methods will be used to fully evaluate the airborne particulate monitoring as required by 10 CFR 20.1501 and 20.1502(b). The applicant has identified methods that will meet the occupational dose limit requirements of Subpart C of 10 CFR Part 20 and will control the concentration of radioactive material in air as required in § 20.1701. Additionally, the applicant has committed to using the sum of fractions method to determine the appropriate DAC if Strata identifies that a mixture exists that does not meet the exclusion rule of 10 CFR 20.1204(g). To ensure the applicant meets this commitment and complies with the exposure limits in 10 CFR 20.1201, § 20.1204 and Table 1 of Appendix B to 10 CFR Part 20, the staff will include the following standard license condition:

Standard License Condition 10.16:

> The licensee shall conduct radiological characterization of airborne samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 for each restricted area air particulate sampling location at a frequency of once every 6 months for the first two years, and annually thereafter to ensure compliance with 10 CFR 20.1204(g). The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required for compliance with 10 CFR 20.1204(g).

In addition to the above license condition, the staff includes a pre-operational license condition in SER Section 5.7.7.4 requiring the applicant, in part, to quantify the principal radionuclides from all point and diffuse sources.

Based upon the review conducted by the staff as indicated above, the staff finds that the information provided in the application, as supplemented by information that will be submitted in accordance with the noted license condition, meets the applicable acceptance criteria of SRP Section 5.7.3.3 and the requirements of 10 CFR Part 20, Subparts B, C, and H, 10 CFR 20.1501, and 10 CFR 20.1502(b).

5.7.4 EXPOSURE CALCULATIONS

5.7.4.1 Regulatory Requirements

The staff determines if Strata has demonstrated that the proposed exposure calculation for the Ross ISR Project meets 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

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria in Section 5.7.4.3 of the SRP (NRC, 2003). Regulatory Guides 8.13 and 8.36 (NRC, 1992c;1999b) provide guidance on how compliance with the regulations can be demonstrated.

5.7.4.3 Staff Review and Analysis

The following sections discuss the exposure calculations to be performed by the applicant, which include internal and external occupational radiation dose, as well as radiation doses to the embryo/fetus. Occupational workers can be exposed externally and internally to radioactive material in a number of ways. This could include radioactive material in the air, loose surface contamination, or radioactive material that might be stored or processed inside equipment or components.

5.7.4.3.1 Worker Dose Calculations

The applicant states in Section 5.7.4 of the technical report (Strata, 2011a) that it will monitor worker exposures by using the following or a combination of the following methods:

- personal dosimeters,
- bioassay results, and
- measurement of radionuclide concentrations in worker breathing zones.

The applicant will use dosimetry to measure the deep dose equivalent (DDE), which can be used as the effective dose equivalent (EDE) or the external component of occupational exposure (Strata, 2011a). The applicant states that the committed effective dose equivalent (CEDE) or internal dose component of the occupational exposure will be calculated from air sampling results and/or bioassays (Strata, 2011a). The staff acknowledges that both of these components are needed to determine the total effective dose equivalent (TEDE) (i.e., TEDE = DDE + CEDE) to assess compliance with 10 CFR Part 20 annual occupational dose limits. Direct calculations of the annual dose of inhaled radionuclides may be determined from the DAC concentration of a radionuclide in air as discussed in SER Section 5.7.4. The applicant committed in Section 5.7.3 of the technical report to assess the DAC for site-specific conditions (Strata, 2011a). Additionally, the applicant proposes to implement corrective actions for workers that exceed 25 percent of the 10 CFR Part 20 annual occupational dose limits (Strata, 2011a).

The applicant states that it will total and enter intakes onto each employee's occupational exposure record (Strata, 2011a). Reporting and recordkeeping will be consistent with Regulatory Guide 8.7 (NRC, 2005) and 10 CFR 20.2103. The staff finds that the applicant's worker dose calculations and record keeping procedures are consistent with acceptance criteria (1) and (8) of SRP Section 5.7.4.3 (NRC, 2003), are consistent with recommendations in Regulatory Guides 8.7 and 8.34, and are in compliance with requirements in 10 CFR Part 20, Subparts C, F, L and M. The staff finds that the applicant described this information in sufficient detail to demonstrate compliance with the NRC's regulations and that it is, therefore, acceptable.

5.7.4.3.2 External Dose Calculation

The applicant describes worker dose calculations in Section 5.7.4 of the technical report (Strata, 2011a) and states that worker doses will be calculated annually based on personal dosimetry data and the airborne radionuclide concentration measurements if air sampling results exceed 10 percent of the DAC specified in 10 CFR Part 20, Appendix B, Table 1. The applicant commits (Strata, 2011a) to following Regulatory Guides 8.30, 8.34, and 8.36, "Radiation Dose to the Embryo/Fetus" (NRC, 1992b;c;2002a).

The applicant states (Strata, 2011a) that exposure calculations will be based on exposure to natural uranium and radon-222 progeny and will be measured with individual dosimeters, such as TLDs, or optically stimulated luminescence (OSLs) dosimeters that will be exchanged quarterly. Dosimetry will be provided by a vendor with NVLAP accreditation as required by 10 CFR Part 20, Subpart F, and will be issued in accordance with 10 CFR 20.1502(a), to employees that may be exposed to 10 percent of the annual limits in 10 CFR 20.1201, 20.1207, and 20.1208 (Strata, 2011a).

Staff finds that this approach is acceptable for determining external exposures by measurement with an external personal monitoring device and that the applicant will use the DDE to define the TEDE from external exposures. The applicant commits (Strata, 2011a) in Section 5.2.3 of the technical report to recording the results in accordance with 10 CFR Part 20, Subpart L;

therefore, this approach is acceptable to the staff to meet the applicable regulatory requirements, as detailed above.

The applicant has not adequately described how it will ensure that unmonitored employees who do not have dosimetry have not exceeded 10 percent of the dose limit (Strata, 2011a). Consequently, the staff has determined that unmonitored employees could possibly receive a dose in excess of 10 percent of the dose limit. Therefore, the staff will include a license condition requiring the applicant to submit to the NRC for review and approval procedures by which Strata will ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C. SER Section 5.7.4.4 describes this license condition.

5.7.4.3.3 Internal Dose Calculation

The applicant provides equations and input parameters for computing the intake from natural uranium and radon progeny in Section 5.7.4.1, 5.7.4.2, and 5.7.4.3 of the technical report (Strata, 2011a). The equations are as follows:

Equation 1: Calculation of Intake of Uranium Using Monitoring Data

$$I_U = b\sum_{i=1}^{n}\frac{(X_i * t_i)}{PF}$$

Where I_U = Uranium intake (µg, mg, µCi)
b = breathing rate, 1.2 m^3/hr
n = number of exposures in the week or quarter
i = exposure period
Xi = Average concentration of uranium in breathing zone (µg/m^3, mg/m^3, or µCi/m^3), adjusted for sampler efficiencies
t_i = period of exposure (hr)
PF = the respirator protection factor (unitless)

Equation 2: Calculation of Intake of Radon Progeny Using Monitoring Data

$$I_R = \frac{1}{170}\sum_{i=1}^{n}\frac{(W_i * t_i)}{PF}$$

Where I_R = Radon progeny intake (WLM)
170 = Number of hours in a working month
n = Number of exposure periods during the year
i = exposure period
Wi = Average number of working level concentrations in or near the worker's breathing zone during the time (t_i),
t_i = period of exposure (hr)
PF = the respirator protection factor (unitless)

Equation 3: Calculation of CEDE from Uranium Intake

$$CEDE_U = \frac{I_U * 5000}{ALI}$$

Where *CEDE* = committed effective dose equivalent from uranium (mrem)
I_U = Uranium intake (µCi)
5000 = Radiation dose in mrem from the intake of 1 ALI
ALI= Annual limit of intake for uranium presented in 10 CFR 20, Appendix B, Table 2 (assume class W solubility for U-nat DAC/ALI until operational data verify class D)

Equation 4: Calculation of CEDE from Inhalation Intake of Radon and Radon Progeny

$$CEDE_U = \frac{I_R * 5000}{ALI}$$

Where *WL CEDE* = committed effective dose equivalent from radon and radon progeny (mrem)
I_R = Radon and radon progeny intake (working level months (WLM))
5000 = Radiation dose in mrem from the intake of 1 ALI, assumed to be equivalent to 4 WLM/yr
ALI= Annual limit of intake for radon and radon progeny in WLM

The staff finds that the equations and input parameters follow recommendations in Regulatory Guides 8.30 and 8.25, and, as such, are in compliance with 10 CFR 20.1202 and 20.1204. The applicant states (Strata, 2011a) that it will analyze the in-plant air particulate samples for gross alpha, assumed to be primarily natural uranium, and will convert the gross alpha counts from the filter paper to airborne concentration of natural uranium. The applicant will assume the airborne uranium particulates to be inhalation Class W with DAC of 3×10^{-10} µCi/mL until it has characterize its air sampling data in the CPP (Strata, 2011a). As stated in SER Section 5.7.3.3.4, the applicant will be required to submit a request with sampling results to the NRC if it wishes to change the inhalation class after operations begin.

The staff finds that the applicant's calculations using the working level for the measured concentration of radon progeny, as determined by the modified Kusnetz method, to determine the CEDE and the equation used to calculate the CEDE are:

(1) consistent with acceptance criteria (2) and (3) of SRP Section 5.7.4.3 because the exposure calculations for natural uranium are consistent with Regulatory Guide 8.30, Section 3, and

(2) airborne radon progeny exposure is consistent with Regulatory Guides 8.30 and 8.34, Section C. Additionally, the staff finds that the applicant's method of calculation is consistent with the recommendations in Regulatory Guides 8.25 and 8.30 and complies with 10 CFR 20.1201(d) and 20.1204.

In accordance with 10 CFR 20.1204(f), if the identity of each radionuclide in a mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the DAC

for the mixture must be the most restrictive DAC of any radionuclide in the mixture. The applicant states that to confirm that natural uranium is the primary radionuclide of concern in airborne particulate samples, isotopic airborne samples will be analyzed from air particulate monitoring locations in Figure 5.7-5 of the technical report (Strata, 2011a). Results of these samples will be compared with the mixture requirements in 10 CFR 20.1204(g) to ensure that the appropriate DAC value is used. If a "mixture" exists that does not meet the exclusion rule of 10 CFR 20.1204(g), a sum of fractions method will be used to determine the appropriate DAC (Strata, 2011a).

As discussed in SER sections 5.7.3.3.2 and 5.7.6.3.1.1, the applicant will need to have the isotopic analyses of the air samples to verify that uranium or radon progeny or a mixture of radionuclides are present and to calculate workers doses in accordance with 10 CFR Part 20. The staff has determined that the applicant will need to conduct periodic isotopic airborne sampling and compare the results to 10 CFR 20.1204(g) to ensure that the appropriate DAC from Table 1 of Appendix B to 10 CFR Part 20. Staff will include a pre-operational license condition in SER Section 5.7.7.4 requiring the applicant to develop a program to quantify the principal radionuclides in its effluent and a license condition, as documented in SER Section 5.7.3.4, that requires to applicant to characterize the radionuclide composition of air samples at the air particulate sampling locations on an established frequency during operations.

The applicant states in Section 5.7.3.1 of the technical report (Strata, 2011a) that it will use breathing zone samplers when workers may be exposed to airborne radioactivity in excess of 10 percent of the DAC, and will record the time of exposure as the actual time the sampler was worn. The staff finds that the applicant's proposed use of (a) breathing zone samplers, (b) the DAC to determine the CEDE, and (c) the equation used to calculate the CEDE is consistent with acceptance criteria (5) and (6) of SRP Section 5.7.4.3 because (a) the applicant described exposure calculations for routine, non-routine, maintenance, and cleanup operations, and (b) exposure calculations are representative of conditions at the site and include time-weighted exposures that incorporate occupancy time and average airborne concentrations. Furthermore, the staff finds that the applicant's above proposal is consistent with guidance in Regulatory Guides 8.25 and 8.30 and in compliance with 10 CFR 20.1204.

In addition to the annual dose limits, the applicant will limit soluble uranium intake by an individual to 10 mg in a week in consideration of the chemical toxicity in accordance with 10 CFR 20.1201(e) (Strata, 2011a). The applicant states the average concentration at the soluble weekly intake limit is approximately equal to 50 percent of the DAC. The applicant assumes a specific activity of 0.67 uCi/gram for natural U from 10 CFR 20, Appendix B, footnote 3, and therefore will use 6.7E-03 uCi as the weekly soluble intake limit. The applicant states it will use solubility Class W to establish the appropriate ALI of 0.8 uCi and DAC of 3.0E-10 uCi/ml for natural U from 10 CFR 20, Appendix B, Table 1. The applicant will demonstrate compliance with 10 CFR 20.1201(e) by recording worker airborne exposure in DAC–hours whenever long-lived particulate concentrations in air are determined to be greater than or equal to 10 percent of the DAC. Strata will use 25 percent of the DAC as an action level requiring RSO investigation and potential corrective actions. The applicant states that positive airborne exposures will be reviewed weekly and any exposures of soluble uranium greater than 5 percent of the 10 mg per week limit will be recorded (in DAC hours) and controlling exposures to be 25 percent of the DAC. The applicant states that this procedure will ensure that the applicant does not exceed the weekly intake limit and will be ALARA (Strata, 2011a).

The staff finds that the applicant's procedures are consistent with acceptance Criterion (1) in SRP Section 5.7.4.3 by describing proposed methodologies in accordance with 10 CFR

20.1201 and 20.1204 and that the applicant has demonstrated an acceptable method for ensuring the soluble intake of uranium is limited to comply with 10 CFR 20.1201(e). Staff presents a license condition in SER Section 5.7.7.4 that will require the applicant to characterize the principal radionuclide composition with regard to mixtures but during the interim, uses sufficiently conservative assumptions on the internal dose intake calculations that are protective of the worker's and public health and safety. Therefore, staff concludes with reasonable assurance that the proposed internal dose calculations, supplemented with the noted license condition, meet the regulatory requirements.

5.7.4.3.4 Prenatal/Fetal Dose

The applicant states in Section 5.7.4.7 of the Technical Report (Strata, 2011a) that it will determine the dose equivalent to the embryo/fetus by monitoring its declared pregnant female employees at the Ross ISR Project. The applicant will use the DDE during the gestation period and the applicant will apply this DDE to the embryo/fetus for external dose. For internal dose, the applicant will perform exposure calculations in accordance with Regulatory Guide 8.36. The staff finds these procedures for calculating and limiting the dose of the pregnant employee and fetus to be acceptable, as they are consistent with the guidance in Regulatory Guide 8.36 and acceptance Criterion (4) of SRP Section 5.7.4.3 (NRC, 2003); thus, they comply with 10 CFR 20.1208.

5.7.4.3.5 Records and Reports

Strata will maintain a permanent dose record for each employee according to Regulatory Guide 8.7 (NRC, 2005). According to 10 CFR 19.13, "Notifications and Reports to Individuals," any employee may request a written report of his or her exposure history at any time. Pursuant to 10 CFR 19.13, these reports must be provided within 30 days of the request or within 30 days after the exposure of the individual has been determined by the licensee, and must provide the information indicated in the regulation. Although the applicant did not specifically state that it would provide an exposure report within 30 days upon request from an employee, the description of the annual worker training in Section 5.5 of the technical report (Strata, 2011a) provides the NRC staff reasonable assurance that the applicant is prepared to meet this regulatory requirement. Because the applicant states in Section 5.5 of the application that annual training would include worker rights, responsibilities, and notifications "to insure that site personnel will, at all times, have sufficient awareness", the staff has reasonable assurance that the applicant is aware of, and will comply with, the regulatory requirements of 10 CFR Part 19.

The staff finds that the applicant's discussion of monitoring, records, and reports is consistent with acceptance Criterion (8) of SRP Section 5.7.4.3 and in compliance with the regulatory requirements in 10 CFR Part 20, Subparts F, L, and M. Therefore, the staff finds these procedures acceptable.

5.7.4.4 Evaluation Findings

The staff reviewed the exposure calculations for the proposed Ross ISR Project in accordance with SRP Section 5.7.4.3. The applicant has identified techniques for exposure calculations at the Ross ISR Project to determine intake of radioactive materials by personnel in work areas. The applicant provided exposure calculations for natural uranium and airborne radon progeny exposure. These calculations include prenatal and fetal radiation, as well as routine operations, nonroutine operations, maintenance, and cleanup activities. The applicant has classified the inhalation class and solubility for the DAC to determine the correct internal dose. The applicant

will also identify each radionuclide in a mixture when the concentration of one or more is not known, so that the DAC for the mixture is the most restrictive DAC of any radionuclide in the mixture, as required by 10 CFR 20.1204 and 20.1502(b). A license condition, described in SER Section 5.7.3.4, will be imposed to ensure that these requirements are met.

The applicant's program for calculating internal and external exposures to workers is acceptable, except that the applicant has not completely described the methods that it will use to comply with 10 CFR 1502(a)(1) by ensuring that unmonitored employees who do not have dosimetry have not exceeded 10 percent of the dose limit. Therefore, the staff has included the following facility specific license condition that must be fulfilled prior to commencement of operations:

Facility Specific License Condition 12.9:

> Prior to the preoperational inspection, the licensee shall submit to the NRC staff, for review and verification, procedures by which it will ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C.

Based upon the review conducted by the staff as indicated above, the staff is reasonably assured that the applicant will properly calculate internal and external exposures to workers, contingent upon the applicant's fulfillment of the above license condition. Furthermore, the information provided in the application, as supplemented by information submitted in accordance with the noted license condition, is consistent with the acceptance criteria of SRP Section 5.7.4.3 and meets the requirements of 10 CFR Part 20, Subparts C, F, L, and M.

5.7.5 BIOASSAY PROGRAM

5.7.5.1 Regulatory Requirements

The staff determines if Strata has demonstrated that the proposed bioassay program for the Ross ISR Project meets the requirements of Subparts C, L, and M of 10 CFR Part 20.

5.7.5.2 Regulatory Acceptance Criteria

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

5.7.5.3 Staff Review and Analysis

The following sections discuss the applicant's proposed bioassay program, which is designed to monitor and document potential internal uptakes and radiation exposures and to confirm the results of the airborne uranium particulate monitoring program.

5.7.5.3.1 Frequency

The applicant stated in Section 5.7.5 of the technical report (Strata, 2011a) that the bioassay program will follow guidelines set forth in Regulatory Guide 8.22 and NUREG-0874, Internal Dosimetry Model for Applications to Bioassay at Uranium Mills (NRC, 1986b;1988b); and that

urinalysis will be the bioassay method used to detect exposures to low-fired, relatively soluble uranium compounds. Strata proposed in Section 5.7.4 of the technical report to initially assume that airborne uranium compounds are inhalation Class W and to evaluate the solubility issue after operations begin. According to the applicant, it will collect bioassay samples at the following frequencies:

- baseline urinalysis sample for new employees prior to working at the facility;
- monthly for employees who have the potential to be exposed to dried yellowcake or more frequently as determined by the RSO; and
- upon termination of employment for all employees.

The applicant stated that it would establish action levels for employees that submit bioassay samples based on Tables 1 and 2 of Regulatory Guide 8.22 (Strata, 2011a). Furthermore, employees will deposit and submit the monthly urine samples following 1–2 days off from work to allow for clearance and elimination of uranium that does not become systemic and absorbed by the kidneys. According to the applicant, standard practice for routine urinalysis programs is to assume that the exposure/intake occurred on the day or days immediately following the previous sample collection. Additionally, the applicant stated (Strata, 2011a) that samples may also need to be collected in response to the following:

- potentially elevated airborne concentrations;
- as may be required by RWPs;
- whenever respiratory protection devices are found to be internally contaminated following use; and
- whenever internal exposure has been suspected, such as in response to positive nasal and/or mouth swabs.

The staff finds that the proposed collection frequency and analysis of urine samples are consistent with recommendations in Regulatory Guide 8.22 to ensure occupational exposures are monitored and comply with the limits in 10 CFR Part 20, Subparts C and F.

Regulatory Guide 8.22 recommends that users consider in vivo lung counts or alternate sampling times and action levels for exposures to Class W or Class Y materials. The applicant does not commit to using in vivo analysis, but states that it would assess in vivo analyses as a necessary follow up to confirmed urinalysis results in excess of action levels (Strata, 2011a), as specified in Table 1 of Regulatory Guide 8.22 (NRC, 1988b). However, the applicant states that the contingency alluded to in NUREG-0874 is not applicable to soluble modern ISR yellowcake products, such as produced at the proposed Ross ISR Project, because the yellowcake products will be typical of soluble, low-fired yellowcake (UO_3/UO_4 class D/W). The applicant states that a National Radiation Protection Board reference (Stradling et al., 2002) suggests that in vivo lung counting as a bioassay technique is unlikely to provide useful information because of the high solubility of low temperature products in vitro (Strata, 2011a). The staff finds that this procedure is acceptable, as it is consistent with the recommendations in Regulatory Guide 8.22 and complies with occupational exposure requirements in 10 CFR Part 20, Subparts C and F.

5.7.5.3.2 Dose Determination

The applicant stated in Section 5.7.5 (Strata, 2011a) that it will assign occupational dose to workers using the stochastic inhalation ALI and DAC per methods 1 and 2 identified in Regulatory Guide 8.30. At air concentrations that exceed 10 percent of the DAC, the applicant

will estimate and assign the DAC-hrs to workers. The applicant stated that the methods and assumptions described in Regulatory Guide 8.9 will be used to estimate and assign internal dose using bioassay results (Strata, 2011a).

The applicant states that if a positive urinalysis result is confirmed, the RSO will conduct an investigation into the circumstances and determine whether internal exposure for an individual should be determined based on bioassay results in accordance with recommendations in Regulatory Guide 8.22 (Strata, 2011a). The applicant states that for any two consecutive samples confirmed to be in excess of 35 ug/liter, or any single specimen confirmed to be in excess of 130 ug/liter, the applicant will collect daily urine samples from the affected employee. The applicant states it may consider at the discretion of the RSO, an in vivo lung count to ascertain if the employee may have been exposed (Strata, 2011a).

The staff finds that the applicant has defined an acceptable method for evaluating events when the applicant confirms positive bioassay urinalysis results and makes a decision to convert the confirmed results to a dose. The staff finds that the applicant's methodology described in the application complies with the requirements in 10 CFR Part 20, Subparts C and F.

5.7.5.3.3 Records and Reporting

10 CFR Part 20, Subparts L and M require recording and reporting monitoring results for employees who are monitored for internal and/or external exposure as required by 10 CFR Part 20, Subpart C. The applicant states that a permanent radiation dose record for each worker will be maintained by the RSO in a format compliant with NRC Regulatory Guide 8.7 (Strata, 2011a). Strata will provide copies annually to each worker and upon termination of employment. As discussed in SER Section 5.7.3, the applicant states that the RSO will investigate the cause and possible methods to modify procedures to reduce exposures if a worker receives greater than ten percent of the occupational dose limits in 10 CFR Part 20, Subpart C. The RSO will document investigation findings and results of any corrective actions (Strata, 2011a).

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

5.7.5.3.4 Quality Assurance/Quality Control (QA/QC)

The applicant commits to follow the QA/QC guidance in Regulatory Guide 8.22 (Strata, 2011a). The applicant will send four blind samples to the laboratory with each batch of samples. The four blind samples will consist of the following: two blank samples with no added uranium, one sample with 10 - 20 µg/L, and one sample with 40-60 µg/L of uranium, respectively, as specified in Regulatory Guide 8.22. Strata states that the contract laboratory's LLD for uranium in urine will be 5 µg/L or less. If the laboratory results are not within 30 percent of the actual uranium concentrations, the laboratory will re-analyze the samples. In addition, 10 percent of the samples, including blanks and standards, will undergo a duplicate analysis by the laboratory (Strata, 2011a).

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

5.7.5.4 Evaluation Findings

The staff reviewed the bioassay program for the proposed Ross ISR Project in accordance with SRP Section 5.7.5.3. The applicant has provided a description of the program for baseline bioassay urinalysis prior to, during, and upon exiting employment. Individuals routinely exposed to yellowcake dust are a part of the bioassay program and, as indicated in SER Section 5.7.6.3.1, action levels identified in Table 1 of Regulatory Guide 8.22 will be used at this site.

The applicant has assumed that the inhalation class for the uranium at the Ross ISR Project is Class W, and acknowledges that tests would be required to change that class. Furthermore, the applicant discussed the manner in which confirmed bioassay (urinalysis) results will be converted and assigned as an internal dose to the individual in accordance with 10 CFR 20.1204(b), 20.1703(c)(2), and 20. 2103(b)(3). Based upon the review conducted by the staff as indicated above, the information provided in the application is consistent with the applicable acceptance criteria of SRP Section 5.7.5.3 and meets the requirements of 10 CFR Part 20, Subparts C, L, and M.

5.7.6 CONTAMINATION CONTROL PROGRAM

5.7.6.1 Regulatory Requirements

The staff determines if Strata Energy (Strata or the applicant) has demonstrated that the proposed contamination control program for the Ross ISR Project meets the requirements of Subparts B, C, and F of 10 CFR Part 20.

5.7.6.2 Regulatory Acceptance Criteria

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

5.7.6.3 Staff Review and Analysis

This section discusses the applicant's proposed contamination control program. The contamination control program is designed to detect radiological contaminants that have escaped the boundary of the uranium recovery process equipment. This contamination can take the form of loose surface contamination that resides on structures, equipment, materials, or personnel. The purpose of this program is to ensure that contamination will be confined and monitored in known areas and not spread to areas outside of the confined area (e.g., lunchroom, bathrooms, office areas, etc.) or to unrestricted areas.

5.7.6.3.1 Contamination Surveys

The applicant proposed a contamination control program that addresses contamination surveys for personnel, plant area, and material and equipment release in Section 5.7.6 of the technical report (Strata, 2011a).

5.7.6.3.1.1 Personnel Contamination Surveys

The applicant states in Section 5.7.6.2 of the technical report (Strata, 2011a) that it will designate and post the processing area of the plant as restricted and limit access to only those individuals who (a) have received appropriate training and/or (b) are escorted by an experienced employee. Application Figure 5.7-4 illustrates the proposed restricted area. Further, the applicant states that it will designate and label all exit doors from restricted areas that do not have contamination survey equipment as emergency exits only. The applicant stated that the RSO might choose to approve a temporary contamination survey station at exits if needed (Strata, 2011a).

According to the applicant, all individuals must perform and document an alpha contamination survey before leaving a restricted area (Strata, 2011a). In addition, individuals who have been in the wellfields or byproduct storage area or near the deep well or storage ponds will perform and document an alpha survey immediately upon returning to the office, before eating, or before leaving the mine site, whichever comes first. The applicant indicated that it will perform contamination surveys with a Ludlum Model 43 alpha detector and a Model 177 alarming ratemeter or equivalent. According to the applicant, a typical alarm setting is 20 counts per minute (Strata, 2011a).

The applicant's description of personnel contamination surveys is acceptable to the staff, except with respect to beta-gamma contamination surveys. The applicant proposes equipment and instruments needed to comply with 10 CFR Part 20; however, it states in Section 5.7.6.2.1 of the technical report (Strata, 2011a;2012b) that it will not perform beta-gamma contamination surveys if it does not detect alpha contamination. The applicant justifies this statement by concluding that in-growth of beta-gamma contamination from fresh yellowcake product will require approximately four months, and that fresh yellowcake will not remain at the facility long enough for such in-growth to occur (Strata, 2012b). Additionally, the applicant states that the radionuclide composition of material in an ISR plant would be almost exclusively natural uranium and/or radium-226 and that there is very small amount of in growth of other progeny during the brief life cycle of the material through the plant. The applicant states that the radionuclide characterization program it plans to conduct during the initial few months of operation will provide information on the potential for the presence of significant beta activity and need for beta/gamma surveys in addition to alpha surveys in the plant (Strata, 2012b).

The staff notes that aged yellowcake can remain in certain portions of the facility from spills and maintenance activities. Further, radon-222 is also a radioactive constituent in groundwater and ISR lixiviant, and is produced from the decay of radium-226 in the plant. Radon-222, a radioactive gas with a 3.8-day half-life, decays to several solid particles that tend to be electrically charged and can deposit on surfaces or attach to dust particles (Mohamed et al., 2008). The short-lived progeny decay to lead-210, a beta-emitter, that can build-up in buildings, if the ventilation is not adequate to ensure complete air exchange. Further, the staff notes that in contrast to applicant's statement that the very small amount of in growth of other progeny will be associated with its alpha emitting parents, such as natural uranium isotopes and radium 226, lead-210 produced from radon-222 gas released in the building, will not be associated with

these alpha-emitters. Therefore, to ensure compliance with the ALARA requirements in 10 CFR Part 20, the staff is including a license condition discussed in SER Section 5.7.7.4. This license condition will require the applicant to develop, prior to the pre-operational inspection, a survey program for beta-gamma contamination for personnel contamination from restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F.

Based on its review of the applicant's personnel contamination survey program, the staff is reasonably assured that this program is sufficient to protect occupational health and safety. This reasonable assurance determination is contingent upon the fulfillment of the license condition presented in SER Section 5.7.7.4 and discussed above.

5.7.6.3.1.2 Plant Area(s) Contamination Surveys

The applicant states in Section 5.7.6.1 of the technical report (Strata, 2011a) that it will regularly evaluate, by visual inspection and measurement, surface contamination in restricted plant areas. The applicant will conduct weekly surveys in the plant using hand held instrumentation, such as portable rate meters with pancake type Geiger-Mueller (GM) or large area scintillation detectors, to assess both fixed and removable contamination. The RSO or RST will conduct daily visual inspections for detecting yellowcake contamination on surfaces, which the applicant will clean up promptly. Further, the applicant states that it will control surface contamination in restricted areas to minimize the potential for resuspension of uranium dust that can result in inhalation or ingestion intake. The applicant proposes to use the alpha contamination limits recommended by the International Atomic Energy Agency (IAEA, 1976) of 10^{-3} μCi/cm^2 (220,000 dpm/100 cm^2), which is equivalent to about 2 mg/cm^2 of natural U (Strata, 2011a).

For unrestricted areas (e.g., offices, laboratory, etc.) and restricted areas of the plant where the applicant will not perform work with uranium, the applicant states that Strata will survey these areas weekly for removable contamination (smear surveys) (Strata, 2011a). The applicant states that it will immediately clean and re-survey any areas that exceed the contamination limit of 1000 dpm alpha per 100 cm^2 (Table 2, Regulatory Guide 8.30 (NRC, 2002a)). Strata states that it will clean and remove any contamination detected in these areas to maintain doses ALARA. The applicant states it will conduct special contamination surveys as specified in SOPs and RWPs. The applicant states that whenever standing SOPs do not address radiation safety controls specific for the work, the applicant will need to prepare and approve an RWP prior to initiation of the job. The applicant states that RWPs will specify additional survey, personal protective equipment, documentation, and related requirements to ensure the applicant performs the work safely and in accordance with ALARA principles (Strata, 2011a). The staff notes that plant area contamination surveys address alpha contamination, but not beta-gamma contamination

Similar to personnel contamination surveys, which the SER discussed in the previous section, Strata's plant contamination survey program is acceptable, except that it does not address the potential for beta-gamma contamination. Therefore, to ensure compliance with the ALARA requirements in 10 CFR Part 20, the staff is including a license condition discussed in SER Section 5.7.7.4. This license condition will require the applicant to develop, prior to the pre-operational inspection, a survey program for beta-gamma contamination in unrestricted and restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F.

Based on its review of the plant area(s) contamination surveys program, the staff is reasonably assured that the applicant will perform the appropriate surveys and control radiological

contamination. This reasonable assurance determination is contingent upon the fulfillment of the license condition in SER Section 5.7.7.4 and discussed above.

5.7.6.3.1.3 Equipment and Materials Contamination Surveys

For releasing potentially contaminated items, the applicant states in application Section 5.7.6.3, that the RSO or RST will survey these items before the applicant releases these items from the facility (Strata, 2011a;2012b). The applicant commits to using Table 1 of NRC "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses, for Byproduct, Source, or Special Nuclear Material" (NRC, 1993a) to determine if Strata can release the equipment for unrestricted use. The applicant will use a Ludlum Model 2224 counter and Model 44-9 pancake GM probe, or equivalent. The applicant will perform daily response checks on instruments used to assess surface contamination and calibrated per manufacturer specifications at least annually.

The applicant states that it will not paint or plate over equipment and surfaces to meet release criteria, but states that it may paint over a contaminated area with that cannot reasonably be decontaminated if the RSO determines the procedure to be ALARA (Strata, 2011a;2012b). The applicant states that it may be allow the RSO to paint the surface as long as the contamination on the article or surface is characterized and documented. The applicant states it must visibly label the area as contaminated. The applicant states it will survey yellowcake packages prior to shipment to comply with DOT release standards in 49 CFR 173.433(a) and the requirements of 10 CFR Part 71.

Staff will include a license condition, which is discussed in SER Section 5.7.6.4, to memorialize the applicant's commitment to comply with 10 CFR 20.1501(a)(2)(i), which requires surveys that evaluate the magnitude of radioactivity.

Based on the information presented for the equipment and materials contamination surveys, staff has reasonable assurance that the applicant will have qualified personnel performing the surveys with state-of-the art survey instruments as discussed in SER Section 5.7.6.3.2.

5.7.6.3.2 Survey Equipment

The applicant describes the alpha and beta/gamma radiation survey instrumentation to be used for contamination surveys in application Section 5.7.6.4, but has not specified the scan minimum detectable concentration (MDC) or survey capability for this instrumentation (Strata, 2011a). The applicant states that it will use a Ludlum Model 2224 counter and Model 44-9 pancake GM probe or equivalent survey equipment or materials for unrestricted release, and that it will calibrate survey equipment according to the manufacturer's specifications and at least annually. The applicant's personnel monitoring system will consist of a Ludlum Model 43-5 or 43-65 alpha detector coupled to a Ludlum Model 2241 scaler or Model 177 alarming rate meter or equivalent. The applicant commits to using check sources to verify instrument operation prior to each use or at least daily. The applicant states that it will immediately remove instruments from service and re-calibrate instruments that have variations from reference readings greater than 20 percent (Strata, 2011a;2012b).

As stated in SER Sections 5.7.7.3.1.1 and 5.7.7.3.1.2, NRC staff also notes that the applicant did not propose conducting both beta-gamma and alpha contamination surveys prior to release of materials and equipment or for personnel contamination, unless it is contaminated with byproduct material or exceeds contamination limits. The staff finds that by not providing the

survey capability or scan MDC in terms of dpm per 100 cm^2 for these surveys meters, the survey instrumentation may not detect contamination for all required contamination surveys. Further, the staff finds that the contamination control program may not be sufficient for detecting and quantifying contamination to prevent it from leaving unrestricted and controlled areas, and subsequently entering unrestricted areas or from leaving the site. A license condition is proposed in Section 5.7.6.4 to specify that the licensee determine the scan MDC for the portable radiation survey instrumentation described above and to provide this information to the NRC.

Based on its review of the applicant's proposed survey equipment, supplemented with License Condition 12.8 presented in SER Section 5.7.6.4, staff has reasonable assurance that the proposed survey equipment with the applicant's commitment for calibration and maintenance of that equipment will provide suitable data for reliable contamination surveys.

5.7.6.3.3 Inspections

The applicant states that the RSO or radiation safety staff will perform all of the daily walkthrough inspections of the plant (Strata, 2011a). The applicant proposes to use selected individuals to perform the weekend daily walkthrough inspections and to perform contamination surveys. The applicant will provide specific training for inspections for radiological safety and in the performance of contamination surveys of areas and for release of material and equipment from the restricted area, in addition to the radiation worker training recommended in Regulatory Guide 8.31, Section 2.5. This training includes specific procedural requirements in Standard Operating Procedures and the applicant states that the RSO or assistant RSO will prepare a checklist to ensure the designated worker performs the tasks consistently. The applicant commits to documenting the training in the individual's training records (Strata, 2011a).

As discussed in SER sections 5.4.3.3,and 6.3.3, the staff finds that the minimum qualifications for the selected individuals or designee identified by the applicant to perform daily inspections, area surveys, and surveys to release equipment and material in the absence of the RSO and RST, do not meet the training and experience requirements of an RSO or HPT, as suggested by Regulatory Guide 8.31. The staff includes a standard license condition, as discussed in SER Section 6.3.4, requiring the applicant to submit a health physics training program for the designee(s) to the NRC for review and written verification prior to the use of a designee to perform daily inspections or surveys at the Ross ISR Project to ensure the designee is qualified through training and experience to use source materials in accordance with 10 CFR 40.32(b).

Based on its review of the applicant's inspection program, as supplemented with the noted license condition, staff finds that the applicant will have qualified personnel conducting the inspections.

5.7.6.3.4 Records and Reporting

The applicant identifies the records that it will maintain for the life of the license in application Section 5.2.3 (Strata, 2011a). These include the following: daily RSO inspections of the plant; weekly RSO inspections of non-process areas; personnel surveys and spot checks; all material release surveys, including transport of yellowcake slurry; calibration and function checks of survey instruments used for material release; personnel surveys; and surface contamination surveys. Section 5.7.6.7 of the technical report describes additional aspects of the recordkeeping and reporting activities proposed by the applicant (Strata, 2011a). NRC staff has determined that the applicant's recordkeeping and reporting activities are consistent with the

guidance in Regulatory Guide 8.30 and comply with the requirements for 10 CFR Part 20, Subparts L and M, and 10 CFR 40.32(b), which requires the applicant to be trained and experienced to protect health and minimize danger to life or property. Therefore, the staff finds the record keeping and reporting element of the applicant's program to be acceptable.

5.7.6.4 Evaluation Findings

The staff reviewed the contamination control program for the proposed Ross ISR Project in accordance with the acceptance criteria in SRP Section 5.7.6.3 (NRC, 2003). The applicant proposed to conduct contamination surveys in clean areas, appropriate survey equipment, and an appropriate survey and inspection schedule to detect and control radiological contamination. The staff finds that the applicant has identified controls for preventing contamination from leaving a restricted area using appropriate survey equipment and instrumentation for natural uranium but several elements of the contamination control program do not appear to comply with guidance pertaining to the qualifications (i.e., scanning capability and training) for personnel other than the RSO or RST. Accordingly, SER Section 5.4.4 presents a license condition to address the training issues associated with an employee other than the RSO or RSTs that may perform daily inspections in the absence of the RSO or RST. In addition, standard License Condition 9.6, as presented in SER Section 6.3.4, list requirements other than training for use of employees other than the RSO or RST to conduct surveys of areas and the release of equipment and material to unrestricted areas.

The staff finds that the applicant's contamination control program is acceptable and that the applicant will appropriately survey, detect, and control radiological contamination, as required by 10 CFR Part 20, Subparts B, C, F and 10 CFR 40.32(c), except that applicant has not addressed beta-gamma contamination in personnel surveys, plant area contamination surveys, and survey equipment. Therefore, the staff is including the following facility specific license condition in the Ross ISR Project license:

Facility Specific License Condition 12.8:

> Prior to the preoperational inspection, the licensee shall develop a survey program that will meet the requirements of 10 CFR Part 20, Subpart F to detect beta-gamma contamination on personnel exiting restricted areas and to detect beta-gamma contamination in unrestricted and restricted areas. The licensee shall provide, for NRC staff review and approval, the surface contamination detection capability (scan MDC) of the radiation survey meters used in surveys for releasing equipment and materials to unrestricted use or personnel contamination. In the scanning mode, the detection capability for any expected alpha and beta radiation shall be provided in terms of dpm per 100 cm^2.

Based on the contamination control program information provided by the applicant, as supplemented by the above license conditions and the staff's own analysis, the staff is reasonably assured that the applicant will appropriately survey, detect, and control radiological contamination.

5.7.7 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAM

During the course of the evaluation, the staff found that there was overlap among the areas of review and acceptance criteria in SRP Sections 4.1, Gaseous and Airborne Particulates; 5.7.1, Effluent Control Techniques; and 5.7.7, Airborne Effluent and Environmental Monitoring

Program (NRC, 2003). As discussed in SER Section 5.7.2, the staff reduced the overlap in the SER by limiting the discussion of the staff's review of the effluent control techniques to SER Section 4.1 and effluent monitoring to SER Section 5.7.8.

5.7.7.1 Regulatory Requirements

The staff determines if Strata has demonstrated that the proposed airborne effluent and environmental monitoring program for the Ross ISR Project meets the requirements of 10 CFR 20.1003, 20.1301, 20.1302, 20.1101(d), 20.1501, 40.65, and Criteria 7 and 8 of Appendix A to 10 CFR Part 40.

5.7.7.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria in Section 5.7.7.3 of the SRP and applicable acceptance criteria in SRP Section 4.1.3 (NRC, 2003). Regulatory Guides 4.14 and 8.37 provide guidance on how the applicant can comply with the applicable regulations.

5.7.7.3 Staff Review and Analysis

The following sections discuss the applicant's proposed airborne effluent and environmental monitoring program. This includes radiation monitoring outside of the plant area during operations and monitoring environmental media within the plant area, at the boundary of the facility, and at a background location.

The applicant is required to demonstrate how it will comply with 10 CFR Part 40, Appendix A, Criterion 7, which states, "Throughout the construction and operating phases of the mill, an operational monitoring program must be conducted to measure or evaluate compliance with applicable standards and regulations; to evaluate performance of control systems and procedures; to evaluate environmental impacts of operation; and to detect potential long-term effects." The applicant is also required to demonstrate how it will comply with 10 CFR Part 40, Appendix A, Criterion 8, which 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. Notwithstanding the existence of individual dose standards, strict control of emissions is necessary to assure that population exposures are reduced to the maximum extent reasonably achievable and to avoid site contamination." The applicant is also required to demonstrate compliance with 10 CFR 40.65. Specifically, it must report "…the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents…"

5.7.7.3.1 Airborne Effluent Monitoring

Aside from the reporting requirements in 10 CFR 40.65, an applicant must provide details on how they will perform surveys sufficient to demonstrate compliance with 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public. An applicant must also demonstrate compliance with 10 CFR 20.1501, which requires surveys that are reasonable under the circumstances to evaluate concentrations or quantities of radioactive materials and the potential radiological hazards.

To comply with 10 CFR 20.1302(a), applicants must demonstrate that they will conduct appropriate surveys of radioactive materials in effluents released to unrestricted and controlled

areas. For point sources (e.g., a defined stack or pipe), the release point will generally be the effluent discharge point (i.e., where the uncontrolled effluent is released to the air). If the effluent is discharged to a restricted area, the applicant may propose measuring or calculating the effluent quantities or concentrations (a) at the effluent discharge point or (b) at the unrestricted/controlled area boundary. If the effluent is measured or calculated at the discharge point, the applicant may use (a) this undiluted value or (b) an appropriate model to estimate the concentrations to which people are exposed. For dose calculations, the applicant may also propose taking direct measurements at the unrestricted area boundary. Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities" (NRC, 1993d), provides additional guidance on airborne radioactive effluent monitoring.

Information in SER Section 5.7.7.3, unless otherwise stated, is from Section 5.7.7 of the technical report (Strata, 2011a). The applicant identified several sources of airborne radiological effluents associated with the Ross ISR Project in Sections 4.1.2, 5.7.1, and 7.3.4 of the technical report (Strata, 2011a). The sources described were both point sources and area, or diffuse sources. Point sources include those operations that have their exhaust confined in a stack, duct, pipe, etc., prior to atmospheric release, such as process tank vents. Area sources are not confined prior to being released to the atmosphere and include, among other things, ore pads. Area sources include radon emanating from the wellfield (Strata, 2011a).

The applicant quotes NUREG-1910, Section 4.2.11.2.1 (NRC, 2009a), in application Section 5.7.1.1.2 (Strata, 2011a), that states that radon gas emitted from ISR wellfields and processing facilities during operations is the only radiological airborne effluent for those facilities that use vacuum dryer technology. Further, the applicant states that the NRC recognizes that the radionuclide particulate emissions from vacuum dryers "is essentially zero" in NUREG-1910. The applicant states that the off-gas treatment system and emission controls for the vacuum dryer system "are ALARA by design relative to potential for particulate emissions to the environment and therefore compliant with the requirements of 10 CFR 40, Appendix A, Criterion 8" (Strata, 2011a). The staff finds that although the vacuum dryer system is designed to minimize particulate emissions, the applicant is required to demonstrate compliance with applicable regulations.

Additionally, the NRC staff notes that the applicant fails to realize that NUREG-1910 is not a technical basis document. Although vacuum dryers minimize uranium particulate emissions, the drying and packaging process may result in surface contamination of uranium particulates that can become airborne within the drying room. Because surface contamination that may become airborne is present in the dryer room, several of the uranium recovery licensees' SOPs require workers to wear respirators during drying and packaging operations and until the dryer room is decontaminated. As discussed in SER Section 4.1.3.1, a dryer is not the only source of radioactive airborne particulates. Radon-222 decays to several solid particles that tend to be electrically charged and can deposit on surfaces or attach to dust particles (Mohamed et al., 2008). Radon progeny can build-up in on surfaces in buildings if the ventilation is not adequate to ensure complete air exchange. NUREG/CR-6733 also states that spills of radioactive liquids can be a source of air particulates and pose an inhalation hazard if the spills dry before they are cleaned. The staff agrees with the applicant that radon will be the primary effluent from the sources within the processing plant, header houses, and wellfields, based on the staff's assessment of the information presented in the application and the staff's knowledge of ISR operations.

The applicant states in Section 5.7.7.1 of the technical report (Strata, 2011a) that it will use calculations to estimate effluent releases and off-site dose to the public. The applicant states it

will follow guidance in Regulatory Guide 3.59, Section 2.6, to estimate the radon source term during ISR operations and follow the MILDOS-AREA methodology described in NUREG-1569, Appendix D, to calculate off-site public dose and demonstrate compliance with the 100 mrem/yr public dose limit of 10 CFR 20.1301 (Strata, 2011a).

The staff finds that the applicant's proposed effluent monitoring program is not acceptable because of two deficiencies: (1) assessing doses in unrestricted areas; and (2) the lack of stack sampling. Regarding doses in unrestricted areas, the applicant provides further evaluations in Section 7.3.2 of the application that suggest the dose limits in 10 CFR 20.1301 would not be exceeded for members of the public in unrestricted areas or at the nearest residence location (Strata, 2011a). However, the evaluation consisted of calculations by MILDOS-AREA, a computer modeling software, and did not propose monitoring. While the staff agrees that licensees are permitted to estimate doses through calculations, calculations must be confirmed through periodic sampling; otherwise, the staff cannot determine with sufficient certainty that doses to the public are below the 10 CFR 20.1301 limits. Sampling of effluents is a clear recommendation in the staff's guidance. For example, Regulatory Guide 3.59 states that the staff prefers "reliable monitoring data when available."

The staff acknowledges that the applicant plans to continue collecting radon and air particulate samples as part of the operational environmental monitoring program at sampling locations used to collect preoperational samples (Strata, 2011a). Based on information provided by the applicant, the staff is reasonably assured that the applicant will monitor airborne effluents and control doses to the public in accordance with 10 CFR 20.1301. This reasonable assurance determination is based on calculations provided by the applicant showing that doses from its operations will not exceed public dose limits, the applicant's commitment to perform operational effluent monitoring, and is contingent upon confirmatory sampling, which will be required by a license condition discussed in Section 5.7.7.4.

Regarding stack sampling, the applicant did not propose stack sampling consistent with acceptance criteria (1) and (2) in SRP 5.7.7.3, and as described in Regulatory Guide 4.14, Section 2.1.1 "Stack Sampling." The regulatory guide recommends that (a) stacks should be sampled at least semiannually; (b) the sampling should be adequate to determine the release concentrations of uranium, Th-230, Ra-226, and Pb-2 10; and (c) flow rates should be measured at the time of sampling. The staff discusses in-plant monitoring for occupational exposures and doses in SER Section 5.7.3, and as stated above, certain samplers and monitors will be located in specific areas outside the plant. While NRC guidance recommends additional stack sampling, the staff notes that licensees have flexibility in meeting the requirements of 10 CFR 40.65 and 10 CFR 20.1301, and the currently proposed sampling program could be part of the applicant's compliance strategy. However, the applicant must inform the NRC of the precise manner in which it will quantify effluents, including those emanating from the stack. This requirement is included in a license condition presented in Section 5.7.8.4. The staff is reasonably assured that the applicant will measure and quantify effluents from the Ross ISR Project based, in part, on the current in-plant and exterior monitoring programs. This reasonable assurance determination is contingent upon the applicant's fulfillment of the license condition in SER Section 5.7.8.4.

Staff finds that, with the aforementioned license conditions to address the noted deficiencies, the effluent airborne monitoring program is acceptable because the program will provide suitable data on the effluent releases from the facility to ensure that the levels are protective of workers and public health and safety and the environment.

5.7.7.3.2 Environmental Monitoring

5.7.7.3.2.1 Air Particulate, Radon, and Direct Radiation Sampling

Regulatory Guide 4.14, Table 2, suggests that air particulate sampling locations should be at or near the site boundaries and in different sectors that have the highest predicted concentrations of airborne particulates, as well as one at the nearest residence or habitable structure(s), and one control location that should be in the least prevalent wind direction from the site The air particulate sampling should be continuous with weekly filter changes and quarterly composite by location for natural uranium, Ra-226, Th-230, and Pb-210 analysis. The following factors should be considered in determining the sampling locations: (1) average meteorological conditions (wind speed, wind direction, atmospheric stability), (2) prevailing wind direction, (3) site boundaries nearest to mill, (4) direction of nearest habitable structure, and (5) location of estimated maximum concentrations of radioactive materials. Additionally, Regulatory Guide 4.14, Table 2, suggests that radon sampling should be conducted at five or more locations using the same guidelines as stated for air particulate sampling with the exception that the frequency of the analysis should be monthly for Rn-222.

The applicant states that air particulate samples will be collected continuously at the five locations identified in SER Figure 2.2-1 using F&J Specialty Products Models DF-40L-BL-AC and LV-1D samplers (Strata, 2011a). Filters will be collected on a weekly basis (or more often as required by dust loading) and analyzed for natural uranium, Th-230, Ra-226, and Pb-210 in accordance with Regulatory Guide 4.14. During operations, the applicant will monitor radon gas and passive gamma radiation using Landauer radon Trak-Etch detectors and environmental low level TLDs at the same locations as discussed in Section 2.9.4 of the technical report and shown in SER Figure 2.2-1. There are 17 radon sampling locations, of which five of these sample sites are co-located with the air particulate samplers as recommended in Regulatory Guide 4.14. The staff finds that the air particulate and radon environmental monitoring locations are consistent with Regulatory Guide 4.14 and are therefore acceptable to meet the operational environmental monitoring requirements in Criterion 7 of Appendix A to 10 CFR Part 40.

5.7.7.3.2.2 Soil Sampling

Regulatory Guide 4.14, Table 2, suggests that soil sampling should be conducted in five or more locations that are the same as for air particulate sampling. It suggests collecting annual grab samples and analyzing for natural uranium, Ra-226, and Pb-210. The applicant states it will collect soil samples to a depth of 152 cm (60 in) annually during operations at the five air particulate sampling locations and analyze them for gross alpha, natural uranium, Ra-226, and Pb-210 in accordance with Regulatory Guide 4.14 (Strata, 2011a). The staff finds that the soil sampling frequency and locations proposed by the applicant are consistent with Regulatory Guide 4.14 and are therefore acceptable

5.7.7.3.2.3 Sediment Sampling

Regulatory Guide 4.14, Table 2, suggests that sediment sampling be conducted as an annual grab sample from each water body identified for surface water sampling. The sediment samples should be analyzed for natural uranium, Th-230, Ra-226, and Pb-210. The applicant states it will collect sediment samples at the same location as surface water samples to a depth of 152 cm (60 in) annually and analyze them for gross alpha, natural uranium, Th-230, Ra-226, and Pb-210 (Strata, 2011a). The staff finds that the sediment sampling frequency and locations

proposed by the applicant are consistent with Regulatory Guide 4.14 and are therefore acceptable.

5.7.7.3.2.4 Vegetation, Food and Fish Sampling

Where a significant pathway to man is identified, Regulatory Guide 4.14 suggests analyzing three of each type of crop, livestock, etc., raised within 3 km of the mill site. Vegetation samples should be collected three times during the grazing season, and food and fish samples should be collected at the time of harvest or slaughter. All should be analyzed for Ra-226 and Pb-210. Note (o) in Regulatory Guide 4.14, Table 2 clarifies that an exposure pathway should be considered important if the predicted dose to an individual would exceed 5 percent of the applicable radiation protection standard. Individual members of the public are subject to the dose limits in 10 CFR 20.1301. Pursuant to 10 CFR 20.1301, the dose limit is 100 mrem/yr TEDE.

The applicant does not propose to perform any vegetation, food or fish sampling during operations because the applicant has determined that there is not a significant pathway to man from these sources (Strata, 2011a). The applicant has established a baseline for decommissioning, but no operational sampling has been proposed unless MILDOS-Area calculations suggest the need. The applicant proposes to follow the protocol used in baseline sampling if MILDOS-Area calculations suggest a need (Strata, 2011a). NRC staff notes that deposition of radon progeny products onto forage and cattle drinking water sources can also provide a pathway for exposure to cattle. Although a potential pathway to man exists, the staff does not find that routine cattle or vegetation sampling as part of the operational monitoring program is needed at this time. However, the staff will include a license condition, as presented in SER Section 5.7.7.4, that requires the applicant specify, in its airborne effluent and environmental monitoring program, particular conditions that will trigger the need for the applicant to conduct operational livestock and vegetation sampling.

5.7.7.3.2.7 Nearby Water Supply Wells

As discussed in SER Section 5.7.8.3.1.1, the applicant proposes to monitor groundwater quality at the domestic, livestock and industrial water supply wells located within a 2-kilometer radius of the Ross Project boundary during both construction and operation phases. The applicant states that monitoring of the nearby water supply wells will be conducted quarterly and results provided to NRC on an annual basis. The monitoring at a specific water supply well will be contingent upon landowner's (well owner's) consent and, for a variety of reasons (e.g., abandoned, non-functioning pump, winterized), may not be available every quarter (Strata, 2011a). The parameters to be analyzed consist of dissolved and suspended uranium, radium-226, thorium 230, lead-210 and polonium-210, and gross alpha and gross beta.

The applicant estimates that 29 wells exist within 2 kilometers of the Ross Project (Strata, 2011a).[42] Based on information in Section 2.7 of the Technical Report (Strata, 2011a), the water supply wells consist of 2 industrial water supply wells, 15 livestock water supply wells and 12 domestic water supply wells. Based on information in Section 2.7 of the Technical Report

[42] On Technical Report Table 5.7-1 (Strata, 2011a), the applicant lists 29 wells within 2 miles of the project area. That reference should have listed 2 kilometers rather than miles. As documented in SER Section 2.4.3, staff estimates that 57 wells (or registered groundwater users) exist within 2 miles of the project area and in Technical Report Section 2.7.3.5.2.3 (Strata, 2011a), the applicant reports the 29 wells within 2 kilometers of the project area.

(Strata, 2011a), four livestock water supply wells and three industrial wells are located within the Ross Project area.[43] As discussed in SER Section 2.3.3, the applicant sampled the nearby water supply wells as part of the pre-operational monitoring program. The proposed monitoring program is a continuation of that pre-operational monitoring program though the parameters analyzed will be reduced from those analyzed in the pre-operational monitoring program.

Staff finds that the proposed sampling of the nearby water supply wells is consistent with guidance in RG 4.14 (NRC, 1980a) and, in general, consistent with effluent monitoring programs currently being conducted at existing NRC-licensed ISR facilities. Those programs have been shown to effectively measure and evaluate compliance with applicable standards and regulations, performance of control systems and procedures and environmental impacts of the operations, and to detect potential long-term effects. The differences between the proposed Ross Project program and programs at existing monitoring programs are (1) the results are reported to NRC semi-annually rather than annually and (2) the nearby wells include those within 2 kilometers of a wellfield rather than 2 kilometers of the project area. Staff included a standard license condition for reporting requirements of the effluent monitoring program as described in SER Section 3.1.4. This license condition includes a provision for an annual review of the inventory of water supply wells located within the study area in the standard license condition for the effluent monitoring program. Prior to operations, staff will include a standard license condition, as presented in 5.7.8.4, to provide an updated inventory.

5.7.7.3.2.8 On-site Groundwater

The applicant states that the on-site groundwater will be monitored as part of the effluent monitoring program (Strata, 2011a). The on-site groundwater monitoring consists of the existing water users, which includes four livestock water supply wells and three industrial water supply wells, and shallow monitoring wells to be installed in the CPP area (see SER Section 5.7.8.3.1.5).

Staff reviewed the proposed on-site groundwater monitoring program and has determined it is adequate with several stipulations met in the form of a license condition (see SER Section 5.7.8.4).

5.7.7.3.2.9 Surface Water

The applicant states that during its construction phase, surface water monitoring will be conducted at the Oshoto reservoir, and three on-site stream gaging stations (SW-1, SW -2 and SW-3) located within Deadman Creek or Little Missouri River (Strata, 2011a). The applicant anticipates that, based on the preoperational monitoring program, flows in the streams will likely be ephemeral primarily during April to October (Strata, 2011a). Surface water is found year-long in the Oshoto reservoir.

During operations, the applicant commits to a surface water monitoring program which was conducted during preoperational monitoring, i.e., quarterly sampling at three on-site stream gaging stations and 11 on-site or nearby reservoirs. The parameters to be analyzed for the operation surface water monitoring program are dissolved and suspended uranium, Th-230, Ra-226, Po-210 and Pb-210, and, gross alpha and gross beta unless sufficient cause can be demonstrated to measure a parameter less frequently.

[43] Of the three on-site industrial water supply wells, water from two wells is mixed for a single end-user.

The applicant also commits to monitoring surface water should monitoring be required for a Wyoming discharge permit through the WYPDES program (Strata, 2011a). Examples of such discharges provided by the applicant are stormwater, temporary or process water discharges.

Staff finds that the proposed construction and operational surface water monitoring programs are adequate by providing defense in depth monitoring for a potential release. Due to the ephemeral nature of the streams, staff acknowledges that stream water quality sampling is not a regulatory requirement but a good best practices techniques and that quarterly sampling will not be available throughout the year. Staff will include a standard license condition to memorialize the applicant's commitment to the surface water monitoring program (see SER Section 5.7.8.4).

5.7.7.4 Evaluation Findings

NRC staff has completed its review of the airborne effluent and environmental monitoring program for the proposed Ross ISR Project in accordance with SRP Section 5.7.7.3 and the applicable parts of SRP Section 4.1.3. The applicant will sample radon, air particulates, surface soils, and direct radiation. The applicant provided justification for not sampling crops, fish, routine surface water, routine sediments, and game, but did not provide sufficient justification for not sampling vegetation and cattle, as recommended in Regulatory Guide 4.14. Furthermore, the applicant did not completely describe its method for measuring and quantifying all radiological effluents or its methods for calculating doses to the public in unrestricted areas. Although the applicant did not completely describe its methods for quantifying airborne effluents, the staff is reasonably assured that the applicant will appropriately measure and quantify effluents pursuant to 10 CFR 40.65. Notwithstanding the currently proposed program, the staff's reasonable assurance determination is contingent upon the applicant providing the information required in the following license conditions:

Standard License Condition 10.9:

> The licensee shall establish and conduct an effluent and environmental monitoring program in accordance with programs described in Section 5.7.8.2 (Operational Monitoring-Surface Water and Operational Monitoring-Private Wells) and Section 5.7.7.1 (radon, air particulate, direct radiation, and soil) of the approved license application. The licensee will conduct a monitoring program in accordance with Section 5.7.8.2 (Operational Monitoring-CPP Area) unless those elements are included in the groundwater detection monitoring program required by LC 10.20.

Standard License Condition 11.2:

> The licensee shall submit the results of at least an annual review of the radiation protection program performed in accordance with 10 CFR 20.1101(c). This review shall include the content and implementation of the radiation protection program. Results shall include an analysis of dose to individual members of the public consistent with 10 CFR 20.1301 and 10 CFR 20.1302. This report shall be submitted to NRC within 90 days following completion of the reporting period.

Facility Specific License Condition 12.7:

> Prior to the preoperational inspection, the licensee shall provide the following information in its airborne effluent and environmental monitoring program:

A) Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring.

B) Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2.

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

To fulfill License Condition 12.7, as described in SER Sections 5.7.7.3.2.4, the applicant must specify the particular conditions that will trigger the need for the applicant to conduct operational vegetation and cattle sampling.

Based on the staff's review of the applicant's airborne effluent and environmental monitoring program, the staff is reasonably assured that the applicant will appropriately measure airborne effluents and doses to the public, as required in 10 CFR 20.1101(b), 20.1302, 20.1501, and 20.1502, and Table 2 to Appendix B of 10 CFR Part 20, and consistent with SRP Section 5.7.7.3. This reasonable assurance determination is contingent upon the applicant's fulfillment of the aforementioned license conditions.

5.7.8 OPERATIONAL GROUNDWATER AND SURFACE WATER MONITORING PROGRAMS

5.7.8.1 Regulatory Requirements

General requirements for contents of an application for a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(h) specifies that an application must clearly demonstrate how requirements and objectives set forth in 10 CFR Part 40 Appendix A are addressed. Technical Criterion 7 of 10 CFR Part 40 Appendix A sets forth requirements and objectives for preoperational and operational groundwater monitoring programs at a uranium recovery facility. A preoperational monitoring program must be conducted to provide complete baseline data on a milling site and its environs and an operational monitoring program must be conducted to measure or evaluate compliance with applicable standards and regulations, performance of control systems and procedures, and environmental impacts of the operations, and to detect potential long-term effects.[44] Technical Criterion 7A of 10 CFR Part 40 Appendix A sets forth requirements and objectives for a groundwater detection monitoring program that are needed to establish the site-specific groundwater protection standards in Criterion 5 of 10 CFR Part 40 Appendix A.

[44] Criteria in Appendix A are written for conventional mill setting. The conventional mill setting differs from an ISR setting in that (1) at a conventional mill, all activities conducted under the license are performed above ground whereas at ISR settings, the uranium extraction from the ore is performed in situ (or in the subsurface), and (2) at a conventional mill, a solid byproduct material, the mill tailings, is stored above ground in a tailing pile whereas at ISR settings, no mill tailings are generated. Staff is applying these criteria to ISR facilities because 10CFR 40.31(h) specifies that the application must clearly demonstrate how both the requirements and objectives set forth in appendix A are met.

Section 10 CFR 40.32(c) requires the applicant's proposed equipment, facilities and procedures to be adequate to protect health and minimize danger to life and property; Section 10 CFR 40.41(c) requires a licensee to confine the possession and use of source or byproduct material to locations and purposes authorized in a license; and Section 10 CFR 40.32(d) requires that issuance of a license will not be inimical to the common defense and security or to the health and safety of the public. Section 10 CFR 40.65 requires licensees authorized to possess and use source material to submit semi-annual effluent monitoring reports to demonstrate compliance with the facility's design objectives.

The applicant's proposed equipment, facilities and procedures for controlling the operational fluids and liquid effluents, including the leak detection system for the retention ponds, have been described and evaluated by staff in SER Section 4.2. In this SER section, staff reviews and evaluates the proposed environmental monitoring programs associated with those equipment, facilities and procedures to ensure compliance with the regulations.

Section 5.7.8 of the SRP (NRC, 2003) provides guidance on reviewing a groundwater detection monitoring program to meet requirements in Criteria 5 and 7(a). The purpose of a groundwater detection monitoring program is to establish groundwater protection standards and ensure that any hazardous constituents that may have entered the groundwater regime comply with those standards. To establish the groundwater protection standards, the applicant defines procedures for determining the baseline data for each wellfield prior to its operation. The baseline data will then be used to set standards for operations (excursion monitoring program) and closure (restoration).

An operational monitoring program as required by Criterion 7 differs slightly from that required by Criterion 7A. An operational monitoring program focuses on potential environmental impacts from the operations and to detect potential long-term effects. Results of the operational monitoring program are required to be reported to NRC by 10 CFR 40.65. Regulatory Guide 4.14 (NRC, 1980a) provides guidance on designs for an effluent monitoring program with respect to radionuclide impacts on various environmental media, including groundwater and surface water, to meet the reporting requirements.

Staff is required to determine that the groundwater and surface water monitoring programs as proposed in the Ross Project license application meet requirements of 10 CFR 40.32(c), 10 CFR 32(d), 10 CFR 40.41(c), 10 CFR 40.65, and 10 CFR Part 40, Appendix A, Criteria 5 and 7.

5.7.8.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the review procedures in Section 5.7.8.2, acceptance criteria in Section 5.7.8.3 of the SRP (NRC, 2003), and guidance on effluent monitoring programs for groundwater and surface water media in RG 4.14 (NRC, 1980a).

5.7.8.3 Staff Review and Analysis

In this SER section, the staff reviews the groundwater and surface water monitoring programs to be implemented at the Ross Project. Pre-operational groundwater and surface water monitoring is addressed in SER Section 2.6.3 and restoration monitoring is addressed in SER Section 6.1.3.

In SER Section 5.7.8.3, unless specifically stated otherwise, the reported information is from Section 5.7.8 of the Technical Report (Strata, 2011a).

5.7.8.3.1 Groundwater Monitoring

The applicant discusses various groundwater monitoring programs to be conducted either during construction or operation phases (Strata, 2011a).[45] During the construction phase, the groundwater monitoring programs consist of monitoring at nearby water supply wells and monitoring to establish baseline conditions (groundwater protection standards) for the wellfields. During the operation phase, the groundwater monitoring programs consist of excursion monitoring at the wellfields, leak detection monitoring at the retention ponds, groundwater monitoring program at the CPP and monitoring of the nearby water supply wells, and a surface water monitoring program that consists of monitoring onsite surface water bodies. A summary of the surface and groundwater monitoring programs is presented in SER Table 5.7-2.

5.7.8.3.1.1 Nearby Water Supply Wells

The applicant proposes to monitor groundwater quality at the domestic, livestock and industrial water supply wells located within a 2-kilometer radius of the Ross Project boundary during both construction and operation phases. The applicant states that monitoring of the nearby water supply wells will be conducted quarterly and results provided to NRC on an annual basis. The monitoring at a specific water supply well will be contingent upon landowner's (well owner's) consent and, for a variety of reasons (e.g., abandoned, non-functioning pump, winterized), may not be available every quarter (Strata, 2011a). The parameters to be analyzed consist of dissolved and suspended uranium, radium-226, thorium 230, lead-210 and polonium-210, and gross alpha and gross beta.

The applicant estimates that 29 wells exist within 2 kilometers of the Ross Project (Strata, 2011a).[46] Based on information in Section 2.7 of the Technical Report (Strata, 2011a), the water supply wells consist of 2 industrial water supply wells, 15 livestock water supply wells and 12 domestic water supply wells. Based on information in Section 2.7 of the Technical Report (Strata, 2011a), four livestock water supply wells and three industrial wells are located within the Ross Project area.[47] As discussed in SER Section 2.3.3, the applicant sampled the nearby water supply wells as part of the pre-operational monitoring program. The proposed monitoring program is a continuation of that pre-operational monitoring program, though the parameters analyzed will be reduced from those analyzed in the pre-operational monitoring program.

Staff finds that the proposed sampling of the nearby water supply wells is consistent with guidance in RG 4.14 (NRC, 1980a) and, in general, is consistent with effluent monitoring programs currently being conducted at existing ISR facilities. Those programs have been shown to effectively measure and evaluate compliance with applicable standards and regulations, performance of control systems and procedures and environmental impacts of the

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[45] Construction means construction of the CPP without operations of principal activities or a specific wellfield prior to any injection of lixiviant.

[46] On Technical Report Table 5.7-1 (Strata, 2011a), the applicant lists 29 wells within 2 miles of the project area. That reference should have listed 2 kilometers rather than miles. As documented in SER Section 2.4.3, staff estimates that 57 wells (or registered groundwater users) exist within 2 miles of the project area and in Technical Report Section 2.7.3.5.2.3 (Strata, 2011a), the applicant reports the 29 wells within 2 kilometers of the project area.

[47] Of the three on-site industrial water supply wells, water from two wells is mixed for a single end-user.

operations, and to detect potential long-term effects. The difference between the proposed Ross and existing monitoring programs is that the results are reported to NRC semi-annually rather than annually. Furthermore, staff is including a requirement for the effluent monitoring program to provide an annual review of the inventory of water supply wells located within the study area in the standard license condition for the effluent monitoring program. Such language will be included in the standard license condition for the effluent monitoring program at the Ross Project.

In addition, a specific license condition will include monitoring of the onsite industrial wells on a monthly basis for the effluent monitoring program if operations at the industrial wells have not been terminated.

5.7.8.3.1.2 Wellfield and Excursion Baseline Monitoring

During the construction phase, the applicant proposes to conduct a baseline monitoring program for each wellfield to define its "primary" restoration goals [restoration standards] and determine its upper control limits (UCLs) for the excursion monitoring program.[48] The program consists of obtaining four sets of groundwater quality data at selected wells in the overlying, underlying and ore zone aquifer. The selected wells in the ore zone consist of those within the production area, the data from which will be used to define the restoration standards, and wells within the perimeter well ring, the data from which, along with the wells in the overlying and underlying aquifers, will be used to define the UCLs for the excursion monitoring program (Strata, 2011a).

The wells for the baseline and excursion monitoring programs will be fitted with dedicated submersible pumps for sampling and possibly pressure transducers to continuously monitor water levels (Strata, 2011a). The applicant states that fluctuations in water levels at the wells will provide additional early time data to aid in the control of fluid migration during operations. The applicant proposes to collect a water quality dataset for the baseline and excursion monitoring programs that consists of at least four samples from each well (Strata, 2011a). The minimum time between sampling events is 2 weeks. The applicant reports that the first two sampling events will include parameters listed in WDEQ Guideline 8 and NRC NUREG-1569 (Strata, 2011a). The analytical parameters are summarized in SER Table 5.7-3. The applicant states that parameters for the last two sampling events may be a reduced list of parameters based on results of the previous sampling events (Strata, 2011a).

For those wells used to define restoration standards, the applicant proposes a density of one baseline well to a maximum of every four acres of production area (Strata, 2011a). Based on the currently defined production area, the applicant estimates 24 such baseline wells encompassing both mine units within the Ross Project. Based on the applicant's responses to RAIs (Strata, 2012b), the applicant commits to one baseline well per wellfield module. The applicant includes a figure showing the anticipated baseline well locations (SER Figure 5.7-1). The applicant states that these wells will be partially penetrating wells targeting the discrete mineralized zones within the OZ aquifer, and will likely be used during operations as production wells (as compared to being solely used as a monitoring well).

Results of the ore zone sampling will be averaged arithmetically to obtain an average baseline value (Strata, 2011a). In Section 6.1.1 of the Technical Report (Strata, 2011a), the applicant

[48] Construction phase is relative to a specific wellfield. A licensee will be required to perform specific tests prior to operations at a wellfield. The tests include establishing a baseline.

states that the baseline water quality (to determine the groundwater protection standard for the detection monitoring program for restoration goals) will be based the average for each parameter on mine unit basis for wells in the ore aquifer within the production area. Furthermore, the applicant states that outliers in the datasets will be removed by quality checks, including visual screening and statistical analysis (e.g., the tolerance-limit formula in accordance with WDEQ/LQD Guideline 4). The restoration goal that the applicant will calculate to define background values for 10 CFR Part 40 Appendix A Criterion 5B(5)(a) is the mean value for the mine unit data set plus a factor to account for the observed variability in baseline data. The applicant states that the factor to determine the variability in the dataset will be based on statistical methods approved by NRC and that those statistical methods will be consistent with requirements in ASTM D 6312-98 (2005) (ASTM, 2005).

Wells to be used for the excursion detection monitoring program consist of those wells in the overlying and underlying aquifers, and wells in the ore aquifer perimeter ring surrounding the production area (Strata, 2011a). Wells in the underlying and overlying aquifers will be completed as well clusters at locations of the baseline wells for the ore zone (i.e., 24 locations within both mine units; see SER Figure 5.7-1). Wells in the perimeter ring will be completed approximately 122 meters [400 feet] from the closest product unit wells, at a spacing of approximately 122 meters [400 feet] within a ring that surrounds the mine unit (Strata, 2012b). In responses to Environmental RAIs (Strata, 2012a), the applicant provided the approximate a graphical depiction of locations for the perimeter well rings for the Ross Project (SER Figure 5.7-2).

The wells in the excursion detection monitoring program will be completed as fully penetrating wells in the respective aquifers (Strata, 2011a). In response to staff's RAI's (Strata, 2012b), the applicant clarified procedures and processes for developing the wellfield data package. In those clarified procedures, the applicant states that production will be initiated on a per module basis and that recovery (production) wells in adjacent modules may be used as temporary perimeter monitoring wells until production is initiated in that adjacent module (page 126; Strata, 2012b).

Sampling of the wells in the excursion detection monitoring program will be conducted as described above. In the Technical Report (Strata, 2011a), the applicant states that UCLs will be set for each excursion parameter after the baseline quality is established for a particular production unit. This narrative suggests that the applicant intends to establish UCLs based on a production (mine) unit average.[49] In responses to RAIs (Strata, 2012b), the applicant proposes to determine UCLs on a per well basis. The statistical analysis of the data set(s) for the excursion monitoring program will be similar to that described above.

The applicant proposes that the excursion parameters for wells in the OZ and SM aquifers are chloride, conductivity and total alkalinity. For wells in the DM aquifer, the applicant proposes that the excursion parameters are sulfate, chloride and conductivity due to the elevated chloride and low sulfate levels shown in the DM aquifer during the pre-operational water quality data (Strata, 2011a). The applicant states that the UCLs for each excursion parameter will be the mean value plus 5 standard deviations. The applicant proposes an alternative method for calculating the UCL for chloride, which consists of the mean plus 15 mg/L. The UCL for chloride will be the higher value from either the mean plus 5 standard deviations or mean plus 15 mg/L.

[49] The applicant did not define production unit. Staff assumed that the production unit equates to Mine Unit, thus prompting the request for additional information.

The staff finds that the proposed wellfield and excursion baseline monitoring programs meet acceptance criteria in SRP Section 5.7.8.3 because the approach is sufficient to define the groundwater protection criteria for restoration and standards for early time detection of an excursion for new wellfields with several minor clarifications as discussed below. The minor clarifications will be included as license conditions.

The proposed analytical parameters to be included in the baseline monitoring programs are consistent with those recommended in the SRP, included in programs at existing ISR facilities, which have operated safely, and covers the constituents, including hazardous constituents, expected to be impact by the proposed operations. The applicant states that four rounds of samples will be collected, a full suite of parameters will be collected for the first two rounds and a reduced suite will be collected during the final two rounds but did not specify criteria to define the reduced suite. This sampling scheme has shown to provide sufficient data to establish the required standards. However, staff will include a specific criterion to establish the reduce list for the final rounds in a license condition. The criterion will be that parameters that were at levels below the minimum analytical detection limit for the first two rounds of sampling can be removed from the final two rounds.

The applicant proposes analytes for most trace metals is the dissolved component (i.e., after filtering the sample aliquot through a 0.45 micron membrane) rather than the total component (i.e., unfiltered sample aliquot). The dissolved component is consistent with the monitoring required by WDEQ (WDEQ, 2005) and recommendations in other guidance documents (e.g., (ASTM, 1992; USGS, 2006; Yeskis and Zavala, 2002). Therefore, staff finds the proposed suite of analytes acceptable because the procedures reflect common practice in the environmental field and the consistency through the monitoring program (i.e., measuring filtered samples during baseline and through the operations and restoration) will provide reasonable assurance of measuring and evaluating compliance with the applicable standards and regulations.

Staff finds the proposed statistical methods adequate for establishing the respective standards in the wellfield or excursion baseline monitoring programs because the methods are widely accepted statistical methods and consistent with those used at existing ISR facilities which have been shown to establish proper standards resulting in operations that are protective of human health and the environment. Staff will include a standard license condition that memorializes the applicant's commitments to establish the wellfield and excursion baseline monitoring programs.

The minimum sampling time of 14 days is consistent with practices at existing ISR facilities where the aquifers are under confined conditions. At the Ross Project, the DM, OZ and SM aquifers are under confining conditions and, based on results of the pre-operational monitoring program, exhibit no season variations (see SER Section 2.5). Consequently, staff finds that the proposed sampling frequency and parameters will provide sufficient data such that the appropriate standards can be established for the DM, OZ and SM aquifers at wellfields throughout the project.

As discussed below, staff will include a license condition that would require monitoring of the SA aquifer in wellfields at which the SA aquifer is within saturated alluvium. Although the applicant provided pre-operation data for the SA aquifer, data for the saturated alluvium are limited to one onsite monitoring well and possibly two nearby water supply wells. Consequently, staff is not reasonably assured that the lack of seasonal variation has been demonstrated for the saturated

alluvial aquifer and will require quarterly sampling of SA aquifer wells for wellfields that will require monitoring in the SA aquifer.

The applicants proposed a frequency of one well per maximum four acres of production area is consistent with that recommended in the SRP, and is consistent with license conditions for NC-licensed facilities. However, the text from the SRP is as follows:

> *An acceptable set of samples should include all well field perimeter monitor wells, all upper and lower aquifer monitor wells, and at least one production/injection well per acre in each well field. For large well fields, it may not be practical to sample one production/injection well per acre. Consequently, enough production/injection wells must be sampled to provide an adequate statistical population if fewer than one well per acre is used. As a general guideline, for normally and log-normally distributed populations, at least six samples are required to achieve 90 percent confidence that any random sample will lie within two standard deviations from the sample mean. In no case should the baseline sampling density for production/injection wells be less than one per 4 acres.*

For reasons stated in SER Section 2.3, staff has determined that the heterogeneities in the OZ aquifer warrant a density of wells more the minimum one well per four acres. In addition, the applicant's commitment of one well per wellfield module cannot be easily reconciled with the one well per four acres if, as the applicant describes, a wellfield module will service 5.7 acres. Therefore, staff will include a license condition that provides staff with reasonable assurance that the baseline data for the production aquifer will provide data to properly establish Commission approved background concentration under Criterion 5B(5)(a). The license condition specifies a minimum density for the ore zone baseline wells to one well per two acres and a minimum of six baseline wells for a Wellfield (Mine Unit). Staff has reasonable assurance that this maximum frequency and minimum number will provide sufficient data talking into account the expected heterogeneities in the ore aquifer. Furthermore, this density of wells will establish continuity within the ore zone and thus identify any barriers to flow, which may result in preferred groundwater migration paths. For the DM, SM and SA aquifer, staff finds the minimum density of one well per four acres adequate to establish the standards.

Staff finds the proposed locations and screened intervals for wells in the wellfield and excursion baseline monitoring program sufficient. Partially penetrating wells that target the mineralized zone is the standard industry practice for the wellfield baseline monitoring program. The partially penetrating wells can be readily converted to a production well that is used for uranium recovery operations. Use of the well as a production well will ensure that any impacts to the aquifer by the uranium recovery operations will be fully identified after production because groundwater velocities and levels of the oxidants and complexing agent in the lixiviant are the highest in the vicinity of a production well. As such, the impacts and effort needed for restoration is best characterized in the vicinity of the production wells. A well used solely for monitoring may be located nearer the fringe of a production area where the groundwater velocities and levels of the oxidants and complexing agent in the lixiviant are less. .

Partially penetrating wells target the ore aquifer within the mineralized zone; the chemistry of a fully penetrating well in the ore zone aquifer would tend to minimize the impact from the operations by diluting the fluids in the affected zones. If the baseline wells were fully penetrating, the licensee would be required to abandoned or recomplete the wells so that the wells do not provide conduits for low to the entire aquifer. As a consequence, a new well will

have to be constructed to measure compliance with the established groundwater protection standard, which, on a global scale, is a situation that staff would not prefer as it would introduce another variable to review in determining that restoration is in compliance with the established groundwater protection standards.

Fully penetrating wells in the perimeter well ring are consistent with guidance in the SRP, regulations of Wyoming for the UIC permit, and standard industry practice. The history of the standard industry practice has shown that excursion detection at fully penetrating wells in the perimeter ring provides adequate early time detection of a horizontal excursion that has shown to be protective of human health and the environment.

Staff finds that fully penetrating wells are appropriate for the DM, SM and SA aquifers for the following reasons. The aquifers are relatively thin and any partially penetrating well will be difficult to complete and difficulties in sampling because of the low yields. Because of the overall thinnest of the aquifers, a fully penetrating well will not measurably diminish the response over a partially penetrating well should a vertical excursion occur, thus meeting the requirement in 10 CFR 40.41(c) for a licensee to confine his possession and use of source and byproduct material to the locations and purposes authorized by a license.

5.7.8.3.1.3 Excursion Detection Monitoring Program during Operations

The applicant proposes that the designated indicator parameters of chloride, conductivity and alkalinity for wells in the ore zone and upper aquifers, and sulfate, conductivity and alkalinity for wells in the underlying aquifer (Strata, 2011a). In Section 5.7.8.2 of the Technical Report (Strata, 2011a), the applicant includes a justification for the indicator parameters for the ore zone and upper aquifers based on chemical makeup of the groundwater and lixiviant, and usage of similar lixiviants at existing ISR facilities in Wyoming. The applicant proposes to replace chloride with sulfate for the lower aquifer due to the elevated levels of chloride and low levels sulfate in the lower aquifer (Strata, 2011a). The applicant proposes to determine the upper control limits (UCLs) for each indicator parameter as discussed in SER Section 5.7.8.3.1.2.

The applicant states that the excursion detection monitoring program will consist of sampling al wells in the program every 10 to 14 days for the designated excursion parameters (Strata, 2011a). The applicant reports that due to emergencies or similar unusual circumstances, sampling at a well may have to be delayed beyond the maximum of 14 days. On such rare occasions, the maximum delay beyond the 14 days will be 5 days (Strata, 2011a). The wells included in the excursion detection monitoring program consist of those wells screened in the ore zone along a wellfield perimeter ring and in the overlying and underlying aquifers, as discussed in SER Section 5.7.8.3.1.2. In Section 6.1 of the Technical Report, the applicant proposes to reduce the frequency of sampling for the excursion detection monitoring program from biweekly to quarterly for a wellfield in its stability monitoring period (Strata, 2011a). Although not directly stated in the application, a change from biweekly to quarterly for the stability period indicates that the frequency of biweekly monitoring is to be conducted from operations through restoration of a wellfield.

The applicant states that if, during the excursion detection monitoring program, the levels of two of the three indicator parameters exceed their respective UCLs or the level of any single excursion parameter exceeds its UCL by 20 percent at a well, the applicant will perform additional sampling – first for verification of the excursion and then under an excursion status, if warranted (Strata, 2011a). Verification monitoring consists of a second re-sampling (within 24

hours) and/or third re-sampling (within 48 hours) of the well at which the excursion parameters levels exceeded the UCLs (Strata, 2011a). If the verification sampling confirms the initial results (i.e., two of the three sampling results exceed one of the triggering thresholds), then the well will be placed on excursion status. If the verification sampling does not confirm the initial results (i.e., the second and third sampling results are equal to or below the triggering thresholds), then the initial result is deemed a "false positive" and the well is returned to the excursion detection monitoring program (Strata, 2011a).

For a well on excursion status, the applicant proposes to notify the NRC Project Manager by e-mail or telephone within 48 hours of verifying the excursion status and with a follow-up written report to the NRC Project Manager within 30 days (Strata, 2011a). While on excursion status, the applicant proposes weekly sampling of the affected well(s) until the excursion status for the well is terminated (Strata, 2011a). If an excursion status is not corrected within 30 days, the applicant proposes sampling for a complete set of parameters per WDEQ requirements. The excursion status is terminated if the weekly sampling for three consecutive weeks shows excursion parameter levels below the respective triggering thresholds (Strata, 2011a). If a well is on excursion status in excess of 60 days, the applicant proposes to terminate lixiviant injection or provide additional reclamation surety that is agreeable to the NRC (Strata, 2011a).

The applicant states that trends wells and/or water level measurements at the excursion wells may be used for early time detection of a potential unwanted upset that ultimately may lead to an excursion status (Strata, 2011a). Monitoring of the water levels may provide early time data that may eliminate an eventual excursion status (Strata, 2011a).

NRC staff reviewed the applicant's proposed excursion monitoring program and finds it acceptable because the program will provide reasonable assurance that the production fluids are confined to the wellfield thus meeting requirements in 10 CFR 40.41(c) for a licensee to confine his possession and use of source and byproduct material to the locations and purposes authorized by a license. The proposed program is consistent with Criterion (5) of SRP Section 5.7.8.3 because it adequately defines the excursion detection monitoring program. Staff is reasonably assured that the proposed monitoring program, in combination with operational program of maintaining an inward gradient, will prevent an unwanted migration of fluids from the wellfield.

The excursion monitoring program as proposed by the applicant will be included as a standard license conditions. Staff also will also include in the standard license condition on reports a requirement to include a quarterly report to notify NRC when an excursion status is terminated.

Monitoring of the trend wells and/or water levels is a voluntary program proposed the applicant. Staff encourages such programs but does not have any such regulatory requirements that an applicant must meet.

5.7.8.3.1.4 Leak Detection Monitoring Program during Operations

The applicant proposes a leak detection monitoring program and a groundwater detection monitoring program for detection of a release from the retention ponds. The leak detection monitoring program is described and evaluated by staff in SER Section 4.2.3.1.9.10. The groundwater detection monitoring program at the SPP is discussed below in SER Section 5.7.8.3.1.5.

5.7.8.3.1.5 CPP Groundwater Detection Monitoring Program during Operations

In Table 5.7-1 of the Technical Report (Strata, 2011a), the applicant lists a groundwater monitoring program for the CPP that consists of three or more wells located downgradient and at least one well located upgradient of the CPP. The applicant lists the upgradient sample as the control sample. The analytical parameters for this program consist of dissolved uranium, radium-226, thorium-230, lead-210, polonium-210, gross alpha and gross beta. The applicant's proposed sampling frequency is monthly for the first year and quarterly thereafter. The applicant states that in conjunction with the monitoring wells, the dewatering French drain/collector well will also be monitored (Strata, 2011a).

In Section 3.1.8.2 and Addendum 3.1-A of the Technical Report (Strata, 2011a;2012b), the applicant proposes installation of a containment barrier wall (CBW) surrounding the CPP area and dewatering system to control the shallow groundwater at the CPP area. Staff reviewed and evaluated the applicant's plans for controlling the shallow groundwater in SER Section 4.2.3.1.9.7 and in this section, focuses on the monitoring program associated with that system. In Section 3.1.8.2 of the Technical Report Strata, 2011a), the applicant states that monitoring wells will be installed on both sides of the CBW to ensure a negative gradient is maintained by the groundwater control system (i.e., groundwater is higher outside of the CBW). In Section 5.7.8 of the Technical Report (Strata, 2011a), the applicant states that in the event of a large spill, samples collected at the monitoring wells outside of the CBW will demonstrate if contaminated groundwater was contained within the CBW. On Figure 5.7-13 of the Technical Report (Strata, 2011a), the applicant displays the proposed locations of six monitoring wells, three of which are located within and three located outside of the proposed CBW. The applicant states that the monitoring wells located along the CBW will be fitted with pressure transducers to continuously monitor water levels.

The applicant states that water levels in the CPP monitoring wells in the SA aquifer and the collector well for the dewatering system will be monitored to determine if leaks from the ponds reached the isolated environment underlying the facility [CPP] (Strata, 2012b). Several collector wells will be installed in the French drains in order to pump fluids captured by the French-drain dewatering system. In Section 4.2.2 of the Technical Report (Strata, 2011a), the applicant states that water generated during the dewatering of the CPP area will most likely meet surface discharge standards and will therefore be discharged under a temporary WYPDES permit.

In Section 6.4 of Addendum 3.1-A of the Technical Report (Strata, 2012b), the applicant states that monitoring of water levels and quality will be conducted at eight monitoring wells to be installed along the CBW.

In Section 3.1.8.1 of the Technical Report (Strata, 2011a), the applicant states that surface water runoff from the CPP area will be collected and stored in a sediment pond. The sediment pond is located in the southeastern corner of the CPP area within the CBW. The applicant states that the sediment pond will be lined and have leak detection configurations similar to those for the proposed retention ponds. The storage capacity for the sediment pond will designed to contain the direct runoff from the 100-year, 24-hour storm event (Strata, 2011a). The applicant states that after a significant storm event, the sediment pond will be dewatered immediately and routed to the deep disposal well.

As proposed, the applicant's "CPP area" monitoring program is an operational monitoring program in accordance with Criteria 7 of 10 CFR Part 40 Appendix A rather than a groundwater detection monitoring program in accordance with Criteria 7A of 10 CFR Part 40 Appendix A.

The “CPP area” monitoring program as proposed is consistent with guidance in RG 4.14 (NRC, 1980a) in the number of wells, sampling frequency and analytical parameters. However, the proposed plan does not meet the entire guidance in RG 4.14. Specifically, footnote (f) of Table 1 in RG 4.14 states:

> *“The location of the ground-water sampling wells should be determined by a hydrological analysis of the potential movement of seepage from the tailings disposal area. In general, the objective is to place monitor wells in all directions around the tailings area with the emphasis on the down gradient locations.”*

The applicant’s proposed program does not include monitoring in all directions.

The introduction to 10 CFR Part 40 Appendix A permits flexibility on the part of the applicant to achieve the technical criteria in the appendix based on site-specific conditions, as long as the application clearly demonstrates how the criteria are addressed. The applicant’s proposed program takes into account the site-specific conditions that include the dewatering system and CBW (i.e., “CPP area”). In essence, the applicant’s conceptual model is that shallow groundwater within the “CPP area” is an isolated environment. The applicant proposes that monitoring the water quality of the discharge from the dewatering system and at monitoring wells within the CBW will provide another system for detection of a release from the ponds in addition to the leak detection system. The application suggests that those leak detection systems combined with the monitoring of shallow groundwater at three wells downgradient of the CPP area forms the CPP monitoring program for demonstrating compliance with the applicable regulations.

The staff is not reasonably assured that the monitoring program meets the primary objective, which is to provide early time detection of a release from the impoundment, given the proposed parameters and lack of specificity. For example, the applicant specifies the frequency of monitoring at the wells downgradient of the CPP area but not for monitoring wells along the CBW or the discharge from the dewatering system. Furthermore, the applicant states that the water generated by the dewatering system will likely meet surface discharge standards and will therefore be discharged under a temporary WYPDES permit. This discharge appears to apply only during the construction phase, when the area is being dewatered, but not to the operation phase, when the applicant states the “maintenance dewater efforts will be minimal”. In fact, in Addendum 3.1-A of the Technical Report (Strata, 2012b), the applicant estimates that seepage into the CPP area from bedrock is 28 gallons per day. If correct, this low flow certainly would require only minimal maintenance efforts. In fact, given the system designs, the discharge would not be continuous and in fact during part of the year may not be required at all. Also, in Addendum 3.1-A of the Technical Report (Strata, 2012b), the applicant states that the discharge from the dewatering system may be conveyed to the lined retention ponds (if contaminated) or to an outfall structure within the proposed diversion (assuming the discharge meets effluent limits).

As stated above, the applicant’s proposed parameters are consistent with those recommended in RG 4.14 (NRC, 1980a). However, RG 4.14 was written in 1980 prior to the promulgation of 40 CFR 192 by EPA in 1983 (see introduction for Criterion 5 in 10 CFR Part 40 Appendix A), and A monitoring program though consistent with guidance in RG 4.14 may not meet the applicable standards adopted afterwards. Promulgation of 40 CFR 192 imposed standards that were subsequently codified into NRC implementing regulations, specifically Criteria 5A-5D, 7A and 13 in 10 CFR Part 40 Appendix A. Therefore, staff will include a license condition for a

"CPP area" groundwater monitoring program that meets the applicable criteria in 10 CFR Part 40.

5.7.8.3.1.6 Nearby Private Water Supply Wells Monitoring Program during Operations

The applicant proposes to monitor the nearby privately owned water supply wells within 2 km of the Ross Project during operations similar to the program initiated during the pre-operation monitoring and proposed during construction (Strata, 2011a).

Staff finds this program acceptable as it is consistent with that currently being conducted at existing ISR facilities which have been shown effective in demonstrating compliance with applicable regulations, specifically Section 10 CFR 40.41(c), which requires the licensee to confine the source or byproduct material to the locations and purposes authorized in the license. Staff will include a standard license condition that memorializes the commitment to monitor the nearby private water supply wells.

5.7.8.3.1.7 Wellfield Hydrogeologic Package

In Section 3.1.6 of the Technical Report (Strata, 2011a), the applicant states that a significant component of a wellfield data package will be demonstrating wellfield and monitoring well integrity by hydrologic testing through pumping of recovery wells in the wellfield area and measuring responses in the surrounding perimeter monitoring wells. The applicant commits to attempt to identify and replug all historic drill holes within the perimeter monitoring well ring and provide that information in the wellfield data package. In Section 5.7.8, the applicant commits to performing aquifer testing only after the historic drill holes are abandoned within the area of influence of the tests and after MITs are completed on all existing wells that will be used during operations.

The applicant commits to institute a groundwater and surface water monitoring program in order to prepare a comprehensive wellfield data package (Strata, 2011a). The wellfield data package will contain the results of aquifer tests, potentiometric surface maps, water quality results, and groundwater modeling predictions. The applicant proposed one well cluster for every four wellfield acres to establish baseline conditions. One well cluster consists of a well in the underlying (DM), ore zone (OZ) and overlying (SM) aquifers. The applicant estimates 24 baseline well clusters based on the existing ore bodies/production areas (Strata, 2011a). The baseline wells in the ore aquifer (OZ aquifer) will target the mineralized zone. The applicant states that no additional monitoring is proposed for the uppermost aquifer (SA aquifer) except for the CPP area. The applicant proposes that the perimeter well ring will consist of wells fully penetrating the ore aquifer (OZ aquifer) on a spacing of 122 to 183 meters [400 to 600 feet} at a distance of 122 to 183 meters [400 to 600 feet] from the nearest production area in order to monitoring for horizontal excursions. In responses to RAIs (Strata, 2012b), the applicant commits to a spacing and offset of 122 meters [400 feet] for wells in the perimeter well ring.

The applicant states the purpose for the aquifer testing for the wellfield data package is to demonstrate that the ore aquifer is isolated from the overlying and underlying aquifers, to demonstrate the perimeter monitoring are in communication with the ore zone wells, and to further improve and calibrate the numeric groundwater flow model.

The applicant commits to providing the baseline water quality data in the wellfield data package (Strata, 2011a). For details on the baseline water quality program, see SER Section 5.7.8.3.1.2.

Staff finds that the proposed information to be included in the wellfield data package will provide reasonable assurance that operations at a specific wellfield will be controlled and monitored by means that are protective of human health and safety and the environment. Furthermore, based on the pre-operational pumping tests and results of the numeric groundwater flow modeling (see SER Section 2.4), staff is reasonably assured that the applicant can operate the Ross Project in a manner that will confine the source and byproduct materials to the authorized locations. These reasonable assurance determinations, that the applicant's operations will be performed in accordance with 10 CFR 40.41(c), are contingent on the fulfillment of a license condition requiring the submittal of each mine unit wellfield data package to the NRC, and the initial wellfield package submitted to NRC staff for review and verification prior to lixiviant injection in each new wellfield as presented in SER Section 5.7.8.4.

The proposed monitoring program for the overlying and underlying aquifers meets the requirements in 10 CFR 40.41(c) for a licensee to confine its possession and use of source and byproduct material to the locations and purposes authorized by the license and is consistent with acceptance Criterion (3) in SRP Section 5.7.8.3.

5.7.8.3.2 Surface Water Monitoring

The applicant states that during its construction phase, surface water monitoring will be conducted at the Oshoto reservoir, and three on-site stream gaging stations (SW-1, SW -2 and SW-3) located within Deadman Creek or Little Missouri River (Strata, 2011a). The applicant anticipates that, based on the preoperational monitoring program, flows in the streams will likely be ephemeral primarily during April to October (Strata, 2011a). Surface water is found year-long in the Oshoto reservoir.

During operations, the applicant commits to a surface water monitoring program which was conducted during the preoperation monitoring, i.e., quarterly sampling at three on-site stream gaging stations and 11 on-site or nearby reservoirs. The parameters to be analyzed for the operation surface water monitoring program are dissolved and suspended uranium, Th-230, Ra-226, Po-210 and Pb-210, and, gross alpha and gross beta unless sufficient cause can be demonstrated to measure a parameter less frequently.

The applicant also commits to monitoring surface water should monitoring be required for a Wyoming discharge permit through the WYPDES program (Strata, 2011a). Examples of such discharges provided by the applicant are stormwater, temporary or process water discharges.

Staff finds that the proposed construction and operational surface water monitoring programs are adequate by providing defense in depth monitoring for a potential release. Due to the ephemeral nature of the streams, staff acknowledges that stream water quality sampling is not a regulatory requirement but a good best practices techniques and that quarterly sampling will not be available throughout the year. Staff will include a standard license condition to memorialize the applicant's commitment to the surface water monitoring program.

5.7.8.4 Evaluation Findings

NRC staff has completed its review of the surface water and groundwater monitoring programs at the Ross Project. This review included an evaluation of the review procedures in SRP Section 5.7.8.2 and the acceptance criteria outlined in SRP Section 5.7.8.3. The applicant 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. As noted above, staff will include several license conditions to define aspects of the monitoring program which the staff identified as needing clarification. The aspects needing clarification consist of the following:

- Monitoring of the water pumped from the on-site industrial wells should the wells continue to be in operation
- Criteria for reducing the parameters to be monitored during the final two rounds of sampling for the wellfield and excursion monitoring programs
- Monitoring wells in the uppermost (SA) aquifer for wellfields located in areas in which the uppermost aquifer is in the shallow alluvium
- Minimum density of one well per two acres of production area for the baseline ore zone monitoring program
- Quarterly notification to NRC on termination of wells on excursion status
- Details of a CPP area groundwater detection monitoring program that meets technical criteria 5 and 7A of 10 CFR Appendix A
- Preoperational and annual update of a survey of the nearby water usage

Therefore, staff will include the following license conditions:

Facility Specific License Condition 10.13:

> Wellfield Package. Prior to conducting principal activities in a new wellfield, the licensee shall submit a hydrologic test data package (wellfield package) to the NRC. The initial wellfield package will be submitted for NRC staff review and verification. Each wellfield package shall be submitted at least 60 days prior to the planned start date of lixiviant injection. In each wellfield data package, the licensee will document that: (1) all perimeter monitoring wells are screened in the appropriate horizon in order to provide timely detection of an excursion; and (2), the baseline values to establish groundwater protection standards and UCLs for the Wellfield in accordance with LC 11.3. The wellfield package will adequately define heterogeneities that may affect the chemical signature and groundwater flow paths within the ore zone as described in Sections 2.7.3.2.3, 3.1.1 and 5.7.8.1 of the approved license application.

Facility Specific License Condition 10.19:

> The licensee shall confine its operations to wellfields located north of Little Missouri River within the area delineated as “Mine Unit 1” on Figure 3.1-1 of the approved license application until use of the three industrial wells, designated as “19XX18”, “22x-19” and “789V” in the approved license application, as water supply sources for the oil field flooding operations have ceased or diminished to an acceptable level, which has been reviewed and verified by NRC staff. For wellfields south of the Little Missouri River, the licensee must demonstrate in the wellfield package that the proposed operations are outside of the area of influence of the industrial wells. The location of a wellfield or a portion of a wellfield shall not include any of the industrial wells if the well has not been properly abandoned. If the licensee’s principal activities are being conducted at a wellfield on the Ross Project and operations of the onsite industrial water

supply wells have not been discontinued, the effluent monitoring program will include monthly sampling of water pumped from the industrial wells.

Facility Specific License Condition 10.20:

The licensee shall conduct a groundwater detection monitoring program for the retention ponds that meets requirements of Criteria 5 and 7A of 10 CFR Part 40, Appendix A. The elements in this program will be documented in the licensee's SOPs.

Standard License Condition 11.3:

Establishment of Background Water Quality. Prior to injection of lixiviant in a wellfield, the licensee shall establish background groundwater quality data for the ore zone, overlying and underlying aquifers. The background water quality sampling shall provide representative baseline data and establish groundwater protection standards and excursion monitoring upper control limits, as described in Section 5.7.8 of the approved license application and this license condition.

The data for each mine unit shall consist, at a minimum, of the following sampling and analyses:

A) Ore Zone. To establish a Commission-approved background concentration pursuant to Criterion 5B(5)(a) of 10 CFR Part 40 Appendix A, samples shall be collected from production and injection wells at a minimum density of one production or injection well per two acres of wellfield production area, or, if a wellfield production area is sufficiently isolated from the other wellfield production areas in the Wellfield, a minimum of two wells. Wells selected for the baseline data will be the same ones used to measure restoration success and stabilization.

B) Perimeter Monitoring Wells. Samples shall be collected from all perimeter monitoring wells that will be used for the excursion monitoring program. The perimeter wells will be installed for a wellfield in accordance with information presented in Section 3.1.6 of the approved license application. In no case will the perimeter monitoring wells be installed outside of the exempted aquifer as defined by the Class III UIC permit issued by the Wyoming Department of Environmental Quality.

C) Overlying and Underlying Aquifers. Samples shall be collected from all monitoring wells in the first overlying and first underlying aquifer at a minimum density of one well per 4 acres of wellfield.

D) Sampling and Analyses. Four samples shall be collected from each well to establish background levels. The sampling events shall be at least 14 days apart. The samples shall be analyzed for parameters listed in Table 5.7-2 of the approved license application. The third and fourth sample events can be analyzed for a reduced list of parameters; the parameters that can be deleted from analysis are those below the minimum analytical detection limits (MDL) during the first and second sampling events provided the MDLs meet the data quality objectives for the sampling.

E) Background Water Quality. For the perimeter ring monitoring wells (Section B) and monitoring wells in the overlying and underlying aquifers (Section C), the background levels shall be the mean values on a parameter-by-parameter, well-by-well, wellfield or sub-set of the wellfield basis, as deemed appropriate, in accordance with Section 5.7.8.1 of the approved license application. The UCLs for monitoring wells in the perimeter ring and overlying and underlying aquifers are established per LC 11.4. For the ore zone monitoring wells, the background levels shall be established on a parameter-by-parameter basis using either the wellfield, sub-set of the wellfield or well-specific mean value. The established background value for each parameter shall be based on the mean value plus a statistically valid factor to account for spatial variability in the data, in accordance with Section 6.1.1.1 of the approved license application.

Standard License Condition 11.4:

Establishment of UCLs. Prior to injection of lixiviant into a wellfield, the licensee shall establish excursion control parameters and their respective upper control limits (UCLs) in the designated overlying aquifer, underlying aquifer and perimeter monitoring wells in accordance with Section 5.7.8.2 of the approved license application. The default excursion parameters for wells in the ore zone and overlying aquifer are chloride, conductivity, and total alkalinity. The default excursion parameters for wells in the underlying aquifer are sulfate, conductivity, and total alkalinity. The UCLs shall be established for each excursion control parameter and for each well, wellfield or subset of the wellfield, as appropriate, based on the mean plus five standard deviations of data collected for LC 11.3. The UCL for chloride can be set at the background mean concentration plus either five standard deviations or 15 mg/l, whichever is higher.

Standard License Condition 11.5:

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

Upon confirmation of an excursion, the licensee shall notify NRC as stated below, implement corrective action, and increase the sampling frequency for the excursion indicator parameters at the well on excursion status to at least once every seven days. Corrective actions for confirmed excursions may be, but are not limited to, those described in Section 5.7.8.2 of the approved license application. An excursion is considered corrected when concentrations of all indicator parameters defining the excursion status are at or below the UCLs defined in LC 11.4 for three consecutive weekly samples.

For wellfields located in an area in which the uppermost aquifer, the "SA Aquifer", is comprised of saturated unconsolidated alluvium, the licensee will include monitoring wells in the SA Aquifer in that area of the wellfield as part of the excursion monitoring program as described above. The wellfield data package must include sufficient justification on the locations, baseline sampling if the frequency is less than quarterly, and operational sampling if the frequency is less than semi-monthly for wells in the uppermost aquifer. The justification must demonstrate that the wells provide early detection of a release (including a surficial release).

If a vertical excursion is detected during operations, then injection of lixiviant into the production area surrounding the monitoring well will cease until the licensee demonstrates to the satisfaction of NRC that the vertical excursion is not attributed to leakage through any abandoned drill hole.

If an excursion is not corrected within 60 days of the initial confirmation, the licensee shall either: (a) terminate injection of lixiviant within the wellfield, or a portion of the wellfield provided the licensee demonstrates to NRC that only a portion of the wellfield is within the area of influence for the excursion) until the excursion is corrected; or (b) increase the financial surety in an amount to cover the full third-party cost for correcting and cleaning up impacts that may be attributed to the excursion. The surety increase shall remain in force until the NRC has verified that the excursion has been corrected and appropriate remedial actions have been undertaken. The written 60-day excursion report shall identify which course of action the licensee is taking if the excursion has not been corrected. Under no circumstances does this condition eliminate the requirement that the licensee remediate the excursion to meet groundwater protection standards as required by LC 11.3.

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

Standard License Condition 12.3:

Prior to commencement of operations, the licensee shall identify the location, screen depth, and estimated pumping rate of any new water supply well or new use for an existing well within 2 kilometers of a proposed wellfield area, as

measured from the perimeter monitoring well ring, since the application was submitted to the NRC. The licensee shall evaluate the impact of ISR operations and recommend any additional monitoring or other measures to protect groundwater users. The evaluation shall be submitted to the NRC staff for review and verification at least 30 days prior to the expected commencement of operations.

Standard License Condition 12.12:

> Prior to construction of the retention ponds, the licensee shall submit, for NRC review and verification, a groundwater detection monitoring program plan for the retention ponds that meets requirements of Criteria 5 and 7A of 10 CFR Part 40, Appendix A. The plan will include specificity of elements discussed in Section 5.7.8.2 (Operational Monitoring-CPP Area) of the approved license application (e.g., monitoring dewatering effluent quality and water level, and water quality monitoring of monitoring wells along the containment barrier wall).

License conditions for effluent and monitoring programs and NRC notification are presented in SER Section 5.7.7.4. The license conditions for reports to be submitted to NRC are presented in SER Section 3.1.4.

Based on the information provided in the application and on the detailed review conducted by staff of the groundwater and surface water monitoring programs at the Ross Project, and contingent upon the license conditions noted above, the staff concludes that the groundwater and surface water monitoring programs are acceptable and comply with the following regulations:

- 10 CFR 40.32(c), which requires the applicant'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 applicant 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 concentration limits 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.

5.7.9 QUALITY ASSURANCE (QA)

5.7.9.1 Regulatory Requirements

Staff's analysis will determine if Strata Energy (Strata or the applicant) has demonstrated that the proposed quality assurance program for the Ross ISR Project meets the requirements of 10 CFR 20.1101, 10 CFR Part 20 Subpart L, and Subpart M.

5.7.9.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with applicable requirements of 10 CFR Part 40 using acceptance criteria outlined in Section 5.7.9.3 of the Standard Review Plan (SRP),

NUREG-1569 (NRC, 2003). Regulatory Guide 4.15 provides guidance on demonstrating compliance with the applicable regulations.

5.7.9.3 Staff Review and Analysis

Unless otherwise stated, the information in SER Section 5.7.9.3 was from Section 5.7.9 of the technical report (Strata, 2011a). This section discusses the proposed QA programs for radiological and non-radiological monitoring activities. QA is a methodical program of procedures and controls required to provide sufficient confidence in the evaluation of monitoring results (NRC, 2007). Quality control (QC) is the methodology, such as tests, audits, and analyses, used within the QA program to verify that established standards are met. The QA/QC program includes all radiological and non-radiological measurements that support the radiological, effluent, and environmental monitoring programs. The QA/QC program is essential to ensure that data collected and recorded to demonstrate compliance with 10 CFR Parts 20 and 40, and 40 CFR Part 190 are reasonably valid and of a defined quality.

5.7.9.3.1 Radiological and Non-radiological Monitoring Programs

Regulatory Guide 4.14, Radiological Effluent and Environmental Monitoring at Uranium Mills, (NRC, 1980a), Sections 3 and 6, describe guidance to ensure that representative effluent and environmental monitoring data are collected by implementing sampling and analytical procedures, collecting samples at appropriate locations, using correct and calibrated equipment, and minimizing random and systemic errors. Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination) - Effluent Streams and the Environment (NRC, 2007) and Regulatory Guide 4.14 state that analytical processes should be tested with periodic cross-check analyses with independent laboratories. Further, Regulatory Guide 4.15 suggests that any contractor performing monitoring activities should provide a QA program and program data summaries consistent with the guidance established in the guide.

The applicant states that Strata will document the QA and QC programs in a QA program (Strata, 2011a). The staff notes that the purpose for a QA program is to ensure that the procedures and practices for any operational or decommissioning monitoring program are based on sound radiation protection principles to achieve doses to the workers and public are as low as reasonably achievable (ALARA) and that the data acquire to make the ALARA determinations are precise and accurate. The underlying regulatory requirement for the QA program is 10 CFR 20.1101. That regulation requires licensees to develop, document, and implement the QA program; however, the regulations do not require that the QA program be developed prior obtaining a license. The applicant states that it will provide a QA program to the NRC during the application review process (Strata, 2011a). The staff notes that to date, the applicant has not yet provided a QA program, therefore, a license condition described in SER Section 5.7.9.4 will require the applicant to provide a QA program 60 days before operations begin.

The applicant indicates that its proposed QA program will include the following items (Strata, 2011a):

- delineation of organizational structure and responsibilities of management, which will include responsibilities for both review/approval of written procedures and monitoring data/reports;

- minimum personnel qualifications and training for individuals performing radiological monitoring, to include job descriptions, training program, and continuing training and education requirements;
- written operating procedures and instructions for general laboratory and internal QC that includes instrument calibration, external performance evaluation, and data verification and validation;
- procedures covering statistical data evaluation, instrument calibration, duplicate sample programs, and spike sample programs;
- audits and qualifications of personnel conducting the audits; and
- preventive and corrective actions to ensure continuous improvements in the program, which include evaluating performance levels and deficiencies, corrective actions, and efficacy evaluations.

In Section 5.2.1 of the Technical Report (Strata, 2011a), the applicant commits that the Radiation Protection Program (RPP) will consist of written operating procedures for all process activities including those activities involving radioactive materials. These written operating procedures will also include quality assurance. Strata will implement management controls throughout the Ross ISR Project by written procedures or instructions consistent with the corporate policies and standards and regulatory requirements. All routine activities involving handling, processing, or storing of radioactive material will be documented by written SOPs. The SOPs will include all pertinent radiation safety practices. The applicant states in application Section 6.4.4 that samples verifying soil decommissioning will be sent to a commercial laboratory for analysis of Ra-226 and natural uranium (Strata, 2011a). Strata will require the commercial laboratory to have a well-defined QA program and that Strata will maintain a laboratory QA file that will include, at a minimum, the laboratory's Quality Assurance Manual (QAM) and audit reports. Strata will require the commercial laboratory’s QA program to comply with the Ross Project QAM (Strata, 2011a).

The applicant commits in application Section 3.2.5 that restoration will begin approximately 6 to 12 months after operations have been finished on the modules, which will occur concurrently with operations of other modules. As a standard license condition, the applicant will submit wellfield data package(s) to NRC for review and verification prior to operations in the respective wellfield. The applicant commits to submitting an updated decommissioning plan after operations are completed.

For the processing and support facilities that will not be removed until the end of the Project, the applicant commits in application Section 6.2 to submitting, at least 12 months prior to the planned decommissioning activities, an updated decommissioning plan to NRC for review and approval.

Staff reviewed the applicant’s description of the QA program and finds that the submitted information is not consistent with the acceptance criteria for a completed QA program in SRP Section 5.7.9.3 (NRC, 2003) nor is it consistent with guidance in Regulatory Guide 4.14, Section 3 and 6 (NRC, 1980a) and Regulatory Guide 4.15 (NRC, 2007). The QA program is supposed to be designed to assure data collected in the monitoring programs are representative of site conditions and those values can be relied on for evaluation of risks to human health or the environment. Section 10 CFR 40.31(h) states that “[*an] application … shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A*”. Although the application contains a comprehensive overview of goals for a QA program, the staff will require that the

applicant provide details on their proposed in-house monitoring programs for the NRC staff to review and verify prior to implementing those programs. Therefore, the NRC staff will require the applicant to submit a completed QA program to NRC staff for review prior to startup of operations for the staff to verify that the QA program will be consistent with Regulatory Guide 4.15 (as revised). Furthermore, the NRC staff will review the QA program to ensure the environmental monitoring data collected meet regulatory requirements in Criterion 7 of Appendix A to 10 CFR Part 40. The license condition is discussed in SER Section 5.7.9.4.

5.7.9.3.2 Organizational Structure and Responsibilities

The applicant states in application Section 5.1 that Strata will maintain a performance-based approach to the management of environment and employee health and safety. Employee health and safety includes radiation safety. Management personnel responsibilities will provide for development, review, approval, implementation, and adherence to quality assurance programs (Strata, 2011a). Four positions – the Chief Operating Officer (COO), General Manager, Facility Manager, and Health, Safety, and Environmental Affairs – represent the applicant’s higher management positions that are located on and off the licensed site. The RSO has responsibility for and authority over, the QA/QC program for the Ross ISR Project (Strata, 2012b). The RSO is responsible for all radiation protection, health and safety, and environmental programs and for ensuring that the applicant complies with all applicable regulatory requirements. The EHS Manager also advises the radiation safety officer (RSO) to ensure that Strata conducts the radiation safety and environmental monitoring and protection programs in a manner consistent with regulatory requirements (Strata, 2011a).

NRC staff has determined that the organizational structure and responsibilities outlined in Sections 5.1 and 5.7.9.1, and Figure 5.1-1 of the technical report (Strata, 2011a;2012b) provides the QA/QC coordinator sufficient authority and organizational freedom to implement the QA program consistent with guidance provided in Regulatory Guide 4.15. The staff will verify that this information is contained within the QA program submitted to NRC for review prior to startup of operations.

5.7.9.3.3 Specification of Qualifications of Personnel

Because the applicant failed to submit a completed QA program detailing the qualifications of personnel in the QA programs, as described in the acceptance criteria in SRP Section 5.7.9.3, NRC staff will require the applicant to submit a completed QA program consistent with Regulatory Guide 4.15 to NRC staff for review and verification.

5.7.9.3.4 Operating Procedures and Instructions

NRC finds that the information the applicant is to provide will be acceptable provided the applicant addresses the information in the QA program in sufficient detail and consistent with the guidance provided in Regulatory Guide 4.15. Accordingly, the NRC staff will require the applicant to submit a completed QA program consistent with Regulatory Guide 4.15 to NRC staff for review to verify the applicant has met the commitments in its approved application prior to startup of operations. SER Section 5.7.9.4 discusses this license condition.

5.7.9.3.5 Records and Quality Control

In application Section 5.2.3, the applicant states that records will be maintained as hard copy originals or stored electronically in accordance with the requirements of 10 CFR 20 Subpart L

and 10 CFR 40.61 (d) and (e) (Strata, 2011a). Application Section 5.2.1 states that management controls will be implemented throughout Strata by written procedures or instructions consistent with the corporate policies and standards and regulatory requirements. All routine activities involving handling, processing, or storing of radioactive material will be documented by written SOPs. SOPs will be implemented at the proposed Ross ISR Project include the Quality Control Requirements for Environmental Bioassay Program and Laboratory Quality Control. The applicant states in application Section 6.1.1.1 that Strata will use quality control checks, such as visual screening and statistical analysis, to remove outliers when reviewing groundwater target restoration values (TRVs). However, the applicant has not provided a QA program that describes the quality control program. Because the applicant did not submit a completed QA detailing the records and documents controls for the QA programs as required by the acceptance criteria in SRP Section 5.7.9.3, NRC staff will require the applicant to submit a completed QA consistent with its TOC to NRC staff for review and verification prior to startup of operations.

5.7.9.3.6 Verification and Validation

The verification and validation (V&V) of certain aspects and support activities of the measurement process or monitoring program are essential to the QA program (NRC, 2007). These aspects and activities include data and computer software V&V and project method validation. Project method validation is the demonstration that a performance-based method is capable of providing analytical results to meet criteria in the analytical protocol specification. Acceptable project method validation is necessary before the radiological analysis of samples or the taking of measurements in a monitoring program (NRC, 2007). The applicant has not addressed V&V details or procedures for the monitoring programs. NRC staff will require the applicant to submit a completed QA program consistent with sufficient detail and consistent with Regulatory Guide 4.15 in its approved license application prior to startup of operations.

5.7.9.3.7 Assessments, Audits, and Preventive and Corrective Actions

Assessments, audits, and surveillances are elements used to evaluate the initial and ongoing effectiveness of the QA program to monitor and control the quality of a radiological monitoring program. Management having responsibility in the area being reviewed should document and review the results of the assessments, audits, and surveillances. Audits of the QA programs of contractors providing materials, supplies, or services affecting the quality of the laboratory's operations should be performed periodically (NRC, 2007).

Integral components of a QA program include identifying areas for improvement, defining performance or programmatic deficiencies, and initiating appropriate corrective or preventive actions. The QA program for radiological effluent and environmental monitoring programs should contain both a continuous-improvement program and a program for implementing corrective actions when conditions adverse to quality have been identified (NRC, 2007).

The applicant states in application Section 5.3 that Strata will perform inspections and audits periodically to ensure compliance with radiological health, operational, and environmental standards (Strata, 2011a). The applicant commits in application Section 5.7.9 that Strata will have the QA program audited periodically by individuals qualified in radiochemistry and monitoring techniques. The applicant states that auditors will not have direct responsibilities in the areas being audited. Strata will document and provide audit results to the NRC and make the results available to members of management with authority to enact any changes needed (i.e., RSO, Mine Manager, etc.) (Strata, 2011a). NRC staff has reviewed the information that

the applicant intends to provide and finds that it will be acceptable provided the information is in sufficient detail and consistent with Regulatory Guide 4.15 and with the assessments noted above. Therefore, the staff has reasonable assurance that the applicant intends to meet its commitment, contingent upon a license condition that requires Strata to submit a completed QA program that is consistent with Regulatory Guide 4.15 to the NRC staff for review and verification.

5.7.9.4 Evaluation Findings

The applicant has provided an acceptable corporate organization that defines management responsibilities with sufficient authority at each level and organizational freedom to implement a QA program. The proposed organizational management structure diagram portrays integration among groups that support the operation and maintenance of the facility that the staff finds adequate because it indicates management intends to comply with the guidance in Regulatory Guides 4.15 to ensure the environmental data collected and analyzed will meet regulatory requirements in 10 CFR Part 40, Appendix A.

The question is whether a description of a proposed QA program forms a sufficient basis from which the staff may conclude regulatory compliance or whether the applicant must submit a completed QA program. Acceptance Criterion (1) of SRP Section 5.7.9.3 presumes that an applicant will submit a complete QA program with its application. NRC staff has determined that the details of the proposed QA program submitted by Strata with the application (Strata, 2011a) identifies that information to be included in the QA program on a level of detail such that staff has reasonable assurance the applicant's proposed QA program would be consistent with the guidance in Regulatory Guide 4.15, However, to ensure that the final QA program remains consistent with the applicant's commitments made in its application and to ensure the environmental data collected will meet regulatory requirements, the staff will include a license condition requiring that the applicant submit the completed QA program to the NRC staff for review and verification prior to preoperational inspection.

Additionally, the staff finds that the components of the QA/QC identified in the application demonstrates the applicant understands the need for precise and accurate data, and commitments made throughout the application demonstrates the applicant understands the ALARA principle. For example, the application included discussions on the calibration, correction factors and measurement procedures (Section 5.7.2 of the application (Strata, 2011a), and responsibilities of personnel performing the radiation protection program (Section 5.7.2 of the application (Strata, 2011a). Staff finds that the understandings documented in the application for a proper radiation protection program and the description of the proposed QA program are sufficient bases for staff's determination that the applicant will develop a program that meets the requirements in 10 CFR 20.1101. Staff's findings are contingent upon the imposition of the following facility specific license condition:

Facility Specific License Condition 12.10

> At least 60 days prior to the preoperational inspection, the licensee will submit a completed Quality Assurance Plan (QAP) for NRC staff review and verification. The QAP will include the requirements in 10 CFR 20.1703(c)(4)(vii), and be consistent with guidance for a Quality Assurance Project Plan (QAPP) in Regulatory Guide 4.15 (as revised). The portion of the QAP fulfilling requirements of 10 CFR 20.1703(c)(4)(vii) may be included as a section or attachment in the applicable SOP(s).

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Table 5.7-1. Summary of the Major Elements of the Ross Operational Environmental Monitoring Program

Program Element	Location	Radionuclides Analyzed	Sampling Frequency	Number of Sampling Locations
Ground water – Monitor Wells	Up-gradient and down-gradient from CPP	Dissolved uranium, Ra-226, Th-230, Pb-210, Po-210, gross alpha, gross beta	Monthly first year, quarterly thereafter	3 or more down-gradient;at least up-gradient control sample
Ground water - Water Supply Wells	Private wells within 3.3 km (2mi) of project area similar to the pre-operational baseline monitoring	Dissolved and suspended uranium, Ra-226,Th-230, Pb-210, Po-210, gross alpha, gross beta	Quarterly	29
Surface Water	Surface waters passing through project area and reservoirs subject to runoff similar to pre-operational baseline monitoring	Dissolved and suspended uranium, Ra-226,Th-230, Pb-210, Po-210, gross alpha, gross beta	Quarterly (as available)	3 surface water monitoring stations and11 reservoirs within project area
Air Particulates	Locations with the highest predicted concentrations, nearest residences and control location similar to pre-operational baseline monitoring	Total uranium, Th-230, Ra-226,Pb-210	Continuous - Composites of weekly filters analyzed quarterly	5 or more
Radon in Air	Particulate in air locations and other areas of interest similar to pre-operational baseline monitoring	Rn-222	Continuous viaTrack-Etch units – quarterly exchange and analysis of units	5 or more
Soil	Particulate in air locations and other locations with the highest predicted concentrations similar to pre-operational baseline monitoring	Total uranium,Ra-226, Pb -210,gross alpha	Annually	5 or more
Sediment	Surface waters passingthrough project area and reservoirs subject to runoff similar to pre-operational baseline monitoring	Total uranium,Ra-226, Pb -210,gross alpha	Annually (as available)	3 surface water monitoring stations and 11 reservoirs within project area
Direct Radiation	Particulate in air locations and other areas of interest similar to pre-operational baseline monitoring	Continuous via TLD	Quarterly	5 or more
Vegetation (2)	Animal grazing areas and other locations with the highest predicted concentrations similar to pre-operational baseline monitoring	Ra-226 and Pb-210	Three timesduring grazing season	Grazing vegetation representing 3 different sectors that have the highest predicted concentrations of radionuclides
Animal Tissue	Livestock (cattle) raised within 3 km of the site and fish from Oshoto Reservoir similar to pre-operational baseline monitoring	Ra-226 and Pb-210	Once during site decommissioning and prior to license termination	3 samples of beef; 1 fish sample (composite to meet laboratory MDL)

(1) Location of air particulate samplers used during the preoperational baseline monitoring will be re-evaluated for operational monitoring based on results of the pre-operational meteorological monitoring program and the results of the MILDOS-AREA analysis to insure at least 3 locations are selected representing 3 different sectors that have the highest predicted concentrations of radionuclides

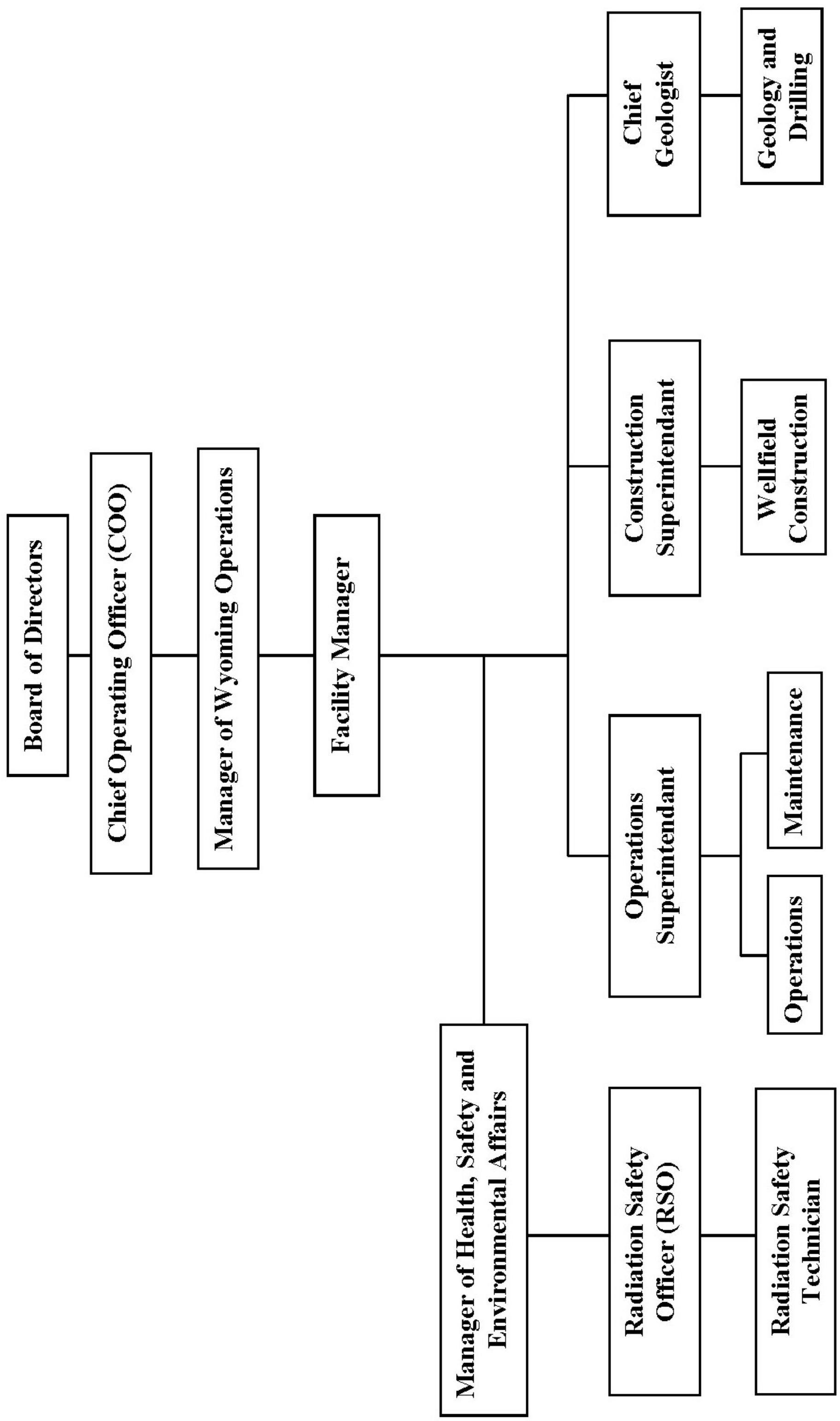
(2) In accordance with the provisions of NRC Regulatory Guide 4.14, Footnote (o) to Table 2: " *vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially pathway...*" defined as a pathway which would expose an individual to a dose in excess of 5% of the applicable radiation protection standard. This pathway was evaluated by MILDOS-AREA.

Source: Table 5.7-1 (Strata, 2011a)

Table 5.7-2 Analytical Paramters for the Groundwater Protection Monitoring Program

Parameter	Units	Parameter	Units
Field		**Metals**	
Field conductivity	umhos/cm	Aluminum, dissolved	mg/L
Field pH	s.u.	Arsenic, dissolved	mg/L
Field turbidity	NTUs	Barium, dissolved	mg/L
Depth to water	Ft	Boron, dissolved	mg/L
Temperature	Deg C	Cadmium, dissolved	mg/L
ORP	Millivolts	Chromium, dissolved	mg/L
Dissolved oxygen	mg/L	Copper, dissolved	mg/L
General		Iron, dissolved	mg/L
Alkalinity (as CaCO3)	mg/L	Iron, total	mg/L
Ammonia	mg/L	Lead, dissolved	mg/L
Fluoride	mg/L	Manganese, total	mg/L
Laboratory conductivity	umhos/cm	Mercury	mg/L
Laboratory pH	s.u.	Molybdenum, dissolved	mg/L
Nitrate/nitrite	mg/L	Nickel, dissolved	mg/L
Total dissolved solids	mg/L	Selenium, dissolved	mg/L
Major Ions		Silver, dissolved	mg/L
Calcium	mg/L	Uranium, dissolved	mg/L
Magnesium	mg/L	Uranium, suspended	mg/L
Potassium	mg/L	Vanadium, dissolved	mg/L
Sodium	mg/L	Zinc, dissolved	mg/L
Bicarbonate	mg/L	**Radiological**	
Carbonate	mg/L	Lead 210, dissolved	pCi/L
Chloride	mg/L	Lead 210, suspended	pCi/L
Sulfate	mg/L	Polonium 210, dissolved	pCi/L
		Polonium 210, suspended	pCi/L
		Ra-226, dissolved	pCi/L
		Ra-226, suspended	pCi/L
		Ra-228, dissolved	pCi/L
		Radon-222	pCi/L
		Th-230, dissolved	pCi/L
		Th-230, suspended	pCi/L
		Gross alpha	pCi/L
		Gross beta	pCi/L

Source: Table 5.7-2 of Strata (2011a)



Source: Figure 5.1-1 of the Technical Report (Strata, 2011a)

Figure 5.1-1 Corporate Organizational Chart for the Ross Project

6.0 GROUND WATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

6.1 PLANS AND SCHEDULES FOR GROUNDWATER RESTORATION

6.1.1 REGULATORY REQUIREMENTS

General requirements for contents of an application for a specific license issued under 10 CFR Part 40 are listed in 10 CFR 40.31. Section 10 CFR 40.31(h) specifies that an application must clearly demonstrate how requirements and objectives set forth in 10 CFR Part 40 Appendix A are addressed. Technical Criterion 7A of 10 CFR Part 40 Appendix A sets forth requirements and objectives for a groundwater detection monitoring program that is needed to establish the site-specific groundwater protection standards in Criterion 5 of 10 CFR Part 40 Appendix A. Technical Criterion 5B(5) of 10 CFR Part 40 Appendix A sets forth requirements and objectives for the maximum concentration of hazardous constituents at the point of compliance.

Section 10 CFR 40.32(c) requires the applicant's proposed equipment, facilities and procedures to be adequate to protect health and minimize danger to life or property; Section 10 CFR 40.41(c) requires a licensee to confine the its possession and use of source or byproduct material to the locations and purposes authorized in the license; and Section 10 CFR 40.32(d) requires that issuance of a license will not be inimical to the common defense and security or to the health and safety of the public.

Section 6.1.3 of the SRP (NRC, 2003) provides guidance on reviewing groundwater restoration plans and schedule to meet requirements in Criteria 5 and 7(a) of 10 CFR Part 40 Appendix A, and sections 10 CFR 40.32(c), 10 CFR 40.32(d) and 10 CFR 40.41(c). The purpose of a restoration is to demonstrate compliance with established groundwater protection standards and ensure that any hazardous constituents that may have entered the groundwater regime comply with those standards. The methods used to establish groundwater protection standards are described and evaluated in SER Section 5.7.8. In this SER section, staff reviews and evaluates the proposed plans and schedules for compliance with the standards.

Staff is required to determine that the proposed plans and schedules for groundwater restoration at the Ross Project meet the requirements of 10 CFR 40.32(c), 10 CFR 32(d), 10 CFR 40.41(c), and 10 CFR Part 40, Appendix A, Criteria 5 and 7.

6.1.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the review procedures in Section 6.1.2 and acceptance criteria in Section 6.1.3 of the SRP (NRC, 2003).

In SER Section 6.1.3, unless specifically stated otherwise, the reported information is from Section 6.1 of the Technical Report (Strata, 2011a).

6.1.3 STAFF REVIEW AND ANALYSIS

This section discusses the applicant's proposed plans for restoration activities at the Ross Project. This discussion includes proposed restoration standards, restoration methods, restoration effectiveness, estimates of the number of pore volumes needed to complete

restoration, restoration and stability monitoring, wastewater disposal, well plugging and abandonment, and the preliminary restoration schedule.

6.1.3.1 Restoration Standards

In the technical report (Strata, 2011a), the applicant commits to using groundwater protection standards meeting 10 CFR Part 40, Appendix A, Criterion 5B(5) for the restoration of the production aquifer following operations on a parameter-by-parameter basis using best practicable technology (BPT). Those groundwater protection standards are either the Commission-approved background values (Criterion 5B(5)(a)) listed in the table in paragraph 5C of 10 CFR Part 40, Appendix A (Criterion 5B(5)(b)), or an alternate concentration limit (ACL) established by the NRC in accordance with Criterion 5B(6) (Criterion 5B(5)(c)). The applicant commits to submitting a license amendment for NRC's approval of an ACL if the criteria 5B(5)(a) or 5B(5)(b) are not achievable.

The staff finds that the applicant's commitments satisfy the regulatory requirements and will include a standard license condition memorializing the applicant's commitments. In reaching this determination, the staff evaluated the applicant's procedures to determine Commission–approved background values as discussed in SER Section 5.7.8.3. Staff acknowledges that applicant refers to the baseline values as the Restoration Target Values (RTVs) or Target Restoration Goals; such references are not derived from NRC implementing regulations, but are common practice in the industry and likely derived from requirements from other regulatory agencies. Similarly, the term BPT is not derived from NRC implementing regulations. However, the introduction to Appendix A of 10 CFR Part 40 states that the Commission will consider "practicable" and "reasonably achievable" as equivalent terms and decisions involving these terms will take into account the state of technology and the economics of improvements in relation to benefits to the public health and safety. In addition, Criterion 5B(6) of 10 CFR Part 40 Appendix A states that for consideration of an ACL, the licensee must provide basis for the proposed limits including consideration of practicable corrective actions, that the limits are as low as reasonably achievable and information on the factors that the Commission must consider. Therefore, staff finds the applicant's commitment to BPT as meeting in part requirements of Criterion 5B(6); however, staff has reasonable assurance that, if an ACL was requested, the applicant would meet the requirements in Criterion 5B(6) in full based on the applicant's commitments to using the groundwater protection standards.

6.1.3.2 Restoration Methods

The applicant states that groundwater restoration methods may consist of: (a) groundwater sweep; (b) groundwater transfer; (c) groundwater treatment; (d) groundwater recirculation; and (e) stabilization monitoring (Strata, 2011a).

Groundwater sweep is a process in which groundwater is pumped from the wellfield without injecting water back into the wellfield, creating an influx of native groundwater surrounding the wellfield into the wellfield (Strata, 2011a). The goal of this method is to flush contaminants from areas affected by the lixiviant flowing through the peripheries of the wellfield area and recover lixiviant from areas of low permeability within the production zone (Strata, 2011a). The primary drawback for this method is consumptive use of water. However, the applicant proposes a strategy to minimize consumptive use by selective use of groundwater sweep at locations near the periphery, treating the fluids pumped during the seep by surficial treatment, and wherever possible, reinject the treated fluids into another module undergoing restoration activities (Strata, 2011a). The applicant states that groundwater sweep is the first phase of restoration but may

selectively use this method at a portion or all of a wellfield at any time during restoration (Strata, 2011a).

Groundwater transfer consists of pumping fluids from one wellfield module entering restoration and reinjecting the fluids into another wellfield entering production (Strata, 2011a). The applicant states that groundwater transfer may occur before groundwater sweep or during other phases of restoration to help homogenize the quality within or between modules (Strata, 2011a). Prior to re-injection, the applicant states that fluids recovered from one module will be passed through the IX columns or filters for additional uranium recovery (Strata, 2011a).

Groundwater treatment consists of pumping fluids from a wellfield to the CPP for treatment (Strata, 2011a). The treatment consists of uranium and vanadium removal through the ion exchange (IX) columns and then treatment through the reverse osmosis (RO) system to reduce the dissolved constituents (Strata, 2011a). The treatment system was described and evaluated by staff in SER Section 3.2. Additional treatments during this phase may include filtration to prevent fouling of the RO membranes, injection of anti-scalent, pH control, minimizing the introduction of oxygen, and de-carbonization (Strata, 2011a). Groundwater treatment will occur immediately following groundwater sweep or in conjunction with groundwater sweep in another wellfield module (Strata, 2011a).

Groundwater recirculation consists of pumping groundwater from a portion of the production zone and re-injecting that water into another portion of the production zone in the same module without any treatment (Strata, 2011a). The purpose for recirculation is to homogenize the water quality throughout the production zone and help reduce hot spots (Strata, 2011a). The only treatment that would occur during recirculation is filtration, unranium and vanium removal through the IX column, minimizing oxygen injection and possibly a reductant addition to the injection fluids (Strata, 2011a). The recirculation will occur after the groundwater treatment phase is completed (Strata, 2011a). The applicant states that the addition of reductants will be tested on a small area before widespread application of reductants (Strata, 2011a). The applicant provides examples of reductant use at analog sites but does not include further elaboration of reductant use and storage.

The applicant states that a primary goal for the restoration is to provide sufficient restoration capacity to restore each wellfield module in a phased approach (Strata, 2011a). In Section 3.1 of the Technical Report (Strata, 2011a), the applicant states that operations and restoration will be conducted on a phased approach using wellfield modules as the basis, and that the baseline water quality will be based on a Mine Unit basis. The applicant further states that the conclusion of activities is the NRC approval of the restoration for each mine unit (Strata, 2011a).

Staff finds that the restoration methods, excluding the use of reductant, are acceptable because they reflect historical ISR industry restoration practices that have achieved the groundwater protection standards of 10 CFR Part 40, Appendix A, Criterion 5B(5) and are included as acceptable methods in acceptance Criterion (3) in SRP Section 6.1.3 (NRC, 2003). The staff finds that such practices have provided NRC-approved restorations that provided a high degree of certainty that water quality in the surrounding aquifers, which might be an underground source of drinking water, will have a negligible potential to be impacted in the foreseeable and extended future (generally up to 300 years based on staff’s review of approved restorations) and longer.

The staff finds that routine use of chemical reductants to accelerate the restoration process at existing ISR facilities have been effective and reductant use and on-site storage have not

adversely affected workers' or the public's health and safety or the environment. However, the applicant did not provide any information for staff to review for the impacts on the site-specific use and storage of chemical reductants or biological reductants. Therefore, staff will include a license condition that the applicant will submit for NRC review and approval any proposed equipment, processes and procedures for on-site use, storage, handling and transport of chemical or biological reductants for the restoration activities.

Staff finds that the applicant's phased approach to restoration is consistent with the acceptance criterion (3) of SRP Section 6.1.3 (NRC, 2003), which allows flexibility and innovation in approaches to restoration, and that applicants are not limited to using one restoration method for all wellfields. Therefore, the staff finds that the applicant's restoration plans are acceptable because the applicant adequately described the sequential phases of restoration that it could use and the most likely restoration scenario based similar restorations successfully used at the Nubeth R&D site and existing commercial ISR facilities.

Should restoration of a mine unit not achieve the groundwater protection standards in criteria 5B(5)(a) or (b), then the staff will expect the applicant to demonstrate with any ACL application that the levels of constituents in the ore zone aquifer after restoration are ALARA. Staff will include a standard license condition for an ACL application.

6.1.3.3 Effectiveness of Groundwater Restoration Methods

In the Technical Report (Strata, 2011a), the applicant provides information on similarities between the hydrogeologic and geochemical setting at the proposed Ross Project and the hydrogeologic and geochemical settings at analogous existing ISR facilities where similar restoration methods were utilized to achieve NRC's groundwater protection standards (Strata, 2011a). The analog sites include Willow Creek's Irrigaray-Christensen Ranch facility (Wyoming), Cameco's Smith Ranch-Highland Uranium Project facility (Wyoming) and Cameco's Crow Butte facility (Nebraska). In addition, the applicant states that successful restoration of the former Nubeth R&D facility within the Ross Project area demonstrates achievement of restoration methods, primarily groundwater sweep (Strata, 2011a).

The applicant acknowledges that the TDS levels in background groundwater quality are higher than those observed at the analog facilities (Strata, 2011a). The higher TDS, which is a measure of ionic activity, generally leads to a greater opportunity for precipitation and scale formation; however, the applicant states that the higher ionic activity is attributed to highly soluble sodium bicarbonate, which the applicant infers will not contribute to precipitation and scale (Strata, 2011a). The applicant further states that due to the higher TDS levels in the background water quality, restoration at the Ross Project may be easier to achieve for the major ions.

The applicant states differences between the analogs and the proposed restoration at Ross Project, including: (1) use of ammonium based lixiviant; (2) overuse and ineffective use of various phases to the restoration; (3) delay in construction and restoration infrastructure; and (4) restoration at the analogs were hindered by extended periods of delay in the implementation of the active restoration activities (Strata, 2011a). The applicant commits to learning from the analogs and incorporating improvements to the groundwater restoration activities to achieve the desired goals (Strata, 2011a).

Staff finds that the proposed analogs are appropriate because of the similarities in hydrogeologic and geochemical settings and proposed restoration methodologies. Analyzing

analogous restoration programs provides the staff with reasonable assurance that the same restoration program can achieve NRC's groundwater protection standards at the Ross Project because the applicant's proposed methods are consistent with those used to achieve restoration of wellfields at existing and former R&D facilities, and have been shown to be protective of human health and safety and the environment. In addition, the applicant commits to performing restoration in the most efficient manner in order to achieve its restoration goals as soon as possible, consistent with the ALARA approach.

6.1.3.4 Pore Volume Estimates

In Section 6.1.4.1 and the Remedial Action Plan in Addendum 6.1-A of the Technical Report (Strata, 2011a), the applicant presents its method to determine pore volumes (PV) as the thickness of the ore sand multiplied by the wellfield area, porosity, flare, and conversion factor. The thickness of the ore sand is the average completion thickness of the production wells. Based on the exploratory drilling, the ore zone thickness ranges from 1.5 to 9.1 meters [5 to 30 feet], with an average of 2.7 meters [9 feet] (Strata, 2011a). The applicant states that the average completion for a well is 20 percent and thus the thickness of the ore sand for the PV calculation is 3.4 meters [11 feet]. The applicant states that this method of calculation is consistent with those used at existing licensed ISR facilities (Strata, 2011a). The wellfield area is based on the surficial area encumbered by the injection and recovery wells (Strata, 2011a). On a wellfield module basis, the applicant estimates a wellfield area of 23000 square meters [248,000 square feet]. The porosity is determined from the laboratory analysis of the core samples. For the ore zone, the applicant's estimate of the porosity is 34 percent.

Flare is an adjustment used to estimate the volume of the aquifer water outside of the wellfield area that may have been affected by lixiviant during operations (Strata, 2011a). Flare consists of two factors, one describing flare in the horizontal dimension and the other describing flare in the vertical dimension. In describing flare, the factors are expressed as a percentage of the horizontal or vertical dimensions. The applicant estimates a horizontal flare factor of 35 percent and a vertical flare factor of 20 percent (Strata, 2011a). The applicant states that the flare is consistent with that used at other ISR facilities and supported by the numeric groundwater model developed by the applicant (Strata, 2011a). The conversion factor depends on the units for the various inputs used to estimate the PV. The applicant uses a conversion factor of 7.48 to convert cubic feet to gallons.

Based upon the above, the applicant's calculated pore volume for one wellfield module is 42.4 million Liters [11.2 million gallons].

The applicant estimates that a minimum of 8.5 pore volumes (PVs) is required for active restoration (groundwater sweep and groundwater treatment phases) of a wellfield (Strata, 2011a). The applicant bases its estimate on 15 percent of the estimated 50 to 60 pore volumes moved through the aquifer during operations (Strata, 2011a). During the last stage of restoration, wellfield recirculation, the applicant proposes an additional 1.0 PV, to bring the total minimum PVs used during restoration to 9.5 PVs (Strata, 2011a).

The applicant commits to using best practicable technology (BPT) to return groundwater quality in the production zone to baseline values (Strata, 2011a). The applicant further commits that should an ACL be needed, an application will include a demonstration that BPT have been applied.

Staff reviewed the applicant's estimated pore volumes and finds that this information is adequate because it meets the acceptance Criterion (3) in SRP Section 6.1.3 (NRC, 2003), which states:

> *"[Pore volume] estimations may be based on historical results obtained from research and development sites or experience in other well fields having similar hydrologic and geochemical characteristics."*

Staff finds the applicant's estimate to be acceptable because (a) the estimate is within the range currently used by industry, and (b) the applicant commits to minimize inefficiencies and to adjust the estimate based on future experience. Similar restoration methodologies have been used successfully at previous ISR facilities and have been shown to be protective of human health and the environment. Pursuant to 10 CFR Part 40, Appendix A, Criterion 5D, the applicant will provide "data from the ground-water monitoring program and other information" for the staff to make a determination that the groundwater restoration program achieved the NRC's groundwater protection standards. This information will be in the form of a report submitted to the staff for its approval, and such approval is required prior to any wellfield reclamation and decommissioning activities. Staff also notes that if the applicant submits an application for an ACL, staff will examine, at that time, whether the applicant was faithful to its commitments. The staff will not approve an ACL unless and until the applicant adequately proves that its restoration was ALARA, regardless of whether 9.5 PVs or more of restoration activities were performed at the Ross Project.

6.1.3.5 Groundwater Restoration Monitoring

In Section 6.1.2.5 of the technical report (Strata, 2011a), the applicant commits to conducting daily, weekly, and monthly analyses to track the production zone aquifer restoration progress. At the end of the active restoration phase, the baseline wells in the production zone will be analyzed for the parameters listed in SER Table 5.7-2. The applicant stated that the values at the end of restoration will be compared to the baseline average on a well-by-well basis for the perimeter wells and overlying and underlying aquifer wells or to the wellfield average for the production zone (Strata, 2011a). The applicant states it will sample all monitoring wells (the perimeter wells, overlying and underlying aquifer wells) for all excursion parameters and static water levels.

In Section 6.1.2.5 of the technical report (Strata, 2011a), the applicant commits to restoring the production zone aquifer to standards in Criterion 5B(5) in Appendix A of 10 CFR Part 40. The applicant states that if the baseline or Maximum Contaminant Level (MCL) standards cannot be achieved after using the best practicable technology (BPT), an alternate concentration limit (ACL) will be requested. Furthermore, the applicant commits to having a sampling frequency for excursion monitoring during the restoration period similar to that used during operations (i.e., semi-monthly sampling with a minimum 10-day interval between sampling events at all monitoring wells along the perimeter ring and in the overlying and underlying aquifers). Corrective actions to be undertaken for an excursion that occurs during restoration will be similar to those taken for an excursion that occurred during operations (see SER Section 5.7.8) (Strata, 2011a).

Staff reviewed the applicant's proposed restoration monitoring and finds it acceptable because similar programs have been conducted at existing ISR facilities and have provided sufficient data to demonstrate that these operations were operated safely. These operations also safely restored groundwater to levels that are protective of the environment, and provided early

detection of unwanted contaminant migration in order to apply appropriate and timely corrective actions.

6.1.3.6 Wellfield Bleed during Restoration Stage

In Section 5.4 of the Environmental Report and 7.2.6.2 of the Technical Report (Strata, 2011a), the applicant commits to maintaining an inward hydraulic gradient for each wellfield module to control the migration of process or restoration solutions from its initial production until the end of active restoration. The staff finds this commitment acceptable because it meets the requirements of 10 CFR 40.41(c), which requires licensees to confine source and byproduct materials to authorized locations. A standard license condition will memorialize this commitment (see SER Section 3.1.4).

6.1.3.7 Restoration Wastewater Disposal

The applicant's disposal of restoration wastewater was described and evaluated in SER Sections 3.1.3.1 and 4.2.3.1. Staff finds that the anticipated wastewater production can be adequately met by the estimates of the waste disposal capacity for the five Class I deep disposal wells as permitted by Wyoming. Therefore, staff finds that the applicant's plans for disposing of restoration wastewater are acceptable.

6.1.3.8 Restoration Stabilization Monitoring

In Section 6.1.2.5 of the Technical Report (Strata, 2011a), the applicant commits to a groundwater stabilization-monitoring program. This monitoring program will begin upon completion of active restoration. The applicant committed to using some or all of the production monitoring wells to evaluate restoration success. The applicant commits to collecting eight (8) rounds of samples over a 12-month stability monitoring period. The applicant indicates the initial frequency of sampling during the monitoring period is monthly but will change to quarterly near the end of the 12-month stability monitoring period. The applicant will sample wells for the parameters listed in SER Table 5.7-2 (Strata, 2011a).

The applicant commits to evaluating temporal trends in each parameter for the production zone monitoring wells using established statistical methods to determine the significance of any trend and /or hot spot (Strata, 2011a). If an increasing concentration trend is evident, the applicant proposes additional actions that it would take, such as resuming active or passive (recirculation) restoration or extending the stabilization-monitoring period. If the analytical results meet the appropriate standards and do not exhibit significant increasing trends, the applicant commits to submitting a restoration report with the supporting documentation to the NRC for its review and approval (Strata, 2011a).

Staff reviewed the restoration stabilization monitoring information provided by the applicant and finds it acceptable because it is consistent with the acceptance criteria (3) and (5) of SRP Section 6.1.3 (NRC, 2003) because the applicant described (a) wellfield restoration plans that included stabilization monitoring schedules and constituents and (b) the post-restoration stability monitoring program. The proposed stabilization-monitoring program is consistent with NRC-approved monitoring programs that licensees currently or have used at existing ISR facilities that have shown to be protective of human health and safety and the environment.

6.1.3.9 Well Plugging and Abandonment

In Section 6.1.2.5 of the Technical Report (Strata, 2011a), the applicant states that plugging and abandonment of wells in a wellfield will be initiated once the regulatory agencies concur that groundwater in a wellfield has been adequately restored and is stable. In Section 6.2 of the Technical Report, the applicant commits to plugging and abandonment of all wells in accordance with State of Wyoming requirements (Strata, 2011a). In Addendum 2.6-E of the Technical Report ((Strata, 2011a), the applicant provides its methodology for abandoning and plugging wells.

NRC staff reviewed the applicant's proposed plugging and abandonment procedures and finds them to be acceptable because they meet acceptance Criterion (7) in SRP Section 6.1.3 (NRC, 2003), which states that plugging and abandonment procedures that are "codified in State regulations or rules are considered acceptable." Furthermore, proper abandonment of the wells meets, in part, requirements of Criterion 6(7) of Appendix A, 10 CFR Part 40, which states that

> *"To the extent necessary to prevent threats to human health and the environment, the licensee should control, minimize or eliminate post-closure escape of nonradiological hazardous constituents, leachate, contaminated rainwater, or waste decomposition products to the ground or surface waters or to the atmosphere."*

Although this regulation was written for mill tailings, specifically the tailing disposal area, the criterion is also applicable to ISR facilities. After termination of the license (post-closure), any existing well will potentially provide a conduit to subsurface for contaminated rainwater. Therefore, the applicant's commitment to plug and abandoned wells pursuant to the State of Wyoming regulations is acceptable to staff.

6.1.3.10 Restoration Schedule

On Figure 6.1-1 of the Technical Report (Strata, 2011a), the applicant presents a general production, restoration and stability monitoring schedule for a typical wellfield module. The staff notes that this schedule indicates that the initiation of restoration is scheduled to occur following a 9-month hiatus after completion of production at the wellfield module, and the duration of the active restoration is an additional 9-month period. The applicant notes that these proposed timelines may need to be updated as necessary (Strata, 2011a).

NRC staff reviewed the proposed restoration schedule and stability monitoring program and finds the proposed schedule meets acceptance Criterion (6) of SRP Section 3.1.3 (NRC, 2003) provided that the applicant updates the schedule as needed in order to comply with the requirements of 10 CFR 40.42. The staff notes that any change to the schedule that requires more than 24 months to complete decommissioning activities will require NRC approval of an alternate schedule pursuant to 10 CFR 40.42, which requires that decommissioning activities be completed within 24 months of initiation of decommissioning. 10 CFR 40.42(g)(2) permits the NRC to approve a request for an alternate schedule for completion of decommissioning under certain circumstances. The staff finds that permanent cessation of lixiviant injection in a wellfield would signify intent to shift from the principal activity of uranium production to the initiation of groundwater restoration. The requirement for the applicant to submit a request for an alternate schedule will be included in a standard license condition.

6.1.4 EVALUATION FINDINGS

The staff has completed its review of the plans and schedules for groundwater quality restoration proposed for the proposed Ross Project. This review included an evaluation of the methods that the applicant proposed to use to develop the groundwater restoration program and schedules using the review procedures in the SRP Section 6.1.2 and the acceptance criteria in the SRP Section 6.1.3.

The applicant's plans and schedules for groundwater restoration are acceptable to the staff, except that the applicant did not include analysis of use, storage and handling of any reductant that the applicant suggested may be used during restoration. Staff will include the following facility specific license condition to obtain approval by NRC prior to the use, storage, handling or transport of a specific reductant:

Facility Specific License Condition 10.10:

> The licensee shall submit to NRC staff for review and approval plans for equipment and procedures prior to the use, storage, handling and transport of biological or chemical materials for reductant injections during restoration.

Staff includes standard license conditions regarding aspects of groundwater restoration activities as presented in other SER Sections (i.e., in SER Section 5.7.8.4, License Condition 11.3 presents procedures for determining baseline or the Commission-approved background values, which constitute part of the groundwater protection standards in 10 CFR Part 40, Appendix A, Criterion 5B(5); and in SER Section 3.1.4, License Condition 10.7 presents a requirement to maintain an inward hydrologic gradient during operations and production, which will meet the requirements of 10 CFR 40.41(c) to confine the possession and use of source and byproduct material to locations and purposes authorized by a license).

Staff will also include the following standard license condition to memorialize the applicant's commitment to the restoration schedule:

Standard License Condition 10.6:

> Groundwater Restoration. The licensee shall conduct groundwater restoration activities in accordance with Section 6.1.5 of the approved license application. Permanent cessation of lixiviant injection in a production area would signify the licensee's intent to shift from the principal activity of uranium recovery to the initiation of groundwater restoration and decommissioning for any particular production area. If the licensee determines that these activities are expected to exceed 24 months for any particular production area, then the licensee shall submit an alternate schedule request that meets the requirements of 10 CFR 40.42.
>
> Restoration Standards. Hazardous constituents in the groundwater shall be restored to the numerical groundwater protection standards as 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 also show that it has first made practicable effort to restore the specified hazardous constituents to the background or maximum contaminant levels (whichever is greater).

Restoration Stability Monitoring. The licensee shall conduct sampling of the parameters included in the baseline sampling under LC 11.3 during the restoration stability period in accordance with Section 6.1.2.5 of the approved application. The sampling consists of eight samples during a 12 month period. The sampling shall include the specified production zone aquifer wells used to define the baseline levels. The applicant shall continue the stability monitoring until the data show, for all parameters monitored, no statistically significant increasing trend, which would lead to an exceedence of the relevant standard in 10 CFR Part 40, Appendix A, Criterion 5B(5).

Based on its review of the information provided in the application, and the license conditions noted above, staff is reasonably assured that the applicant will restore groundwater to the groundwater protection standards of 10 CFR Part 40, Appendix A, Criterion 5B(5) and will provide the information for the NRC's determination required per 10 CFR Part 40, Appendix A, Criterion 5D. The staff also finds these procedures acceptable because they meet the applicable acceptance criteria in SRP Section 6.1.3 (NRC, 2003) and requirements of 10 CFR 40.32(c), 10 CFR 40.42, and Criteria 5B(5) and 6(7) of Appendix A to 10 CFR Part 40 by:

- Committing to adopt wellfield groundwater restoration standards that are representative of background conditions;
- Committing to maintaining a hydrologic gradient during restoration;
- Committing to perform restoration using methods consistent with the ALARA approach;
- Providing estimates of pore volumes based on appropriate measured or estimated parameter values;
- Providing an acceptable list of indicator constituents and procedures to be used to establish statistically valid data sets to measure restoration success and stabilization;
- Documenting standards to be used to plug and abandon wells properly after the ISR operations are complete; and
- Establishing an acceptable schedule for restoration.

6.2 PLANS FOR RECLAIMING DISTURBED LANDS

6.2.1 REGULATORY REQUIREMENTS

The staff determines if the application has demonstrated that the proposed plans for reclaiming disturbed lands for the Strata Ross Project meet the requirements of 10 CFR 40.42 and Criteria 6(6) and 6(7) of Appendix A to 10 CFR Part 40.

6.2.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria in Section 6.2.3 of the SRP (NRC, 2003).

6.2.3 STAFF REVIEW AND ANALYSIS

The applicant discusses various aspects for reclamation of disturbed lands in Section 6.2 (Reclamation of Disturbed Land) and Section 6.5 (Methodologies for Conducting Post-

Reclamation and Decommissioning Radiological Surveys) of the Technical Report (Strata, 2011a). The staff based its review on information from these sections of the application.

The applicant states that the surface reclamation plan goals would be to return the land to equal or better condition than existed prior to uranium recovery and thus making it available for “unrestricted use” (Strata, 2011a). Baseline soils, vegetation, and radiological data would be used to guide the reclamation activities. Prior to final decommissioning and surface reclamation of any area, the applicant commits to submitting a detailed decommissioning and reclamation plan to the NRC at least 12 months prior to the commencement of the activities. Surface reclamation activities would include plugging and abandoning all wells; determining the proper soil cleanup criteria; performing a pre-reclamation radiological survey of all facilities, process related equipment and soils to determine the extent of contamination; cleaning up contaminated areas; performing a final soil radiological survey; contouring all disturbed areas; and establishing vegetation and temporary erosion control on all disturbed areas.

In Section 6.3.1 of the Technical Report (Strata, 2011a), the applicant states that soil contamination release limits would be modeled using the RESRAD computer model or an equivalent to assure compliance with 10 CFR Part 40, Appendix A, Criterion 6. In Section 6.4 of the Technical Report (Strata, 2011a), the applicant states that the survey methods provided in NUREG–1575 “Multi-Agency Radiation Survey and Site Investigation Manual” (NRC, 2000), along with the applicable site conditions, would be used to define sampling techniques. Determination of background concentrations of radium-226 and other naturally occurring uranium series radionuclides would be based upon the pre–operational baseline sampling and analysis program and the results of ongoing operational environmental monitoring programs (Strata, 2011a).

The applicant proposes to use hand-held radiological survey instrumentation and GPS- based gamma surveys to guide soil remediation efforts (Strata, 2011a). Field personnel would monitor soil excavations to ensure contaminated material is removed in order to meet the cleanup criteria. Support would be provided by GPS-based gamma surveys periodically to more accurately assess the progress of excavation. Remediation of soils are expected to be restricted to a few areas where there are known (or suspected and verified through survey) spills. Final GPS- based gamma surveys would be conducted in potentially contaminated areas by dividing the area into 100 m^2 grid blocks. In addition, soil samples would be collected from grid blocks with gamma count rates previously correlated with radium-226 concentrations exceeding the action level (e.g., 5 pCi/g Ra-226).

The applicant commits to following the cleanup criteria in Criterion 6 of Appendix A to 10 CFR Part 40 and using the benchmark dose approach to determine the soil cleanup criteria for radionuclides other than radium-226. The applicant has provided a description of the techniques that it would use to compare the pre-operational and post-operational radiological surveys to identify potential areas of contamination (Strata, 2011a).

The staff finds that the reclamation surveys as provided in the application are acceptable because the applicant’s description of the procedures is consistent with acceptance criteria (2) and (3) of SRP Section 6.2.3 (NRC, 2003) as the applicant has described the survey program in sufficient detail, would perform pre-operational and pre-reclamation surveys in a similar manner, and has developed plans to compare baseline (pre-operational) survey data to pre-reclamation data to determine areas requiring cleanup. The staff finds that the applicant’s survey program is designed to meet regulatory standards in 10 CFR Part 20, which are protective of human health and safety for unrestricted use.

The applicant states that soil replacement following reclamation would approximate the pre-operational contours, which would include re-establishing drainage features (Strata, 2011a). The goals of surface restoration would be to restore the lands disturbed by operations to pre-extraction land use for livestock grazing and wildlife habitat. The applicant would remove surface features, such as buildings, roads, wells, and retention ponds, and it would reclaim the disturbed areas, unless it obtains prior approval from the NRC and WDEQ to leave the facilities in place (Strata, 2011a).

The staff finds that these practices reflect accepted practices for NRC-licensed ISR operations and have shown to be protective of the environment and the public's health and safety. The applicant's description of its soil replacement plan is consistent with acceptance Criterion (4) of SRP Section 6.2.3 (NRC, 2003) because it includes discussion of surface pre-construction surface contours and planned activities for surface restoration.

The applicant describes its determination of its soil cleanup criteria in application Section 6.4.1 (Strata, 2011a). The applicant states that it used the RESRAD model to determine the concentration of natural uranium in soil above background that would result in a maximum radium benchmark dose of 33.4 mrem/yr. The applicant states that the method involved modeling the dose from a preset concentration of 100 pCi/g natural uranium in soil with an isotopic composition of 48.9 percent U-234, 48.9 percent U-238, and 2.2 percent U-235. The model calculated a maximum dose of 6.98 mrem/yr. Strata then compared this dose to the radium benchmark dose and scaled to arrive at the maximum allowable natural uranium concentration in soil, which calculated a uranium soil standard limit of 479 pCi/g to meet the radium benchmark dose criteria (Strata, 2011a).

The applicant commits to using the unity (sum of fractions) rule for Ra-226 and natural uranium contaminations when both constituents are present (Strata, 2011a). The applicant does not expect elevated concentrations of Th-230 based on its baseline monitoring and the ISR process, but commits to analyze soil samples for Th-230. The applicant states it will remediate soils if elevated concentrations are indicated, using a sum of fractions rule similar to that described for radium and uranium, to develop a clean-up criteria for Th-230 such that, combined with Ra-226, it would result in a radium concentration that meets the radium clean-up criteria and/or the radium benchmark dose. Additionally, the applicant states that it does not anticipate elevated concentrations of Pb-210 because as Ra-226 decays into Rn-222, much of the radon gas escapes the surface soil prior to decay into its progeny (Strata, 2011a). The staff agrees with the applicant's assessment of Th-230; however, the staff disagrees with the applicant's assessment of Pb-210. As the staff states in SER Section 2.6.3.1, radon progeny are solid particles that tend to be electrically charged and can deposit on surfaces or attach to dust particles (Mohamed et al., 2008) and atmospheric transport and deposition of the progeny may result in terrestrial variations in Pb-210 concentrations (Arnold et al., 2009). Additionally, Regulatory Guide 4.14 recommends that licensees analyze all operational soil samples for natural uranium, Ra-226, and Pb-210 (NRC, 1980a).

Based on its review of the applicant's decommissioning, decontamination, and reclamation procedures, the staff is reasonably assured that the applicant would appropriately decommission its facility because it has addressed the necessary procedures for decommissioning the Strata Ross Project. The staff finds that the applicant meets part of SRP Section 6.2.3 acceptance Criterion (1) by describing its soil cleanup criteria for uranium, radium-226, and thorium-230, and its intention to analyze for these isotopes and use of the sum of the ratios for each radionuclide and the unity rule to determine its cleanup criteria. However, the

applicant did not commit to analyzing soils for Pb-210, which is an analyte recommended by Regulatory Guide 4.14 for operational soil samples. The staff's reasonable assurance determination is contingent upon the license condition presented in SER Section 6.4.4 that requires the applicant to submit soil cleanup criteria to the NRC staff for review and approval.

All solid byproduct material would be disposed of offsite at a facility licensed by the NRC or an Agreement State (Strata, 2011a). SER Section 4.2.4 discusses disposal of solid byproduct material. The staff finds that this approach is consistent with 10 CFR Part 40, Appendix A, Criterion 2, which requires that byproduct material from ISR operations be properly disposed of at existing mill tailings disposal sites, with limited exceptions.

The applicant states that it would prepare a decommissioning plan for each mine unit (Strata, 2011a). The applicant commits to submitting a final decommissioning plan for structures remaining until the end of the active life of the facility 12 months before the planned decommissioning of the facilities. This final detailed decommissioning plan would reflect as-built conditions at the facility, which might differ slightly from the initial licensing plans. The detailed decommissioning plan would also reflect the operational history of the site and should account for items such as spills, areas of radionuclide deposition, and unanticipated groundwater restoration (Strata, 2011a).

The staff finds the applicant's commitments are consistent with acceptance criteria (7) and (9) of SRP Section 6.2.3 (NRC, 2003) because the applicant committed to provide a final decommissioning plan at least 12 months before the planned reclamation of a wellfield commences, and the plan would include a quality assurance program. Therefore, the staff finds the applicant's plans for submitting a final decommissioning plan acceptable.

The applicant discusses decommissioning aspects of non-radiological hazardous constituents, as required by 10 CFR Part 40, Appendix A, Criterion 6(7) (Strata, 2011a). Although the applicant does not describe or address specific non-radiological hazardous constituents, the applicant commits to storing hazardous wastes generated at the facility in accordance with applicable OSHA and EPA standards; the applicant states that a licensed contractor would dispose of these wastes offsite.

The staff finds the applicant's discussion of non-radiological hazards meets acceptance Criterion (8) of SRP Section 6.2.3 (NRC, 2003). For this reason and because the applicant included procedures to ensure the health and safety of workers, the public, and the environment, the staff finds the applicant's discussion of non-radiological hazards acceptable.

The applicant would perform pre-reclamation radiation surveys using instruments and techniques similar to the pre-operational survey used to establish baseline site conditions (Strata, 2011a). This is acceptable to the staff as it reduces the possibility of errors resulting from using different techniques. Areas that the applicant would evaluate include wellfield surfaces, structures in process and storage areas, on-site transportation routes, and historical spill areas. This is acceptable to the staff because the applicant has identified the areas that are most likely to be contaminated.

6.2.4 EVALUATION FINDINGS

The staff reviewed the plans for reclaiming disturbed lands of the proposed Strata Ross Project in accordance with SRP Section 6.2.3 (NRC, 2003). The applicant described various aspects of reclamation activities at the site, including plugging and abandoning all wells, surveying for

contaminated soils and removing contaminated soils to a licensed disposal facility, performing final surveys, re-contouring disturbed areas, salvaging and replacing topsoil, and re-vegetating disturbed areas.

The staff finds that the applicant's plans for reclaiming disturbed lands are acceptable and consistent with the acceptance criteria in SRP Section 6.2.3. Because the applicant's plan is pre-operational, the applicant cannot account for actual future facility build-out conditions, which might differ from initial licensing plans due to the dynamic nature of ISR operations. To address the effect of facility changes during the life of the Strata Ross Project, the applicant commits to submitting a final decommissioning plan consistent with acceptance criteria (7) and (9) of SRP Section 6.2.3 (NRC, 2003) and pursuant to 10 CFR 40.42(g)(1). Because of the applicant's proposed decommissioning, decontamination, and reclamation plans and commitments to provide detailed final plans, the staff is reasonably assured that the applicant would properly decommission the Strata Ross Project. This reasonable assurance determination is contingent upon the applicant's fulfillment of the following standard license condition and the license condition presented in SER Section 6.4.4.

Standard License Condition 10.3:

> At least 12 months prior to initiation of any planned final site decommissioning, the licensee shall submit a detailed decommissioning plan for NRC staff review and approval. The plan shall represent as-built conditions at the Ross Project.

This standard license condition is to ensure that the applicant submits a detailed decommissioning plan prior to final site decommissioning in accordance with 10 CFR 40.42(d).

6.3 REMOVAL AND DISPOSAL OF STRUCTURES, WASTE MATERIAL, AND EQUIPMENT

6.3.1 REGULATORY REQUIREMENTS

The staff determines if Strata Energy (Strata or the applicant) has demonstrated that the proposed plans for removal and disposal of structures, waste material and equipment for the Strata Ross Project meet the requirements of 10 CFR 40.32(c).

6.3.2 REGULATORY ACCEPTANCE CRITERIA

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

6.3.3 STAFF REVIEW AND ANALYSIS

The applicant states in Section 6.3 of the application that prior to process plant decommissioning, procedures for removing and disposing of structures and equipment would be established (Strata, 2011a). These procedures would include: 1) establishing surface contamination limits, 2) conducting preliminary radiological surveys of process building surfaces, equipment and piping systems, 3) cleaning and removing process building materials and equipment, 4) sorting materials according to contamination levels and potential for salvage, and 5) preparing materials for transport and offsite use or disposal (Strata, 2011a).

Strata states that radiological surveys would be conducted prior to process plant decommissioning to characterize the levels of contamination on structures and equipment and to identify any potential hazards (Strata, 2011a). The applicant states that these surveys would be used to develop a program to control residual contamination on structures and equipment. Strata plans to collect measurements of radioactivity at access points, such as traps, to determine the radioactivity present on the interior surfaces of pipes, drain lines, and duct work (Strata, 2011a).

The applicant states that as determined by radiological surveys, all contaminated equipment would be removed to a new location within the proposed project area for further use or storage, removed to another licensed facility for either use or permanent disposal, or decontaminated to meet unrestricted use criteria for release (Strata, 2011a). The applicant states that it would give special attention to equipment and structures in which radioactive materials could accumulate, including piping, traps, junctions and filters. The applicant describes materials and equipment that could be decontaminated to include pipes, valves and instrumentation and expects to decontaminate, dismantle and release process buildings for unrestricted use at another location. The applicant describes the process for decontaminating salvageable building materials and equipment, and releasing for unrestricted use by: 1) completing a preliminary radiological alpha survey to determine the location and extent of the contamination and to identify any hazards; 2) removing loose contamination by use of high-pressure washing; 3) performing a secondary decontamination by washing with dilute acid or equivalent compatible solution if needed; and 4) performing a final alpha or beta survey upon completion of decontamination processes (Strata, 2011a).

The staff finds that the applicant's contamination control program is consistent with acceptance Criteria (1), (2), and (3) of SRP Section 6.3.3 (NRC, 2003) by (a) having a program to control residual contamination on structures and equipment; (b) committing to survey interior surfaces of pipes, drain lines, and duct work; and (c) presuming inaccessible surfaces for purposes of measurement to be contaminated in excess of release limits. The staff also finds that the applicant has developed a radiation survey program to properly release structures, materials, and equipment using per the NRC-approved release limits, which is consistent with acceptance Criterion (4) of SRP Section 6.3.3 (NRC, 2003).

As discussed in SER Section 5.7.6.3, the staff finds that the applicant's survey program for beta-gamma contamination did not specify the surface contamination detection capability (scan MDC) for radiation survey meters used for contamination surveys to release equipment and materials for unrestricted use. Staff presents License Condition 12.9 in SER Section 5.7.6.4 to ensure that the scan MDC is properly determined for the survey meters. With the noted license condition, staff finds the applicant's contamination control program satisfies the acceptance criteria in SRP Section 6.6.3 (NRC, 2003).

6.3.4 Evaluation Findings

The staff reviewed the procedures for removing and disposing of structures and equipment at the Ross ISR Project per SRP Section 6.3.3 (NRC, 2003). The applicant has established an acceptable program for the measurement and control of residual contamination on structures and equipment, consistent with SRP Section 6.3.3, and has addressed beta contamination survey and release criteria in accordance with Subpart F in 10 CFR Part 20 and as recommended by Policy and Program Guidance (NRC, 1993b). Staff will include the following

standard license condition for compliance with release survey procedures as specified in the aforementioned guidance document:

Standard License Condition 9.6:

> Release of surficially contaminated equipment, materials, or packages for unrestricted use shall be in accordance with the NRC guidance document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," (the Guidelines) dated April 1993 (ADAMS Accession No. ML003745526) or suitable alternative procedures approved by NRC prior to any such release.
>
> Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides shall apply independently.
>
> Personnel performing contamination surveys for items released for unrestricted use shall meet the qualifications as health physics technician or radiation safety officer as defined in Regulatory Guide 8.31 (as revised). Personal effects (e.g., notebooks and flash lights) which are hand carried need not be subjected to the qualified individual survey or evaluation, but these items should be subjected to the same survey requirements as the individual possessing the items.
>
> Regulatory Guide 8.30 (as revised), Table 2 shall apply to the removal to unrestricted areas, of equipment, materials, or packages that have potential accessible surface contamination levels above background. The contamination control program shall provide sufficient detail to demonstrate how the licensee will maintain radiological controls over the equipment, materials, or packages that have the potential for accessible surface contamination levels above background, until they have been released for unrestricted use as specified in the Guidelines, and what methods will be used to limit the spread of contamination to unrestricted areas. The contamination control program shall demonstrate how the licensee will limit the spread of contamination when moving or transporting potentially contaminated equipment, materials, or packages (i.e. pumps, valves, piping, filters, etc.) from restricted areas through unrestricted areas. Prior to its implementation, the licensee shall receive written NRC verification of the licensee’s contamination control program if recommendations in RG 8.30 are not followed.
>
> The licensee may identify a qualified designee(s) to perform surveys, as needed, associated with the licensee’s contamination control program when moving or transporting potentially contaminated equipment, materials, or packages from restricted or controlled areas through uncontrolled areas and back into controlled or restricted areas. The qualified designee(s) shall have completed education, training, and experience, in addition to general radiation worker training, as specified by the licensee. The education, training, and experience required by the licensee for qualified designees shall be submitted to the NRC for review and written verification. The licensee shall receive written verification of the licensee’s qualified designee(s) training program prior to its implementation.

Based on the staff's review and the noted license condition, the staff is reasonably assured that the applicant would properly release structures, materials, and equipment for unrestricted use. Therefore, the staff has determined that the information provided in Section 6.3 of the application, as supplemented with the noted standard license condition, is acceptable, in compliance with 10 CFR 40.32(c), and consistent with acceptance criteria in SRP Section 6.3.3.

6.4 POST RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

6.4.1 REGULATORY REQUIREMENTS

The staff determines if Strata has demonstrated that the applicant's proposed methodologies for conducting post reclamation and decommissioning radiological surveys for the Ross ISR Project meet the requirements of Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.4.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria in Section 6.4.3 of the SRP (NRC, 2003).

6.4.3 STAFF REVIEW AND ANALYSIS

6.4.3.1 Cleanup Methodology and Criteria

The applicant commits to meeting the soil cleanup criteria established in 10 CFR Part 40, Appendix A, Criterion 6(6) in Section 6.4 of the technical report (Strata, 2011a). Strata will follow survey methodology as described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000). Strata states it used the benchmark dose approach to model the site-specific dose from the radium standard (5 pCi/g) and then used that dose to determine the concentrations of other radionuclides that would result in a similar dose to the average member of the critical group, which the applicant identified as the resident rancher for the proposed Ross ISR Project. The applicant states that it considered the resident farmer, businesses based in the home, and light industry and mining as possible critical groups. The applicant states the resident farmer is unrealistic because no prime farmland is identified within the proposed licensed area. Businesses based in the home are not likely because the proposed licensed area is rural. The applicant finds that light industry and mining are potential scenarios, but less likely to receive a dose as high as a rancher living on the land and consuming locally grown food. The applicant finds that records indicate that the area has historically been used for lower density livestock production of cattle, horses and sheep; and therefore, would be expected to receive a higher dose spending significant time outdoors and consuming locally grown livestock and produce (Strata, 2011a).

As discussed in SER Section 6.2.3, the applicant states that the RESRAD Version 6.3 computer code was used to calculate annual doses from the current radium cleanup standards. The radium benchmark dose, which is the maximum annual dose as determined by the modeling, was the standard used to establish the cleanup criteria for natural uranium contamination. The applicant identifies in the application Section 6.4.1 that the critical group for the modeling effort consists of a resident rancher who would be located on the proposed licensed area directly over a 10,000-m^2 contamination zone and near a surface water (i.e., Oshoto Reservoir) from which livestock, which was a food source for the rancher, drank. The applicant states that it assumed no drinking water contamination above background.

Results of the applicant's modeling indicate a maximum Total Effective Dose Equivalent (TEDE) from surface contamination will occur at year zero, while the maximum TEDE for subsurface contamination will occur approximately 25 years following decommissioning. Strata states that the surficial radium benchmark dose yielded the maximum TEDE of 33.4 mrem per year. The maximum TEDE includes contributions from external deep dose equivalent associated with ground shine and internal dose from inhalation and ingestion of plants, animals and soil (Strata, 2011a).

The applicant then calculated a uranium soil standard limit that would yield the dose equivalent to the maximum radium benchmark TEDE of 33.4 mrem per year (Strata, 2011a). The calculations are based on the model derived dose from 100 pCi/g natural uranium in soil with an isotopic composition of 48.9 percent U-234, 48.9 percent U-238, and 2.2 percent U-235. The model calculated a maximum dose from the 100 pCi/g natural uranium at 6.98 mrem per year (Strata, 2011a). By ratio of the radium benchmark dose (33.4 mrem per year) to the dose of 100 pCi/g natural uranium (6.98 mrem per year), the applicant estimates a uranium soil standard limit of 479 pCi/g. This uranium soil standard yields a dose equivalent to the radium benchmark dose criteria (Strata, 2011a). The applicant commits to using the unity (sum of fractions) rule for Ra-226 and natural uranium contaminations when both constituents are present (Strata, 2011a).

The applicant does not expect elevated concentrations of Th-230 in the soil based on its baseline monitoring and the ISR process, but commits to analyze soil samples for Th-230. The applicant states it will remediate soils if elevated concentrations are indicated, using a sum of fractions rule similar to that described for radium and uranium. The clean-up criteria for Th-230, combined with Ra-226, is based on a radium concentration that meets the radium clean-up standards and/or the combined dose not exceeding the radium benchmark dose. The applicant states that it does not anticipate elevated concentrations of Pb-210 in the soil because, as Ra-226 decays into its radon progeny, Rn-222, a large fraction of the radon gas escapes from the surface soil prior to decay into its progeny, including Pb-210 (Strata, 2011a).

While staff agrees with the applicant's assessment of Th-230 in the soil, the staff disagrees with the applicant's assessment of Pb-210 in the soil. As the staff states in SER Section 2.6.3.1, (1) radon progeny are solid particles that tend to be electrically charged and can deposit on surfaces or attach to dust particles (Mohamed et al., 2008), and (2) atmospheric transport and deposition of the progeny may result in terrestrial variations in Pb-210 concentrations (Arnold et al., 2009). Additionally, Regulatory Guide 4.14 recommends that licensees analyze all operational soil samples for natural uranium, Ra-226, and Pb-210 (NRC, 1980a). The staff includes License Condition 12.7, as presented in SER Section 5.7.7.4, requiring the applicant to develop an airborne effluent and environmental monitoring program.

The applicant commits to meeting the regulatory cleanup criteria using the methodology required in Criterion 6(6) of Appendix A to 10 CFR Part 40. As discussed in SER Section 6.2.3, the applicant has not yet developed the soil cleanup criteria for all possible radiological constituents, such as Pb-210, but the staff is reasonably assured that the applicant will develop the appropriate soil cleanup criteria prior to initiating cleanup activities and will reclaim soils to meet the cleanup standards based upon the decommissioning information provided in the application and contingent upon the license condition discussed in SER Section 5.7.7.4.

6.4.3.2 Uranium Chemical Toxicity Assessment

Acceptance Criterion (1) in SRP Appendix E, Guidance to the U.S. Nuclear Regulatory Commission Staff on the Radium Benchmark Dose Approach, Section E2.2.3 (NRC, 2003), recommends that in modeling the soil cleanup criteria, the natural uranium source term input is represented as percent activity of the uranium isotopes e.g., 48.9 percent U-238, 48.9 percent U-234, and 2.2 percent U-235). Also, the uranium chemical toxicity is considered in deriving a soil concentration limit if soluble forms of uranium are present (NRC, 2003). Because the applicant did not provide soil cleanup criteria, uranium chemical toxicity was not addressed. However, the staff will review uranium toxicity analyses during its review and approval of the soil cleanup criteria, the submission of which is required prior to cleanup activities by the license condition discussed in Section 6.4.4.

6.4.4 Evaluation Findings

The staff reviewed the applicant's proposed methodologies for conducting post-reclamation and decommissioning radiological surveys for the proposed Ross Project in accordance with SRP Section 6.4.3 (NRC, 2003). Although the applicant has provided its decommissioning, decontamination, and reclamation plans for the Ross Project, it has not included soil cleanup criteria for radionuclides other than radium in the decommissioning, decontamination, and reclamation plan in accordance with 10 CFR 20.1501 and 10 CFR Part 40, Appendix A, Criterion 6(6). The staff reiterates its reasonable assurance determination that the applicant will decommission the Ross Project appropriately because of its decommissioning plans and commitment to submit final plans prior to final mine unit and facility decommissioning (SER Section 6.2.3). However, the staff's reasonable assurance determination is contingent upon the fulfillment of the license condition 12.7, which, among other things, requires the applicant to characterize the principal radionuclide composition with regard to mixtures (see SER Section 5.7.7.4).

Based upon the review conducted by the staff as indicated above, the information provided in the application, as supplemented by this license condition, meets the applicable acceptance criteria of SRP Section 6.4.3 and the requirements of 10 CFR 20.1501 and 10 CFR Part 40, Appendix A, Criterion 6(6).

6.5 FINANCIAL ASSURANCE

6.5.1 Regulatory Requirements

The staff determines if the proposed financial assurance for the Strata Ross Project submitted by Strata meets the requirements of 10 CFR Part 40, Appendix A Criterion 9.

6.5.2 Regulatory Acceptance Criteria

The staff reviewed the application for consistency with the applicable regulations in 10 CFR Part 40 using the acceptance criteria in Section 6.5.3 of the SRP (NRC, 2003).

6.5.3 Staff Review and Analysis

Unless otherwise stated, the information in SER Section 6.5.3 is from Section 6.5 and Addendum 6.1-A of the technical report (Strata, 2011a).

The applicant has summarized the Restoration Action Plan (RAP) for the CPP, first five (5) wellfield modules, and all related facilities anticipated to be constructed during the first year of

licensed activities of the Ross ISR Project. The estimate puts the costs of restoration to be performed by an independent contractor at $9,672,068.85 over an approximately 3-year period during which the CPP, the initial five (5) wellfield modules, and associated infrastructure would be reclaimed to a condition agreed upon by NRC that would return the site to unrestricted use. The RAP encompasses the full cycle of activities necessary for: facility decommissioning, aquifer restoration and well plugging, radiological survey and environmental monitoring, project management and miscellaneous costs, labor and equipment overhead, and contractor profit. The following tabulation summarizes these estimated costs:

Item	Cost
Aquifer restoration	$ 2,940,923.42
Facilities area reclamation	$ 2,344,689.50
Wellfield equipment & disposal	$ 1,653,423.27
Well abandonment	$ 1,030,261.08
Radiological surveys	$ 37,857.50
Re-vegetation	$ 66,000.00
Misc. reclamation activities	$ 268,082.14
Subtotal	$ 8,395,385.15
Project management @ 2%	$ 167,907.70
Contingency @ 15%	$ 1,259,307.77
Total	$ 9,822,600.63

Strata's submittal employed assumptions that are based on best professional judgment given the data currently available. Annual reviews would provide the iterative format by which NRC could continually update the financial assurance amount based on work completed at the site and newly available information. Groundwater restoration costs are based on treatment of 0.5 pore volumes (PVs) for groundwater sweep and 7.0 PVs for reverse osmosis (RO) and 1.0 PV for groundwater recirculation for a cumulative of 8.5 PVs (Strata, 2011a). This cumulative differs from the proposed 9.5 PVs as discussed in SER Section 6.1.4.2. Based on discussions during the December 20, 2012 public meeting on the draft license, the applicant submitted revised cost estimates based on data that corrected the earlier apparent typographical error (Strata, 2013a).

The staff finds that the decommissioning cost estimate (including detailed cost breakdown and bases for assumptions) provided by the applicant is consistent with the outline in Appendix C of the Standard Review Plan (NRC, 2003) and is acceptable to the staff because the estimate contains the appropriate items and reasonable costs. The initial license would have a standard license condition requiring submittal of an updated decommissioning cost estimate prior to the commencement of operations. This condition is included in the license to ensure that an updated decommissioning cost estimate based on current dollars is reviewed prior to commencement of operations.

The applicant has committed to the following administrative issues related to financial assurance:

- Providing an annual adjustment of the decommissioning cost estimate and the technical basis for this estimate at least 90 days prior to any major construction that has not been previously addressed in the estimate.

- Automatically extending the financial assurance instrument if the NRC has not approved the proposed revision 30 days before the expiration date.
- Revising the financial assurance arrangement within 3 months of NRC approval of a revised closure (decommissioning) plan if estimated costs exceed the amount of the existing arrangement.
- Providing the NRC with a copy of WDEQ's review and final financial assurance arrangement.

Through a standard license condition for the annual updates, the financial assurance amount would be reviewed on an annual basis by the staff; this would provide the staff with the ability to review and revise this portion of the amount to reflect the performance of the facility as it relates to spill prevention and cleanup. This is consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 9, and thus, is acceptable to the staff.

The staff finds that the applicant has established an acceptable decommissioning cost estimate based on the requirements in 10 CFR Part 40, Appendix A, Criterion 9. Sufficient funds would be available for completion of the reclamation plan by an independent contractor. The staff reviewed the information in the decommissioning cost estimate and notes that all the activities in the reclamation plan or in SRP Sections 6.1–6.3 (NRC, 2003) have been addressed by the applicant's financial analyses. Financial assurance assumptions are based on analyses of on-site conditions, including experiences with generally accepted industry practices, research and development at the site. The staff finds that the applicant has defined reasonable costs for the required reclamation activities. The applicant has not proposed a financial assurance instrument at this time. The applicable regulations in 10 CFR Part 40, Appendix A require that the financial assurance arrangement be established prior to commencement of operations. Therefore, as noted below, the staff includes a standard license condition requiring establishment of an acceptable financial assurance prior to commencement of operations.

6.5.4 EVALUATION FINDINGS

Based on the information provided in the application and the staff's detailed review of the decommissioning cost estimate for the Strata Ross Project, the staff concludes that the amount of the applicant's proposed financial assurance and its methods of estimation are acceptable and consistent with 10 CFR Part 40, Appendix A, Criterion 9, which requires that financial assurance arrangements be established by each operator. As maintaining adequate financial assurance is an important aspect of the facility, compliance with the applicable regulations would be required through the following standard license condition:

Standard License Condition 9.5:

> Financial Assurance. The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR 40, Appendix A, Criterion 9, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination, which includes offsite disposal of radioactive solid process or evaporation pond residues, and groundwater restoration. The surety shall also include the costs associated with all soil and water sampling analyses necessary to confirm the completion of decontamination.

Proposed annual updates to the financial assurance amount, consistent with 10 CFR Part 40, Appendix A, Criterion 9, shall be provided to the NRC 90 days prior to the anniversary date (e.g. renewal date of the financial assurance instrument/vehicle). The financial assurance update renewal date for the Ross Project will be determined following consultation with the licensee and the State of Wyoming. If the NRC has not approved a proposed revision 30 days prior to the expiration date of the existing financial assurance arrangement, the licensee shall extend the existing arrangement, prior to expiration, for one year. Along with each proposed revision or annual update of the financial assurance estimate, 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 the estimated costs for site closure. Within 90 days of NRC approval of a revised closure (decommissioning) plan and its cost estimate, the licensee shall submit, for NRC staff review and approval, a proposed revision to the financial assurance arrangement if estimated costs exceed the amount covered in the existing arrangement. The revised financial assurance instrument shall then be in effect within 30 days of written NRC approval of the documents.

planned expansion or operational change that was not included in the annual financial assurance update, the licensee shall provide, for NRC approval, an updated estimate to cover the expansion or change. The licensee shall also provide the NRC with copies of financial assurance-related correspondence submitted to the State of Wyoming, a copy of the State's financial assurance review, and the final approved financial assurance arrangement. The licensee also must ensure that the financial assurance instrument, where authorized to be held by the State, identifies the NRC-related portion of the instrument and covers the aboveground decommissioning and decontamination, the cost of offsite disposal of solid 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 C to NUREG-1569 entitled "Recommended Outline for Site-Specific In Situ Leach Facility Reclamation and Stabilization Cost Estimates."

The licensee shall continuously maintain an approved surety instrument for the Ross Project, in favor of the State of Wyoming. The initial surety estimate shall be submitted for NRC review and approval within 90 days of license issuance, and the surety instrument shall be submitted for NRC staff review and approval 90 days prior to commencing operations.

6.6 REFERENCES

Arnold, D. A., A. Vargas and X. Ortega, 2009. "Analysis of outdoor radon progeny concentration measured at the Spanish radioactive aerosol automatic monitoring network", Applied Radiation and Isotopes **67**(5): 833-838.

Mohamed, A., A. A. Ahmed, A. E. Ali and M. Yuness, 2008. "Attached and Unattached Activity Size Distribution of Short-Lived Radon Progeny (214Pb) and Evaluation of Deposition Fraction", Journal of Nuclear and Radiation Physics, **3**(2): 101-108.

NRC, 1980a. Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills", Washington, DC., April 1980.

NRC, 1993b. Policy and Program Guidance, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material", Office of Nuclear Material Safety and Safeguards, Division of Fuel Cycle, Medical, Academic, and Commercial Use Safety,Washington, DC, ADAMS Accession No. ML003745526, April 1993.

NRC, 2000. NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual", Washington, DC., August 2000.

NRC, 2003. NUREG-1569, "Standard Review Plan for In-Situ Leach Uranium Extraction License Applications—Final Report", Washington, DC., June 2003.

Strata, 2011a. Ross ISR Project USNRC License Application, Crook County, Wyoming, prepared by Strata Energy, Inc., Docket No. 040-09091. ADAMS Accession No. ML110120063, January 2011.

Strata, 2013a. Letter to John Saxton (NRC) from Ben Schiffer (WWC) with Information submitted based on Discussions during the December 20, 2012 Public Conference, Docket No. 040-09091. ADAMS Accession No. ML13037A473, January 2013.

7.0 ACCIDENTS

7.1 REGULATORY REQUIREMENTS

General requirements for issuance of a Part 40 specific license are listed in 10 CFR 40.32. Section 10 CFR 40.32(c) requires that an applicant's proposed procedures be adequate to protect public health and minimize danger to life or property. Section 10 CFR 20.1101 specifies that a licensee develop, document, and implement a radiation protection program commensurate with the scope and extent of the licensed activities and sufficient to ensure compliance with 10 CFR Part 20, which establishes standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the NRC. Sections 10 CRF 20.2201 and 20.2202 specify notification and reporting requirements for a loss, incident or accident that may impact public health and safety and the environment. Finally, for unrestricted release of the area upon license termination, Criteria 6(6) and 6(7) of 10 CFR Part 40 Appendix A provide standards for residual radiation levels in soil and closure to prevent threats to human health and the environment from nonradiological hazards.

Section 7.5.1 of the SRP (NRC, 2003) states that the NRC has evaluated the effects of accidents at ISR and conventional milling facilities and has determined that the consequences are minor for most credible potential accidents and an applicant need not conduct and independent accident analysis, provided that:

1) effective emergency procedures and properly trained personnel are used; and
2) the proposed facility is consistent with the operating assumptions, site features and designs examined in the prior NRC analyses.

Guidance in the SRP (NRC, 2003) indicates that staff should pay particular attention to procedures related to monitoring, identification, and response to accidents related to the following:

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

The staff determines if the applicant has addressed potential accidents at the proposed Ross Project and has 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; the response program requirements of 10 CFR 20.2202 and 20.2203; and closure requirements of Criteria 6(6) and 6(7) of Appendix A of 10 CFR Part 40.

7.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for consistency with applicable regulations of 10 CFR Part 40 and Part 20 using review procedures in Section 7.5.2 and acceptance criteria in Section 7.5.3 of the SRP (NRC, 2003).

7.3 STAFF REVIEW AND ANALYSIS

Unless otherwise stated, the information in SER Section 7.3 is from Section 7.5 of the technical report (Strata, 2011a). This SER chapter describes the effects of potential accidents that could occur at the proposed Ross Project and the accident reporting and cleanup criteria that the applicant would follow in the event of an accident. The staff's review included an evaluation using the areas of review, review procedures, and acceptance criteria as described in Sections 7.5.1, 7.5.2, and 7.5.3 of the SRP (NRC, 2003), respectively. If, after staff's detailed review of information supplied by applicant in an application, staff is reasonable reasonably assured that the applicant, by training, experience and expertise, is capable of developing, documenting and implementing an adequate program, staff may, by a pre-operational license condition, accept the documentation immediately prior to its implementation.

The applicant describes what it considers to be credible accidents following guidance provided in NUREG/CR-6733 (Mackin et al., 2001). The applicant states that all of the accident scenarios described will require reporting to various regulatory agencies and might require immediate notification depending on the severity of the accident. In Section 7.5 of the technical report (Strata, 2011a), the applicant commits to preparing an emergency response Standard Operating Procedure (SOP) as part of its emergency response program. Staff's review of the applicant's program for emergency responses to chemical accidents, radiological release accidents, groundwater contamination, wellfield spills, transportation accidents, fire and explosions, and natural events is discussed below.

7.3.1 CHEMICAL ACCIDENTS

In Section 3.2.8 of the Technical Report (Strata, 2011a), the applicant discusses use and storage of process and non-process chemicals. The process chemicals are as follows:

- hydrochloric acid
- sulfuric acid
- oxygen
- carbon dioxide
- anhydrous ammonia
- sodium hydroxide
- hydrogen peroxide
- sodium carbonate/sodium bicarbonate
- salt (sodium chloride)
- barium chloride

The non-process chemicals are as follows:

- gasoline
- diesel
- propane

In SER Section 3.2, staff reviewed and evaluated the applicant's use and storage of the process and non-process chemicals.

In Section 6.1.2.4 of the Technical Report (Strata, 2011a), the applicant suggests it may use a reductant addition during aquifer restoration (groundwater recirculation). In Section 6.1.6.4 of

the Technical Report (Strata, 2011a), the applicant suggests it may test reductant use on a small area before widespread application. The applicant did not provide a description of the reductant to be use or hazard analyses of its storage, use and handling, or through an accident.

In Section 7.5 of the technical report, the applicant provides a comprehensive evaluation of the potential accidents, including those involved in transportation, for the following process chemicals:

- sulfuric acid
- oxygen
- carbon dioxide
- anhydrous ammonia
- hydrogen peroxide
- sodium carbonate/sodium bicarbonate
- salt (sodium chloride)

For the above chemicals, the applicant acknowledges the associated hazards and provides plans to minimize the potential for an accident to occur, as well as mitigative measures should an accident occur (Strata, 2011a). The applicant's proposed emergency response program includes discussions on the compatibility of the chemicals, ventilation requirements, monitoring, inspections, training and secondary containment. For several chemicals (e.g., anhydrous ammonia and sulfuric acid), the applicant acknowledges that the volumes to be stored may trigger compliance with additional regulations (e.g., 40 CFR Part 355, 40 CFR Part 27 and 40 CFR Part 68).

The applicant did not provide a comprehensive evaluation of accidents involving the use and storage of hydrochloric acid and sodium hydroxide.

The applicant provides an evaluation of accidents involving the non-process chemicals (Strata, 2011a). The non-process chemicals will be stored in aboveground tanks. The applicant's proposed emergency response program includes discussions on the compatibility of the non-process chemicals, ventilation requirements, monitoring, inspections, training and secondary containment. The applicant acknowledges that the volumes to be stored may trigger compliance with additional regulations (e.g., 40 CFR Part 112).

In Section 5.7.8 of the Technical Report (Strata, 2011a), the applicant states that reporting of overexposures of workers will be conducted in accordance with 10 CFR 20.2202, 20.2203 and 20.2205. In Section 7.5.1.6 of the Technical Report (Strata, 2011a), the applicant states the emergency response plan for a spill of waste and process fluids will include a determination of whether or not reporting pursuant to 10 CFR 20.2202, 20.2203 and 20.2205 or 10 CFR 40.60 is required (Strata, 2011a).

Staff reviewed the applicant's proposed emergency response program related to chemical accidents and finds that the program adequately addresses the program requirements for an emergency response to a chemical accident for the process and non-process chemicals, except those noted below, because the applicant's designs and measures prevent the occurrence of an accident and the proposed emergency response procedures in the event of an accident are similar to and based on those in NUREG/CR–6733 (Mackin et al., 2001) and NUREG-0706 (NRC, 1980b). The noted exceptions are the accidents associated with following chemicals:

- hydrochloric acid
- sodium hydroxide
- chemical reductant for aquifer restoration

For hydrochloric acid and sodium hydroxide, staff finds that the applicant did provide an evaluation of chemical hazards associated with their use and storage (see SER Section 3.2.3). However, the applicant did not include an accident analysis for those chemicals. The applicant indicated that its use of those chemicals will be on a temporary basis (e.g., see Section 3.2.8.1.3 of the Technical Report (Strata 2011a)). However, an emergency response program needs to include hazard assessment for all chemicals used at a facility. Staff will include a license condition that requires the applicant to prepare its Standard Operating Procedures, including the emergency response program, prior to operations and maintain those SOPs during operations. The license condition will specify that the emergency response program include a hazard assessment of all chemicals used at the facility including an accident analysis (see SER Section 3.1.4). A copy of the current written procedures will be required to be kept in area(s) of the production facility where the chemicals are utilized.

For the chemical reductant, because the application lacked discussions on which chemicals the applicant plans to use, staff will include a license condition prohibiting the use and storage of chemicals associated with reductant addition for groundwater restoration until the applicant submits to the NRC staff, for review and approval, a chemical hazard assessment on the use, storage and transport of chemicals to be used for the chemical reductant (see License Condition 10.10 as presented in SER Section 6.1.4).

7.3.2 Radiological Release Accidents

The applicant identifies tank and plant pipe failures as potential accidents that could pose a radiological risk (Strata, 2011a). The applicant states that the CPP building structure and concrete curb will contain spills from tanks and leaks from pipes. The floor sump system will direct liquids to other tanks or to a lined storage pond. Section 3.1 in the applicant's technical report provides information on the operation and shutdown mechanisms that will be used if a piping failure occurs (Strata, 2011a). The applicant states that leak detection sensors will be located in the module building sumps and the valve manholes that will activate audible and visual alarms at the location and at the CPP if fluid is detected. In application Section 5.7.1.2.1.3, the applicant states that in addition to the instrumentation controls described in application Section 3.1, controls will include pressure monitoring instrumentation on pipelines which will trigger alarms and automatic shutdown in the case of an upset condition. Additionally, the applicant commits to developing an emergency response Standard Operating Procedure (SOP) that will define under what circumstances reporting is required and to which agency(ies) (Strata, 2011a).

NRC staff reviewed the potential radiological release accident scenarios and commitments made by the applicant and finds the information is acceptable because it is consistent with requirements of Part 20, current industry standard practices, and historical release accidents at existing facilities. The number of accidents historically at ISR facilities has been low and often not related to radiological materials. Practices at existing ISR facilities demonstrate that historical monitoring programs for the workers' health and safety, and for the effluent and environmental monitoring have been shown to be protective of workers' and public safety and

the environment. The applicant has committed to similar practices as those that have been used at the existing ISR facilities.

Staff has reasonable assurance that the applicant will be required to meet its commitments for preparing SOPs to address any release, and specifically any radiological release accident, prior to and during operations. NRC staff will review the applicant's SOPs as part of the required pre-operational inspection to ensure compliance with its commitments. During operations, NRC staff will continue to review the SOPs through routine inspections as the applicant will be required to update the SOPs to reflect future conditions.

7.3.3 GROUNDWATER CONTAMINATION

The applicant describes plans for the prevention and mitigation of excursions using systems that include monitoring injection and production rates, maintaining the appropriate bleed rate, measuring water levels, and monitoring ground water quality by sampling for specific parameters (Strata, 2011a). The applicant presents information on its operational controls in Sections 3.1, 3.2 and 3.3 of the application and groundwater monitoring programs in Section 5.7.8 of the application (Strata, 2011a). SER Section 3.0 discusses the control systems in detail and staff's analyses. SER Sections 2.4.3, 4.2.3, 5.7.8.3 discuss the groundwater monitoring programs and control of excursions and staff's analyses.

In brief, the applicant will be required to maintain controls on fluid migration and several monitoring programs for the early detection of a release. The monitoring programs consist of a leak detection system for the on-site ponds which is design to detect a loss of integrity of the primary liner system before the integrity of the secondary liner is compromised, which would then result in a pathway to the environment. The primary groundwater detection monitoring program is the excursion monitoring program, which requires semi-monthly sampling of the groundwater quality at designated wells surrounding a wellfield.   This program provides early detection of a potential release by measuring for the more highly mobile constituents in close proximity to a wellfield. Another groundwater detection monitoring will be performed for the ponds. This program will provide defense-in-depth to ensure that a release from the retention ponds does not impact the environment or potentially impact the health and safety of workers or the public.

Staff has reviewed the applicant's proposed control systems and monitoring programs and finds them to be protective of the health and safety of workers and the public and protective of the environment because they are consistent with those used at existing facilities which have been shown to provide early time detection of a release.

7.3.4 WELLFIELD SPILLS

The applicant states that pond failure or rupture of an injection or recovery line in a wellfield or between a wellfield and the plant could contaminate the ground in area of the break (Strata, 2011a). SER Sections 3.1 and 4.2 discuss the applicant's designs of the wellfield infrastructure proposed to minimize the likelihood of this type of accident and the methodologies to detect leaks. The applicant states that it will develop a response plan for wellfield spills that will include procedures for notification, spill containment and recovery, post-spill sampling and cleanup, and reporting.

NRC staff reviewed the commitments by the applicant to prepare a response plan, and finds that the information is adequate because it meets the requirements of 10 CFR Part 20 as it is

consistent with current industry standard practices. Requirements of 10 CFR Part 20 includes establishment of an adequate radiation safety protection program for the protection of public and worker's safety. The programs currently employed by existing ISR facilities have been shown to be protective of worker's and public health and safety and also promotes the ALARA principle and provides protection of the environment in the realm of loss of integrity of near-surface equipment.

Staff has reasonable assurance that the applicant will be required to meet its commitments for preparing SOPs to address any release, and specifically any wellfield spills or releases, prior to and during operations. NRC staff will review the applicant's SOPs as part of the required pre-operational inspection to ensure compliance with its commitments. During operations, NRC staff will continue to review the SOPs through routine inspections as the applicant will be required to update the SOPs to reflect future conditions.

As discussed in SER Section 3.1, the applicant will be require to document that environmental impacts resulting from wellfield spills meet the requirements of Criteria 6(6) and 6(7) of Appendix A, 10 CFR Part 40 prior to license termination.

7.3.5 TRANSPORTATION ACCIDENTS

In Section 7.5.4 of the Technical Report (Strata, 2011a), the applicant considers the potential for transportation accidents involving shipments of ion exchange resins, yellow cake, chemicals, vanadium, and radioactive wastes. The applicant identifies several procedures and actions to prevent transportation accidents, including maintaining vehicles in good operating condition, using properly trained and licensed drivers, inspecting vehicles prior to shipment, and following the Federal Hazardous Materials Transportation Law (Federal Hazmat Law), 49 U.S.C. § 5101 et seq., and DOT hazardous materials shipping requirements in 49 CFR Parts 171-180. Strata commits to providing continuing training for local emergency personnel to include firefighters, police, and emergency medical technicians (EMT) in the emergency response procedures. Moreover, Strata commits to implementing specific mitigation measures for shipment of yellowcake, uranium-loaded IX resin, and radioactive wastes. In accordance with 49 CFR Part 171, Subpart B – Incident Reporting, Strata commits to perform all notifications, to prepare and submit incident and examination reports, and to assist with investigations and special studies following an incident or accident. Strata will perform a post-cleanup radiological survey of the affected area following an accident that results in a release of any hazardous materials to the environment, to ensure that there are no long-term hazards associated with the material released or its response and cleanup operations (Strata, 2011a).

NRC staff finds that the applicant's commitments to (1) follow transportation regulations pursuant to 49 CFR Parts 171-180, (2) develop procedures which minimize and mitigate traffic accident consequences and (3) adhere to response reporting requirements of 10 CFR 20.2202 and 20.2203 are consistent with acceptance criteria (1), (2) and (4) of Section 7.5 in the SRP (NRC, 2003). Staff finds that the applicant has not committed to the requirements of 10 CFR 71.5, which specifies that each licensee who transports licensed material outside its site or on public highways must comply with DOT regulations in 49 CFR Parts 107, 171 through 180, and 390 through 397, as appropriate to the mode of transport. If the DOT requirements are not applicable, then a licensee must submit a request for modification, waiver or exception to the NRC.

NRC staff includes License Condition 12.11 described in SER Section 3.1.4 specifying that an SOP including information on transportation of license material outside of the license area be

prepared. This license condition will fulfill the deficiency noted above with respect to a commitment to comply with 10 CFR 71.5. NRC staff will review the applicant's SOPs as part of the required pre-operational inspection to ensure compliance with its commitments and with requirements of 10 CFR 71.5. During operations, NRC staff will continue to review the SOPs through routine inspections as the applicant will be required to update the SOPs to reflect future conditions. Based on the applicant's commitments, the noted license condition, and future compliance inspections, staff has reasonable assurance that the applicant will meet its commitments for preparing SOPs to address transportation of licensed material outside of the license area prior to and during operations.

7.3.6 FIRES AND EXPLOSIONS

The applicant discusses the potential for fires and explosions at the Ross Project in Section 7.5.3 of the Technical Report (Strata, 2011a). The applicant states that the hazard of fire or explosion is minimal, but commits to taking precautions to further reduce the risk. The applicant states it will take preventative measures to ensure that chemicals do not inadvertently come into contact with each other. The applicant states that it will locate the oxygen storage facility at a safe distance from the CPP and module buildings to avoid damage to those buildings and operations. As stated earlier, the applicant states that buildings will be adequately ventilated to reduce the opportunity for buildup of explosive gases in the buildings. Strata commits to ensuring that all employees will be trained on the proper procedures and evacuation plans in the event of a fire or explosion.

NRC staff reviewed the information provided by the applicant and finds it acceptable because the proposed handling and storage of the natural gas and oxygen on the Ross Project site follow the best management practices for an industrial setting, at which similar materials are used.

7.3.7 NATURAL EVENTS

In Section 7.5.5 of the Technical Report, The applicant concludes that the most significant risk from natural events at the proposed Ross Project is a tornado or earthquake that disperses yellowcake or failure of the chemical storage facilities (Strata, 2011a). The probability of a tornado occurring at the site is low (about one per 10,000 to one in 1,000,000 years). The applicant states that earthquakes are common in Wyoming and have occurred in every county in the State over the past 120 years. Strata states that most earthquakes have occurred in the northwestern part of the State; only one with a magnitude greater than 2.5 as measured on a Richter Magnitude Scale has been recorded in Crook County, and only five have been recorded in Campbell County. The applicant states that the primary hazard associated with an earthquake at an ISR facility is from the rupture of hazardous chemical tanks and mixing of incompatible fluids. The applicant states that it will have separate containment berms around storage tanks to reduce the risk of mixing of incompatible chemicals in the event of a spill. Also, the applicant commits to locate tanks such that there is a low risk of a chemical reaction during an accident that follows a tank rupture (Strata, 2011a). The applicant states that SOPs, training, and personal protective equipment will be available to personnel for response and mitigation of hazardous chemical spills.

NRC staff reviewed the information provided by the applicant and finds it acceptable because it is risk-informed and reflects best management practices for such industrial facilities. The training for emergency responses includes procedures for situations that may arise, based on the facility design and planned operations, resulting from a natural event. Any release or spill

involving radiological exposures will have to be reported and evaluated by the applicant pursuant to requirements in Part 20, regardless of whether the spill or release was a result of a man-made incident or natural events.

The applicant did not state that it will develop emergency procedures to include notification of personnel of potential severe weather, evacuation procedures, damage inspection and reporting. Notification of personnel of potential severe weather is not a requirement to meet an NRC regulation but a good management practice in order to be compliant with other regulations (e.g., regulations promulgated for the Emergency Planning and Community Right-to-Know Act of 1986, Title III. Pub. L. 99–499). In Section 3.10.3.6 of the Environmental Report (Strata, 2011a), the applicant commits to training local emergency responders in preparing and responding to potential environmental, safety and health emergencies associated with the Ross Project. Staff includes License Condition 12.2, in SER Section 7.4 to memorialize this commitment.

7.4 EVALUATION FINDINGS

The staff reviewed potential accidents that could occur at the Ross Project in accordance with review procedures in Section 7.5.2 and acceptance criteria in Section 7.5.3 of the SRP (NRC, 2003). The applicant cites information in NUREG-0706 and NUREG/CR-6733 as the bases for its assessment of accident consequences at the Ross Project. The staff concludes that these accident consequences analyses are applicable to the Ross Project.

Based on its review of information provided in the application, staff finds that the applicant's designs, plans, and training are acceptable because the applicant's emergency response program will:

- address the hazards of chemicals to be used at the facility;
- minimize the potential for accidents to happen;
- provide procedures to mitigate the hazards that are protective of worker's and the public health and safety and the environment;
- include training for the workers;
- document the hazard analysis of the emergency; and
- provide proper notification to the federal and state agencies.

Staff findings are based on the applicant's commitments to prepare such an emergency response program and license conditions requiring that the applicant prepares adequate SOPs for emergency response program. The license conditions consists of those presented in SER Sections 3.1.4 and 5.2.4 and the following license condition below memorializing the applicant's commitment to train local emergency responders to potential hazards at the Ross Project:

Standard License Condition 12.2:

> Prior to commencement of operations, the licensee shall coordinate critical emergency response requirements with local authorities, fire department, medical facilities, and other emergency services. The licensee shall document these coordination activities and maintain such documentation on-site.

Based upon staff's review and the requirements of the license conditions, staff finds that the applicant's emergency response program is 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; Criteria 6(6) and 6(7) of Appendix A of 10 CFR PART 40, which specifies standards for residual radiation and nonradiation hazards in the environmental media at license termination; 10 CFR 20,2201 and 20.2202, which specifies NRC notification of an incident; and 10 CFR 20.1101, which specifies that a radiation protection program commensurate with the scope and extent of the licensed activities and sufficient to ensure compliance with 10 CFR Part 20.

7.5 REFERENCES

Mackin, P. C., D. Daruwalla, J. Winterle, M. Smith and D. A. Pickett, 2001. NUREG/CR–6733, "A Baseline Risk-Informed Performance-Based Approach for In-Situ Leach Uranium Extraction Licensees", Prepared by the Center for Nuclear Waste Regulatory Analyses for the Nuclear Regulatory Commission, Washington, DC., September 2001.

NRC, 1980b. NUREG-0706, "Final Generic Environmental Impact Statement on Uranium Milling", Washington, DC., September 1980.

NRC, 2003. NUREG-1569, "Standard Review Plan for In-Situ Leach Uranium Extraction License Applications—Final Report", Washington, DC., June 2003.

Strata, 2011a. Ross ISR Project USNRC License Application, Crook County, Wyoming, prepared by Strata Energy, Inc., Docket No. 040-09091. ADAMS Accession No. ML110120063, January 2011.

APPENDIX A STANDARD LICENSE CONDITIONS

Standard License Conditions

SER Section	LC	License Condition (LC)
1.4	9.1	The authorized place of use shall be the licensee's Ross Project in Crook County, Wyoming. The licensee shall conduct operations within the license area boundaries shown in Figure 1.4-2 of the approved license application.
1.4	9.2	The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license application dated January 4, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML110120063), which is supplemented by submittals dated February 28, 2011 (ML110800187), March 30, 2012 (ML121030404), April 6, 2012 (ML121020343), August 10, 2012 (ML12227A369) and January 18, 2013 (ML130370654). The approved application and supplements, hereby, are incorporated by reference, except where superseded by specific conditions in this license. The licensee must maintain the approved, updated, license application on site. Whenever the word "will" or "shall" is used in the above referenced documents, it shall denote a requirement. The use of "the Wellfield" in this license is synonymous with the use of mine unit as defined in the approved license application. The use of "verification" in this license with respect to a document submitted for NRC staff review means a written acknowledgement by U.S. Nuclear Regulatory Commission (NRC) staff that the specified submitted material is consistent with commitments in the approved license application, or requirements in a license condition or regulation. A verification will not require a license amendment.
1.4	9.3	All written notices and reports sent to the NRC as required under this license and by regulation shall be addressed as follows: ATTN: Document Control Desk, Director, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. An additional copy shall be submitted to: Deputy Director, Decommissioning and

SER Section	LC	License Condition (LC)
		Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Mail Stop T-8F5, 11545 Rockville Pike, Two White Flint North, Rockville, MD 20852-2738. Incidents and events that require telephone notification shall be made to the NRC Operations Center at (301) 816-5100 (collect calls accepted).
1.4	9.11	The licensee is hereby exempted from the requirements of 10 CFR 20.1902(e) for areas within the facility, provided that all entrances to the facility are conspicuously posted with the words, "CAUTION: ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."
1.4	12.1	Prior to commencement of operations, the licensee shall obtain all necessary permits and licenses from the appropriate regulatory authorities. The licensee shall submit a copy of the permits it has obtained from other regulatory agencies for any effluent or waste disposal that includes treated or non-treated byproduct material, as well as documents clearly delineating the approved aquifer exemption areas and boundaries for the Class III UIC wells to the NRC.
3.1.4	10.1	The licensee shall use a lixiviant composed of native groundwater; carbon dioxide, sodium carbonate and/or sodium bicarbonate; and hydrogen peroxide and/or oxygen, as specified in Section 3.1.3.1 of the licensee's approved license application.
3.1.4	10.2	Facility Throughput. The Ross Project processing facility throughput shall not exceed a maximum instantaneous flow rate of 7,500 gallons per minute, excluding restoration flow. The annual production of dried yellowcake shall not exceed 3 million pounds.
3.1.4	10.5	Mechanical Integrity Tests. The licensee shall construct all wells in accordance with methods described in Section 3.1.2 of the approved license application. Mechanical integrity tests shall be performed on all wells (injection, extraction, and monitoring wells) before the well is utilized and on wells that have been serviced with equipment or procedures that

SER Section	LC	License Condition (LC)
		could damage the well casing. Each well shall be retested at least once every five (5) years it is in use. Integrity tests shall be performed in accordance with Section 3.1.2.3 of the licensee's approved license application. Any failed well casing that cannot be repaired to pass the integrity test shall be appropriately plugged and abandoned in accordance with Addendum 2.6-E of the approved license application.
3.1.4	10.7	The licensee shall maintain a net inward hydraulic gradient at a wellfield as measured from the surrounding perimeter monitoring well ring starting when lixiviant is first injected into the production zone and continuing until initiation of the stabilization period.
3.1.4	11.1	In addition to reports required to be submitted to NRC staff or maintained on-site by the applicable parts of Title 10 of the Code of Federal Regulations, the licensee shall prepare the following reports related to operations at the facility: A) A quarterly report that includes a summary of the excursion indicator parameter concentrations, corrective actions taken, and the results obtained for all wells that were on excursion status during that quarter. This report shall be submitted to NRC within 60 days following completion of the reporting period. B) A quarterly report summarizing daily flow rates and pressures for each injection manifold within the operating system. This report shall be made available for inspection upon request. C) A semi-annual report that discusses: status of wellfields (or wellfield modules if appropriate) in operation (including last date of lixiviant injection), progress of wellfields (wellfield modules) in restoration, status of any long term excursions and a summary of MITs during the reporting period. This report shall be submitted to NRC within 60 days following completion of the reporting period. D) Consistent with Regulatory Position 2 of Regulatory Guide 4.14 (as revised), a semiannual report that summarizes the results of the operational effluent and environmental monitoring program. For this program, the nearby water supply wells are those

SER Section	LC	License Condition (LC)
		within 2 km of the perimeter ring monitoring wells for all wellfields undergoing recovery operations or restoration. This report shall be submitted to NRC within 60 days following completion of the reporting period. E) An annual report pursuant to LC 9.4(E). F) An annual report that summarizes modifications to the inventory of nearby water supply wells and land-use survey within 2 kilometers of any production area. This report shall be submitted to NRC within 90 days following completion of the reporting period.
4.2.4	9.9	The licensee shall dispose of solid byproduct material from the Ross Project at a site that is authorized by NRC or an NRC-Agreement State to receive such byproduct material. The licensee's approved solid byproduct material disposal agreement shall be maintained on site during any time the facility is in operation. In the event that the agreement expires or is terminated, the licensee shall notify the NRC within seven working days after the date of expiration or termination. A new agreement shall be submitted for NRC review within 90 days after expiration or termination, or the licensee will be prohibited from further lixiviant injection.
4.2.4	10.8	The licensee is permitted to construct and operate lined retention pond(s) as described in Section 4.2.2 and Addendum 3.1-A of the approved license application subject to requirements of LC 10.11. The ponds will be used for retention of liquid byproduct material prior to disposal in a deep disposal well as described in Section 4.2.3 of the approved license application. Routine pond inspections will be conducted in accordance with procedures defined in Section 5.3.2 of the approved license application. The inspections include: A) Daily Inspection. The licensee will perform daily inspections in accordance with Section 5.3.2.1 of the approved license application. The inspections will include visual inspections of the piping, berms, diversion ditches, freeboard and leak detection systems. The minimum freeboard is 3 feet. If during the daily inspections a fluid height in any of the standpipes for the pond leak detection system is found to be in excess of six (6) vertical inches, then

SER Section	LC	License Condition (LC)
		the licensee will collect a sample of the fluid for analysis of specific conductance. If the specific conductance of the fluid in the leak detection system is in excess of 50 percent of the specific conductance of fluids in the pond, then it is concluded that a leak has occurred in the pond primary liner and the licensee will perform mitigative and corrective actions. The corrective actions include notifying the NRC Project Manager by telephone or email within 48 hours and lowering the water level in the pond sufficiently to eliminate the leak. If corrective actions are not completed within 60 days, the pond will not be used to store any byproduct material until the liner is inspected by qualified personnel as required by Subsection E (Annual Technical Inspection). The licensee will submit a report to NRC upon completion of the corrective actions including documentation of all pond repairs. Routine daily inspections reports will be maintained on-site for NRC staff to review during routine inspections. B) Weekly Inspection. The licensee will conduct weekly inspections in accordance with Section 5.3.1.2 of the approved license application. The inspections will include visual inspection of the entire area including perimeter fencing. The inspection report will be reviewed by the RSO, Manager of Health, Safety and Environmental Affairs, and the Facility Manager. The weekly inspection reports will be maintained on-site for NRC staff to review during inspections. C) Monthly Inspection. The licensee will conduct inspections monthly in accordance with Section 5.3.2.2 of the approved license application or following a major storm event (precipitation greater than 1-inch of water during a 24-hour period) of the condition of structures associated with the diversion of the stream around the CPP area in accordance with Section 5.3.4 of the approved license application. The reports will be maintained on-site for NRC staff to review during inspections. D) Quarterly Inspection. The licensee will conduct quarterly inspections in accordance with Section 5.3.2.3 of the approved license application. Results of the quarterly inspections will be included in the

SER Section	LC	License Condition (LC)
		semi-annual report submitted to NRC as required by LC 11.2. If groundwater quality in the monitoring wells indicates a release of fluids from the pond, then the licensee will immediately perform corrective actions to eliminate the leak and any appropriate remedial actions including characterization of impacts to shallow soils and water in the uppermost aquifer. Results of the quarterly inspections will be submitted to NRC for review. E) <u>Annual Technical Inspection.</u> The licensee will conduct annual inspections in accordance with Section 5.3.2.4 of the approved license application. The annual inspection will include a review of the previous year's daily, weekly, and quarterly inspections, assessment of the hydraulic and hydrologic capacities, and a survey of the embankment by qualified personnel. A copy of the report will be submitted to NRC for review.
4.2.4	12.5	Prior to commencement of operations, the licensee shall submit a copy of the solid byproduct material disposal agreement to the NRC.
5.1.4	9.4	Change, Test, and Experiment License Condition A) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition: i Make changes in the facility as described in the license application (as updated); ii Make changes in the procedures as described in the license application (as updated); and iii Conduct tests or experiments not described in the license application (as updated). B) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would: i Result in more than a minimal increase in the frequency of occurrence of an accident

SER Section	LC	License Condition (LC)
		previously evaluated in the license application (as updated); ii Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated); iii Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated); iv Result in more than a minimal increase in the consequences of a malfunction of an SEMS important to safety previously evaluated in the license application (as updated); v Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated); vi Create a possibility for a malfunction of an SEMS important to safety with a different result than previously evaluated in the license application (as updated); or vii Result in a departure from the method of evaluation described in the license application (as updated) used by the NRC in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA), technical evaluation reports (TERs), or other analyses and evaluations for license amendments. For purposes of this paragraph as applied to this license, SEMS important to safety means any SEMS that has been referenced in a staff SER, TER, EA, or EIS, and supplements and amendments thereof. C) Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and SERs, TERs,

SER Section	LC	License Condition (LC)
		EAs, and EISs issued with amendments to this license. D) The licensee's determinations concerning (B) and (C) of this condition, shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management (e.g., Plant Manager) and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent meeting recommendation in paragraph 2.4 of Regulatory Guide 8.31 with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate, to address technical aspects such as groundwater or surface water hydrology, specific earth sciences, and other technical disciplines. Temporary members or permanent members, other than the three above-specified individuals, may be consultants. E) The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes are in compliance with (B) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation of each. In addition, the licensee shall annually submit to the NRC page changes, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.
5.2.4	9.8	<u>Cultural Resources.</u> Before engaging in any developmental

SER Section	LC	License Condition (LC)
		activity not previously assessed by the NRC, the licensee shall administer a cultural resource inventory. All disturbances associated with the proposed development will be completed in compliance with the National Historic Preservation Act (as amended) and its implementing regulations (36 CFR Part 800), and the Archaeological Resources Protection Act (as amended) and its implementing regulations (43 CFR Part 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 to proceed from the NRC, Wyoming State Historic Preservation Officer or the Bureau of Land Management, as appropriate.
5.2.4	9.10	The results of the following activities, operations, or actions shall be documented: sampling; analyses; surveys or monitoring; survey/ monitoring equipment calibrations; audits and inspections; all meetings and training courses; and any subsequent reviews, investigations, or corrective actions required by NRC regulation or this license. Unless otherwise specified in a license condition or applicable NRC regulation, all documentation required by this license shall be maintained until license termination, and is subject to NRC review and inspection.
5.2.4	10.4	The licensee shall develop and implement written standard operating procedures (SOPs) prior to operation for: A) All routine operational activities involving radioactive and non-radioactive materials associated with licensed activities that are handled, processed, stored, or transported by employees; B) All routine non-operational activities involving radioactive materials including in-plant radiation protection and environmental monitoring; and C) Emergency procedures for potential accident/unusual occurrences including significant equipment or facility damage, pipe breaks and spills, loss or theft of yellowcake or sealed sources, significant fires, and other natural disasters.

SER Section	LC	License Condition (LC)
		The SOPs shall include appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. A copy of the current written procedures shall be kept in the area(s) of the production facility where they are utilized. Should an activity be deemed 'non-routine', its procedures will be documented in a specific Radiation Work Permit for that non-routine activity.
5.2.4	11.6	Until license termination, the licensee shall maintain documentation on spills of source or byproduct materials (including process solutions) and process chemicals. Documented information shall include, but not be limited to: date, spill volume, total activity of each radionuclide released, radiological survey results, soil sample results (if taken), corrective actions, results of post remediation surveys (if taken), a map showing the spill location and the impacted area, and an evaluation of NRC reporting criteria. The licensee shall have procedures used to evaluate the consequences of the spill or incident/event against 10 CFR Part 20 Subpart M and 10 CFR 40.60 reporting criteria. If the criteria are met, then the licensee will report the spill or incident/event to the NRC Operations Center, as required. If the licensee is required to report to a State or other Federal agency incidents/events that may have an impact on the environment, including wellfield excursions or spills of source, byproduct material, and/or process chemicals, the licensee shall submit a report to the NRC Headquarters Project Manager (PM) by telephone or electronic mail (e-mail) within 24 hours. This notification shall be followed, within 30 days of the notification, by submittal of a written report to NRC Headquarters in accordance with LC 9.3, detailing conditions leading to the spill or incident/event, corrective actions taken, and results achieved.
5.2.4	12.6	The licensee shall not commence operations until the NRC performs a preoperational inspection to confirm, in part, that operating procedures and approved radiation safety and environmental monitoring programs are in place, and that preoperational testing is complete. The licensee should inform the NRC, at least 90 days prior to the expected commencement of operations, to allow for sufficient time for NRC to plan and perform the

SER Section	LC	License Condition (LC)
		preoperational inspection.
5.4.4	9.7	The licensee shall follow the guidance set forth in NRC Regulatory Guides 8.22, “Bioassay at Uranium Recovery Facilities” (as revised), 8.30, “Health Physics Surveys in Uranium Recovery Facilities” (as revised) and 8.31, “Information Relevant to Ensuring that Occupational Radiation Exposure at Uranium Recovery Facilities will be As Low As Is Reasonably Achievable (ALARA),” (as revised) or NRC-approved equivalent with the following exception: The licensee may identify qualified designee(s) to perform daily inspections in the occasional absence of the RSO and radiation safety technician(s) (RST). The qualified designee(s) will have health physics training, and the licensee will specify the training program to qualify a designee and submit it to the NRC staff for review and written verification. A qualified designee may perform daily inspections on weekends, holidays, or times when both the RSO and RST(s) must both be absent (e.g., illness or offsite training). A designee shall not perform daily inspections for more than two consecutive days except in the event of a Federal or company holiday, whereby the designee will not exceed more than three consecutive days. Reports generated by the designee will be reviewed by the RSO or RST as soon as practical, but no later than 3 hours from the beginning of the next work day following an absence, weekend, or holiday. The licensee will also have the RSO or RST available by telephone while the qualified designee is performing the daily inspections. Notwithstanding the License Condition (LC) 9.4 change process, no additional exceptions to the guidance will be implemented without written NRC verification that the criteria in LC 9.4 do not require a license amendment.
5.4.4	12.4	Prior to commencement of operations, the licensee shall submit the qualifications of radiation safety staff members, including the qualifications and responsibilities of a designee, and the policy on the work situations for a declared pregnant worker, for NRC review and verification.
5.7.7.4	10.9	The licensee shall establish and conduct an effluent and environmental monitoring program in accordance with programs described in Section 5.7.8.2 (Operational

SER Section	LC	License Condition (LC)
		Monitoring-Surface Water and Operational Monitoring-Private Wells) and Section 5.7.7.1 (radon, air particulate, direct radiation, and soil) of the approved license application. The licensee will conduct a monitoring program in accordance with Section 5.7.8.2 (Operational Monitoring-CPP Area) unless those elements are included in the groundwater detection monitoring program required by LC 10.20.
5.7.7.4	11.2	The licensee shall submit the results of at least an annual review of the radiation protection program performed in accordance with 10 CFR 20.1101(c). This review shall include the content and implementation of the radiation protection program. Results shall include an analysis of dose to individual members of the public consistent with 10 CFR 20.1301 and 10 CFR 20.1302. This report shall be submitted to NRC within 90 days following completion of the reporting period.
5.7.8.4	11.3	<u>Establishment of Background Water Quality.</u> Prior to injection of lixiviant in a wellfield, the licensee shall establish background groundwater quality data for the ore zone, overlying and underlying aquifers. The background water quality sampling shall provide representative baseline data and establish groundwater protection standards and excursion monitoring upper control limits, as described in Section 5.7.8 of the approved license application and this license condition. The data for each mine unit shall consist, at a minimum, of the following sampling and analyses: A) <u>Ore Zone</u>. To establish a Commission-approved background concentration pursuant to Criterion 5B(5)(a) of 10 CFR Part 40 Appendix A, samples shall be collected from production and injection wells at a minimum density of one production or injection well per two acres of wellfield production area, or, if a wellfield production area is sufficiently isolated from the other wellfield production areas in the Wellfield, a minimum of two wells. Wells selected for the baseline data will be the same ones used to measure restoration success and stabilization. B) <u>Perimeter Monitoring Wells</u>. Samples shall be collected from all perimeter monitoring wells that will

SER Section	LC	License Condition (LC)
		be used for the excursion monitoring program. The perimeter wells will be installed for a wellfield in accordance with information presented in Section 3.1.6 of the approved license application. In no case will the perimeter monitoring wells be installed outside of the exempted aquifer as defined by the Class III UIC permit issued by the Wyoming Department of Environmental Quality. C) Overlying and Underlying Aquifers. Samples shall be collected from all monitoring wells in the first overlying and first underlying aquifer at a minimum density of one well per 4 acres of wellfield. D) Sampling and Analyses. Four samples shall be collected from each well to establish background levels. The sampling events shall be at least 14 days apart. The samples shall be analyzed for parameters listed in Table 5.7-2 of the approved license application. The third and fourth sample events can be analyzed for a reduced list of parameters; the parameters that can be deleted from analysis are those below the minimum analytical detection limits (MDL) during the first and second sampling events provided the MDLs meet the data quality objectives for the sampling. E) Background Water Quality. For the perimeter ring monitoring wells (Section B) and monitoring wells in the overlying and underlying aquifers (Section C), the background levels shall be the mean values on a parameter-by-parameter, well-by-well, wellfield or sub-set of the wellfield basis, as deemed appropriate, in accordance with Section 5.7.8.1 of the approved license application. The UCLs for monitoring wells in the perimeter ring and overlying and underlying aquifers are established per LC 11.4. For the ore zone monitoring wells, the background levels shall be established on a parameter-by-parameter basis using either the wellfield, sub-set of the wellfield or well-specific mean value. The established background value for each parameter shall be based on the mean value plus a statistically valid factor to account for spatial variability in the data, in accordance with Section 6.1.1.1 of the approved license application.
5.7.8.4	11.4	

SER Section	LC	License Condition (LC)
		Establishment of UCLs. Prior to injection of lixiviant into a wellfield, the licensee shall establish excursion control parameters and their respective upper control limits (UCLs) in the designated overlying aquifer, underlying aquifer and perimeter monitoring wells in accordance with Section 5.7.8.2 of the approved license application. The default excursion parameters for wells in the ore zone and overlying aquifer are chloride, conductivity, and total alkalinity. The default excursion parameters for wells in the underlying aquifer are sulfate, conductivity, and total alkalinity. The UCLs shall be established for each excursion control parameter and for each well, wellfield or subset of the wellfield, as appropriate, based on the mean plus five standard deviations of data collected for LC 11.3. The UCL for chloride can be set at the background mean concentration plus either five standard deviations or 15 mg/l, whichever is higher.
5.7.8.4	11.5	Excursion Monitoring. Monitoring for the excursion monitoring program shall be conducted twice monthly (semi-monthly) and at least 10 days apart for wells installed under LC 11.3 (B and C). If, at any well during a semi-monthly sampling event, the concentrations of any two excursion indicator parameters exceed their respective UCL or any one excursion indicator parameter exceeds its UCL by 20 percent, then the excursion criterion is exceeded and a verification sample shall be taken from that well within 48 hours after results of the first analysis are received. If the verification sample confirms that the excursion criterion is exceeded, then the well is placed on excursion status. If the verification sample does not confirm that the excursion criterion is exceeded, a third sample shall be taken within 48 hours after results of the first verification sampling are received. If the third sample shows that the excursion criterion is exceeded, the well shall be placed on excursion status. If the third sample does not show that the excursion criterion is exceeded, the first sample shall be considered to be an error and routine excursion monitoring is resumed (the well is not placed on excursion status). Upon confirmation of an excursion, the licensee shall notify NRC as stated below, implement corrective action, and increase the sampling frequency for the excursion indicator parameters at the well on excursion status to at least once every seven days. Corrective actions for confirmed excursions may be, but are not limited to, those described in Section 5.7.8.2 of the approved license application. An excursion is considered corrected when concentrations of all

SER Section	LC	License Condition (LC)
		indicator parameters defining the excursion status are at or below the UCLs defined in LC 11.4 for three consecutive weekly samples. For wellfields located in an area in which the uppermost aquifer, the “SA Aquifer”, is comprised of saturated unconsolidated alluvium, the licensee will include monitoring wells in the SA Aquifer in that area of the wellfield as part of the excursion monitoring program as described above. The wellfield data package must include sufficient justification on the locations, baseline sampling if the frequency is less than quarterly, and operational sampling if the frequency is less than semi-monthly for wells in the uppermost aquifer. The justification must demonstrate that the wells provide early detection of a release (including a surficial release). If a vertical excursion is detected during operations, then injection of lixiviant into the production area surrounding the monitoring well will cease until the licensee demonstrates to the satisfaction of NRC that the vertical excursion is not attributed to leakage through any abandoned drill hole. If an excursion is not corrected within 60 days of the initial confirmation, the licensee shall either: (a) terminate injection of lixiviant within the wellfield, or a portion of the wellfield provided the licensee demonstrates to NRC that only a portion of the wellfield is within the area of influence for the excursion) until the excursion is corrected; or (b) increase the financial surety in an amount to cover the full third-party cost for correcting and cleaning up impacts that may be attributed to the excursion. The surety increase shall remain in force until the NRC has verified that the excursion has been corrected and appropriate remedial actions have been undertaken. The written 60-day excursion report shall identify which course of action the licensee is taking if the excursion has not been corrected. Under no circumstances does this condition eliminate the requirement that the licensee remediate the excursion to meet groundwater protection standards as required by LC 11.3. The licensee shall notify the NRC Project Manager (PM) by telephone or email within 24 hours of confirming a lixiviant excursion, and by letter within 7 days from the time the excursion is confirmed, pursuant to this license condition and LC 9.3. A written report describing the excursion event, corrective actions taken, and the corrective action results shall be submitted to the NRC within 60 days of the excursion confirmation. For all wells that remain on

SER Section	LC	License Condition (LC)
		excursion status after 60 days, the licensee shall submit a report as discussed in LC 11.1(A).
5.7.8.4	12.3	Prior to commencement of operations, the licensee shall identify the location, screen depth, and estimated pumping rate of any new water supply well or new use for an existing well within 2 kilometers of a proposed wellfield area, as measured from the perimeter monitoring well ring, since the application was submitted to the NRC. The licensee shall evaluate the impact of ISR operations and recommend any additional monitoring or other measures to protect groundwater users. The evaluation shall be submitted to the NRC staff for review and verification at least 30 days prior to the expected commencement of operations.
6.1.4	10.6	Groundwater Restoration. The licensee shall conduct groundwater restoration activities in accordance with Section 6.1.5 of the approved license application. Permanent cessation of lixiviant injection in a production area would signify the licensee's intent to shift from the principal activity of uranium recovery to the initiation of groundwater restoration and decommissioning for any particular production area. If the licensee determines that these activities are expected to exceed 24 months for any particular production area, then the licensee shall submit an alternate schedule request that meets the requirements of 10 CFR 40.42. Restoration Standards. Hazardous constituents in the groundwater shall be restored to the numerical groundwater protection standards as 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 also show that it has first made practicable effort to restore the specified hazardous constituents to the background or maximum contaminant levels (whichever is greater). Restoration Stability Monitoring. The licensee shall conduct sampling of the parameters included in the baseline sampling under LC 11.3 during the restoration stability period in accordance with Section 6.1.2.5 of the approved application. The sampling consists of eight samples during a 12 month period. The sampling shall include the specified production zone aquifer wells used to define the baseline

SER Section	LC	License Condition (LC)
		levels. The applicant shall continue the stability monitoring until the data show, for all parameters monitored, no statistically significant increasing trend, which would lead to an exceedence of the relevant standard in 10 CFR Part 40, Appendix A, Criterion 5B(5).
6.2.4	10.3	At least 12 months prior to initiation of any planned final site decommissioning, the licensee shall submit a detailed decommissioning plan for NRC staff review and approval. The plan shall represent as-built conditions at the Ross Project.
6.3.4	9.6	Release of surficially contaminated equipment, materials, or packages for unrestricted use shall be in accordance with the NRC guidance document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," (the Guidelines) dated April 1993 (ADAMS Accession No. ML003745526) or suitable alternative procedures approved by NRC prior to any such release. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides shall apply independently. Personnel performing contamination surveys for items released for unrestricted use shall meet the qualifications as health physics technician or radiation safety officer as defined in Regulatory Guide 8.31 (as revised). Personal effects (e.g., notebooks and flash lights) which are hand carried need not be subjected to the qualified individual survey or evaluation, but these items should be subjected to the same survey requirements as the individual possessing the items. Regulatory Guide 8.30 (as revised), Table 2 shall apply to the removal to unrestricted areas, of equipment, materials, or packages that have potential accessible surface contamination levels above background. The contamination control program shall provide sufficient detail to demonstrate how the licensee will maintain radiological controls over the equipment, materials, or packages that have the potential for accessible surface contamination levels above background, until they have been released for unrestricted use as

SER Section	LC	License Condition (LC)
		specified in the Guidelines, and what methods will be used to limit the spread of contamination to unrestricted areas. The contamination control program shall demonstrate how the licensee will limit the spread of contamination when moving or transporting potentially contaminated equipment, materials, or packages (i.e. pumps, valves, piping, filters, etc.) from restricted areas through unrestricted areas. Prior to its implementation, the licensee shall receive written NRC verification of the licensee's contamination control program if recommendations in RG 8.30 are not followed. The licensee may identify a qualified designee(s) to perform surveys, as needed, associated with the licensee's contamination control program when moving or transporting potentially contaminated equipment, materials, or packages from restricted or controlled areas through uncontrolled areas and back into controlled or restricted areas. The qualified designee(s) shall have completed education, training, and experience, in addition to general radiation worker training, as specified by the licensee. The education, training, and experience required by the licensee for qualified designees shall be submitted to the NRC for review and written verification. The licensee shall receive written verification of the licensee's qualified designee(s) training program prior to its implementation.
6.5.4	9.5	Financial Assurance. The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR 40, Appendix A, Criterion 9, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination, which includes offsite disposal of radioactive solid process or evaporation pond residues, and groundwater restoration. The surety shall also include the costs associated with all soil and water sampling analyses necessary to confirm the completion of decontamination. Proposed annual updates to the financial assurance amount, consistent with 10 CFR Part 40, Appendix A, Criterion 9, shall be provided to the NRC 90 days prior to the anniversary date (e.g. renewal date of the financial assurance instrument/vehicle). The financial assurance update renewal date for the Ross Project will be determined following consultation with the licensee and the State of Wyoming. If the NRC has not approved a proposed revision 30 days prior to the expiration date of the existing financial assurance arrangement, the licensee shall extend the existing

SER Section	LC	License Condition (LC)
		arrangement, prior to expiration, for one year. Along with each proposed revision or annual update of the financial assurance estimate, 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 the estimated costs for site closure. Within 90 days of NRC approval of a revised closure (decommissioning) plan and its cost estimate, the licensee shall submit, for NRC staff review and approval, a proposed revision to the financial assurance arrangement if estimated costs exceed the amount covered in the existing arrangement. The revised financial assurance instrument shall then be in effect within 30 days of written NRC approval of the documents. At least 90 days prior to beginning construction associated with any approved, planned expansion or operational change that was not included in the annual financial assurance update, the licensee shall provide, for NRC approval, an updated estimate to cover the expansion or change. The licensee shall also provide the NRC with copies of financial assurance-related correspondence submitted to the State of Wyoming, a copy of the State's financial assurance review, and the final approved financial assurance arrangement. The licensee also must ensure that the financial assurance instrument, where authorized to be held by the State, identifies the NRC-related portion of the instrument and covers the aboveground decommissioning and decontamination, the cost of offsite disposal of solid 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 C to NUREG-1569 entitled "Recommended Outline for Site-Specific In Situ Leach Facility Reclamation and Stabilization Cost Estimates." The licensee shall continuously maintain an approved surety instrument for the Ross Project, in favor of the State of Wyoming. The initial surety estimate shall be submitted for NRC review and approval within 90 days of license issuance, and the surety instrument shall be submitted for NRC staff review and approval 90 days prior to commencing operations.

SER Section	LC	License Condition (LC)
7.4	12.2	Prior to commencement of operations, the licensee shall coordinate critical emergency response requirements with local authorities, fire department, medical facilities, and other emergency services. The licensee shall document these coordination activities and maintain such documentation on-site.