Application for Amendment of USNRC Source Materials License SUA-1601,

Ross ISR Project, Kendrick Expansion Area

RAI Question and Answer Responses for the Kendrick Expansion Area Technical Report Docket #40-09091

Prepared for:
U.S. Nuclear Regulatory Commission
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November 2016

PENINSULA
OPERATING THROUGH
STRATA ENERGY

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Section 1.0

RAI 1.0-1

Description of Deficiency

On page 1-8 of the Kendrick Technical Report (TR), Strata states that the "[l]iquid and solid waste from the KEA will be nearly identical in composition, annual quantity, and generation rate to the Ross ISR Project."

Basis for Request

Acceptance Criterion 3.1.3(5)(e) of the NUREG-1569 (hereinafter the "Standard Review Plan" or "SRP") requires a description of the wastes and effluents generated at a licensed facility. The "nearly identical" description is too general. If the waste is different from that previously described for the Ross area, that difference needs to be described.

Request for Additional Information

Please clarify the definition of "nearly identical" in the sentence "[l]iquid and solid waste from the KEA will be nearly identical in composition, annual quantity, and generation rate to the Ross ISR Project" on Page 1-8.

TR RAI 1.0-1 Response

For clarification, the phrase "nearly identical" refers to the fact that liquid and solid waste would be generated from ISR wellfields within the KEA (as opposed to processing facilities, which would not occur within the KEA). This waste would be very similar but not identical to that generated from ISR wellfields within the current license area. This is described in the opening sentence of Chapter 4 of the KEA TR, which states, "Liquid, solid, gaseous, and particulate effluents produced at the KEA wellfields will be nearly identical in composition, annual quantity, and generation rate to the wellfields at the Ross ISR Project." Thus, the phrase "nearly identical" refers the fact that the composition, annual quantity, and generation rate of wastes produced in KEA wellfields will be very similar but not identical to those produced in Ross wellfields. While the wastes produced from the KEA wellfields will result from the identical ISR and groundwater restoration processes approved for the Ross ISR Project, no two wellfields would have identical water quality, size, or bleed volume. Minor differences in baseline OZ aquifer water quality between different mine units within the current license area are shown in the MU1 and MU2 wellfield data packages, which have similar but not identical target restoration values (TRVs). They are also shown in comparing the Ross regional baseline monitor network results in Section 2.7.3.5.2.2 of the approved Ross TR with those for the KEA in Section 2.7.3.4.1.2 of the KEA TR. For example, all of the regional baseline OZ wells in both areas were dominated by sodium anions, but bicarbonate contributed a relatively higher percentage of anions in the KEA compared to the Ross license area. Based on these minor differences in pre-operational water quality, liquid waste resulting from ISR and groundwater restoration activities would be similar but not identical. With respect to the generation rate and annual quantity of waste, both of these parameters will depend on the size, production rate, and production bleed rate of each mine unit. As specified in Section 3.1.4 of the KEA TR, the production bleed will range from 0.5% to 2% and average approximately 1.25%. Although the

production bleed rate as a percentage will be similar across mine units, this recognizes that it may be higher or lower in a given mine unit depending on site-specific hydrogeologic conditions. Similarly, the annual quantity of liquid waste will depend on the production and restoration bleed rates and the number of recovery wells operating within each mine unit. No revisions to the license amendment application are proposed in response to this RAI.

RAI 1.0-2

Description of Deficiency

In addition to the request to expand operations to the Kendrick area, the licensee has included several proposed revisions to the existing license (e.g., minimum density of one baseline well per two acres, perimeter well spacing and offset, DM monitoring program, on-site disposal). In several cases, the additional changes are clearly identified in the application and the application provides grounds for those changes. However, several changes affect other areas of this application which are not clearly marked which is difficult for staff to clearly identify the changes. Also, several of those additional changes have been submitted as separate amendment request(s) to the NRC.

Staff will need a summary table of any proposed changes to avoid confusion in the future should ambiguities exist between the Kendrick and Ross applications because many changes have been incorporated as subtle references throughout the Kendrick application. If the change is not listed on that table and staff has not directly addressed this change in its safety evaluation report, then requirements of the Ross application supersede those of the Kendrick amendment.

Basis for Request

Section 10 CFR 40.44 states that "[a]pplications for amendment of a license … shall specify the respects in which the licensee desires the license to be amended and the grounds for such amendment.

Request for Additional Information

Please provide a summary table of the proposed changes from the Ross approved license application/license contained in this amendment request and whether those changes are specific to the Kendrick expansion area or applicable to both the Kendrick and Ross area.

TR RAI 1.0-2 Response

Table TR RAI 1.0-2-1 provides the currently proposed amendments to SUA-1601 and, as relevant, the locations where the proposed changes are discussed in the KEA TR. The table also lists other changes proposed in the KEA TR that are not contained in separate amendment requests and indicates whether each change (if approved) would be specific to the currently licensed Ross area, the KEA, or both. In the October 4, 2016, Category 1 public meeting between NRC staff and Strata (ML16265A542), NRC staff indicated that it anticipates completing the review process for the critical wellfield amendment applications (LC 10.12, LC 11.3(A), LC 11.3(B), and LC 11.3 (C)) prior to completion of the KEA amendment review. Therefore, Strata anticipates updating the Ross TR through the Safety and Environmental Review Panel (SERP) process following each amendment approval. Strata anticipates updating the KEA TR prior to amendment approval, similar to the process that was undertaken prior to issuance of the final SER for the Ross ISR Project. No revisions to the license amendment application are proposed in response to this RAI.

Table TR RAI 1.0-2-1. License SUA-1601 Amendment Requests and Other Proposed Changes in the KEA TR

SUA-1601 Amendment or Proposed Change	KEA TR page(s) if Applicable	Applicable to Ross, KEA, or Both
LC 11.3(A) - Ore zone baseline well density (December 21, 2015; ML16004A032)	1-33, 3-10, 3-12, 3-13	Both
LC 11.3(B) - Perimeter monitor well spacing (December 21, 2015; ML16004A032)	Not included	Both
LC 11.3(C) - DM or underlying interval operational monitoring (July 16, 2015; ML15205A337)	2-223 through 2-225, 3-10 through 3-12	Both
LC 10.12 - Downgradient drill hole abandonment (December 23, 2015; ML16020A370)	Not included	Both
LC 9.7 - Daily inspection by Qualified Designee (July 6, 2015; ML15197A033)	Not included	Both
LC 12.13 - Meteorological station operation (May 1, 2014; ML14125A277)	Not included	Both
Addition of booster pump stations and inspections (March 20, 2015; ML15096A141)	1-6, 1-29, 3-1, 3-2, 3-5, 3-7, 3-8, 3-14, 4-1, 4-3, 5-2, 5-5, 5-6, 7-11, 7-12, Figures 2.1-2, 3.1-1, and 3.1-2	Both
LC 11.3(E) - Use of ProUCL for calculating Commission-approved background concentrations, upper confidence limits, and determining groundwater restoration adequacy	1-34, 1-35, 5-12, 6-4	Both
Disposal of non-contaminated and decontaminated materials on-site (March 20, 2015; ML15096A141)	1-9, 6-7	Both
License Amendment 2 LC 11.3(D) - Update of Table 5.7-2, Wellfield Background Aqueous Sampling Parameter List (July 15, 2015; ML15181A246)	5-18	Both

Section 2.6

RAI 2.6-1

Description of Deficiency

The boring logs which are included in the cross sections in this amendment request do not extend to the Deep Monitoring (DM) unit or underlying confining unit specifically in areas in which the "ore zones" are delineated. The isopach mapping indicates that the DM unit is found throughout the Kendrick area but the isopach mapping does not include locations on which this interpretation is based.

Basis for Request

Review procedures in Section 2.6.2 of the SRP states "[t]he reviewer should determine that the application contains accurate geologic maps, isopach maps of the mineralized strata and of the confining layers, geologic cross sections at places critical to a thorough understanding of the selected site, descriptions of representative supporting core samples, geophysical and lithologic logs, and other data required for a thorough understanding of the pertinent geology." Acceptance criterion 2.6(1)(d) of the SRP states [t]he application includes a description of the local and regional stratigraphy based on … [g]ologic interpretations of surface geology and balanced cross sections … accompanied by … geologic, topographic and isopach maps that show … locations of all wells used in defining the stratigraphy".

Request for Additional Information

Please revise the geologic cross sections (Addendum 2.6-A) and isopach and structural mapping (Addendum 2.6-B) to verify that the DM and underlying confining units are present throughout the Kendrick area.

TR RAI 2.6-1 Response

Presence of the underlying confining interval(s) and underlying sand interval(s) are discussed in Section 2.6.2.2.3 of the KEA TR. To summarize, above the Pierre Shale (regional aquitard) and below the mineralized portions of the Fox Hills and Lance Formations, two sand members separated by interbedded shales and silts exist within the KEA. The basal sandstone, called BFS 1 and ranging in thickness from 10 to 50 feet underlies nearly the entire KEA, although it thins and pinches out in the northern portion of the KEA. Overlying the BFS 1 is the BFH 1 shale unit, which is comprised of dark gray to black shale, claystone and mudstone with thicknesses from 10 to 50 feet in the KEA. Overlying the BFH 1 shale unit is the BFS 2 sand interval, comprised of thinly bedded sandstones with interbeds of shale, siltstone and calcareous-cemented sandstones. The BFS 2 sand interval is the underlying or deep monitor (DM) interval for the current license area. Detailed geologic and hydrologic characterization of the BFS 2 sand are provided in the Mine Unit 1 and Mine Unit 2 wellfield data packages (ML15209A703 and ML16243A163, respectively). Overlying the BFS 2 sand interval is the BFH 2 shale, which is not continuous in the KEA. The BFH 2 shale thickness decreases to 0 feet at the line of coalescence or DM transition line. In the northern portion of the KEA, the BFH 2 shale thickens to greater than 50 feet and the BFS 2 sand interval nearly pinches out.

In KEA TR Addendum 2.6-A, 261 geophysical logs of sufficient resolution and representativeness were used in the geologic cross sections to illustrate the subsurface stratigraphy. Of those 261 logs, 108 or 41% penetrate to the BFS 1 and/or BFS 2 sand interval(s). No other geophysical logs of sufficient resolution, representativeness and that penetrate to the depths below the mineralized zone were available for use in the cross sections.

NRC staff is correct that there is a lower percentage of geophysical logs that penetrate to the BFS 1 and/or BFS 2 sand interval(s) within areas designated in the cross sections as "ore" areas compared to the overall percentage for all logs. However, the number of logs penetrating the DM interval within the KEA is consistent with that in the current license area, as discussed below. Areas designated as "ore" represent the approximate limits of economic mineralization, as described in the cross section legend. These were based on a grade-thickness (GT) cutoff criteria. Upon revisiting the cross sections in response to this RAI, it was determined that a more appropriate and helpful indicator of potential future wellfields would show the approximate extents of the perimeter monitor well rings for each mine unit; therefore, the cross sections have been revised accordingly. The revised cross sections indicate the approximate extents of the potential perimeter monitor well rings. Revised cross sections are included in Appendix A of this response package.

Figure TR RAI 2.6-1-1 depicts the approximate perimeter monitor well ring extents, line of coalescence (DM transition line) and locations of the KEA geologic cross sections. As background, in both the Mine Unit 1 and Mine Unit 2 wellfield data packages, Strata characterized the subsurface geology out to and often beyond the perimeter monitor well rings. This information, along with the addition of the planned mine unit extents to the cross sections, should allow the staff to better understand the level of information provided regarding the DM and underlying confining interval(s) in KEA mine unit areas. In addition to incorporating the planned mine unit extents into the revised cross sections, Strata also revisited several geophysical logs that were used to construct the cross sections, including revising the DM intercepts on two logs and picking previously unmarked DM intercepts on four logs. The revised logs appear on cross sections A-A' (log SP 210R), B-B' (logs SPD 341M and SPD 342M), C-C' (logs RMR 1488 and RMR 1487), and J-J' (log SP 456R). The revised intercepts more accurately reflect the thickness of the underlying confining layer on the updated cross sections. Revised isopach contours for the BFH1 and BFH2 intervals are provided on Figure TR RAI 2.6-1-1. As stated previously, the number of logs penetrating to the DM interval is consistent between the Ross and KEA cross sections. Based on the updated KEA cross sections, 158 geophysical logs are within planned KEA perimeter monitor well rings. Of these, 29% or 46 drill holes penetrate to the DM interval. This is consistent with the proportion of drill holes penetrating to the DM interval in the approved Ross TR. For example, cross section A-A' in Addendum 2.6-C of the Ross TR included 149 geophysical logs, of which 47 or 32% penetrated to the DM interval (BFS 2 sand). Considering the above information, Strata believes that the characterization of the underlying confining interval both across the KEA and, more importantly, within future mining areas is sufficient.

KEA TR Addendum 2.6-B included structure contour maps of the top and bottom of the DM interval (Figures 1 and 2, which note that the DM interval is designated as the BFS 2 sand to the east of the DM transition line and the BFS 1 sand to the west of the

transition line), an isopach map of the DM interval (Figure 3, which includes both BFS sands) and, most importantly with respect to confinement, an isopach map of the BFH 1 and BFH 2 confining interval(s) (Figure 4). Providing structure contour and isopach maps of the DM interval was beyond standard industry practice and guidance in SRP, Section 2.6.1, which suggests isopachs should be provided "of the mineralized strata and of the confining layers" but not underlying monitoring intervals. These maps were provided to aid in NRC staff review of the underlying confinement and characterization of the underlying water-bearing interval. Both the structure contour and isopach maps, depict continuous underlying water bearing intervals in both the BFS 1 and BFS 2 as well as the underlying confinement provided by the BFH 1 and BFH 2 shale layers. Data sources are indicated on the figures in Note 2, which states, "Surfaces shown derived from geologic cross sections using Rockworks© software." To further aid in staff review and beyond what was done in the approved Ross TR, the isopach of the underlying confining layer was updated and simplified to depict the thickness of the underlying confining unit at each geophysical log. Updated isopach contours included on Figure TR RAI 2.6-1-1. This figure depicts the revised isopach contours of the underlying confining interval, the data points used to develop the contours, a revised DM transition line based on the revised cross sections, and planned perimeter monitor well rings. The isopach was developed using 108 drill holes, of which 46 are within planned perimeter monitor well rings. Thus, Figure TR RAI 2.6-1-1 provides the locations of the data used for interpretation purposes and, more importantly, data within each of the planned KEA mine units.

Table TR RAI 2.6-1-1, summarizes the characterization of the underlying confining interval(s), underlying water-bearing interval(s), and drill hole penetrations to the DM interval within planned KEA mine units. This includes an estimate of the number of future drill holes that will penetrate through the DM interval based on the approximate wellfield pattern acreage. SUA-1601 LC 10.13 requires Strata to provide wellfield data packages to NRC staff for review, and LC 11.3(C) (as amended) would require each wellfield data package to include a minimum number of penetrations through the DM (either BFS 1 or BFS 2 as appropriate) in order to characterize the underlying confining and water-bearing intervals. At a minimum density of one penetration per 4 acres of pattern area, it is estimated that at least 274 additional data points would be provided to NRC staff in separate wellfield data packages over the course of the KEA development. These additional drill hole penetrations would be used in developing mine unit-specific isopach maps of both the underlying confining interval and underlying water-bearing interval as appropriate. Similarly, these drill hole penetrations and associated geophysical logs would be used to construct geologic cross sections through the perimeter monitor well rings and wellfield pattern areas similar to those provided in the Ross Mine Unit 1 and 2 wellfield data packages.

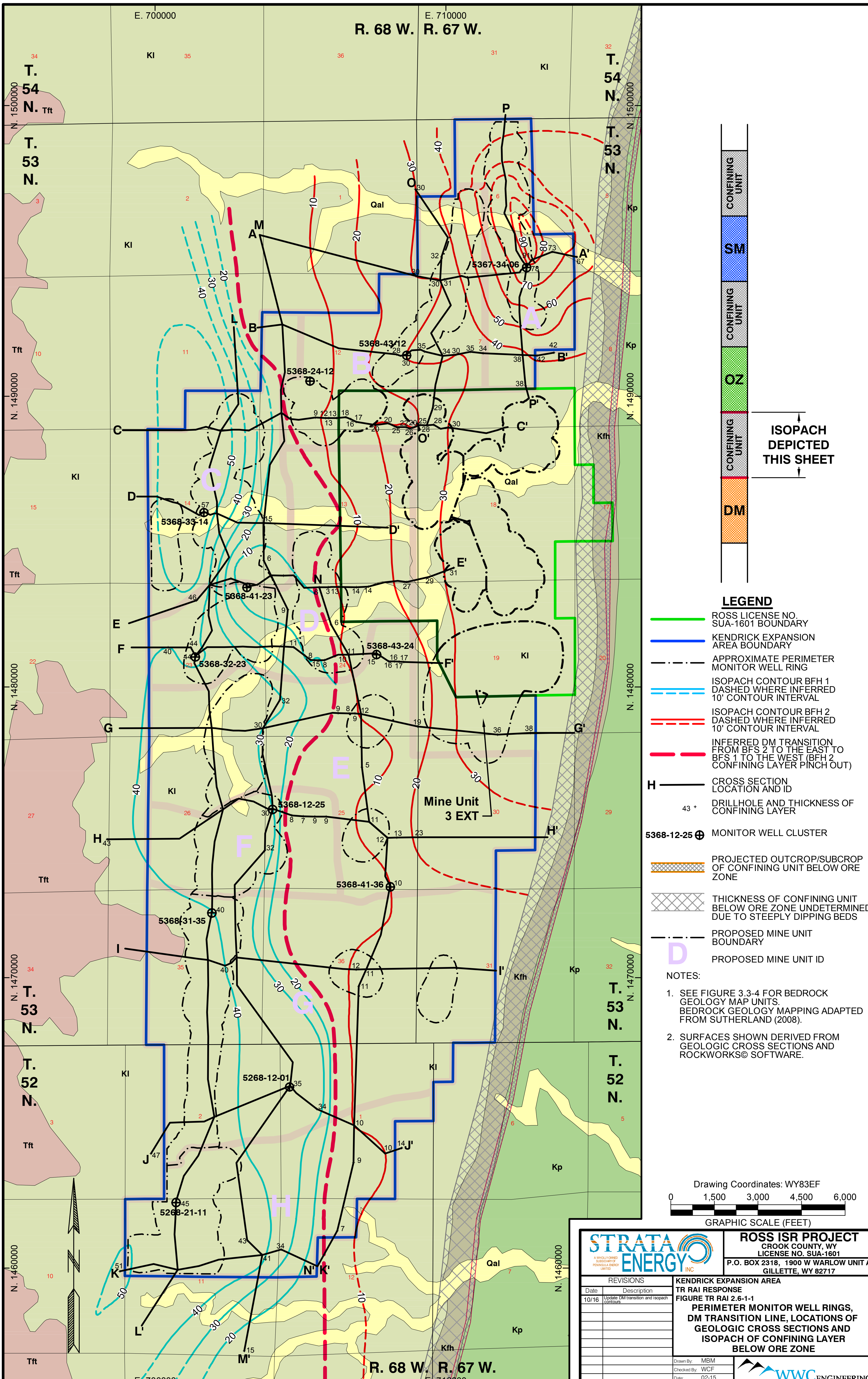
Strata will replace the geologic cross sections and isopach map in the KEA TR with those included as part of this response package, pending acceptance of the responses by NRC staff. The structure contour maps of the top of the DM (KEA TR Addendum 2.6-B, Figure 1) and bottom of the DM (KEA TR Addendum 2.6-B, Figure 2) were not revised as part of this response, since these simply confirm the direction of dip and presence of the strata within the KEA. Similarly, the isopach of the DM (KEA TR Addendum 2.6-B, Figure 3) was not modified as part of this response, since the focus for the RAI was the underlying confining interval, as discussed during the public meeting with Strata held

on October 4, 2016. No other changes to the license amendment application are proposed in response to this RAI.

Table TR RAI 2.6-1-1. Summary of Underlying Confining Interval Characterization for each KEA Mine Unit

Parameter	Proposed Mine Unit ID								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**3 Ext[4]**
Applicable geologic cross section(s)	A-A’, P-P’	A-A', B-B', C-C', O-O’	C-C', D-D', E-E', L-L', M-M'	E-E', F-F', L-L', M-M', N-N'	G-G', H-H', L-L', M-M', N-N'	H-H', L-L', M-M'	I-I', J-J', L-L', M-M', N-N'	K-K', L-L', M-M'	F-F’, G-G’
Underlying confining interval ID	BFH 2 Shale	BFH 2 Shale	BFH 1 Shale	BFH 2 Shale (east) BFH 1 Shale (west)	BFH 2 Shale (east) BFH 1 Shale (west)	BFH 1 Shale	BFH 2 Shale (east) BFH 1 Shale (west)	BFH 1 Shale	BFH 2 Shale
Underlying confining interval thickness (approximate, feet)	80	10-30	10-70+	5-15 (BFH 2) 40 (BFH 1)	10 (BFH 2) 30-35+ (BFH 1)	30-35	12-13 (BFH 2) 32-35 (BFH 1)	40-50	15-40
Underlying sand interval ID	BFS 2	BFS 2	BFS 1	BFS 2 (east) BFS 1 (west)	BFS 2 (east) BFS 1 (west)	BFS 1	BFS 2 (east) BFS 1 (west)	BFS 1	BFS 2
Underlying sand interval thickness (approximate, feet)	10-15	10-25	20	20-30 (BFS 2) 45 (BFS 1)	25 (BFS 2) 20 (BFS 1)	15-45	15-18 (BFS 2) 15-44 (BFS 1)	12-18	25-30
Number of drill holes that penetrate to DM[1] within PM ring[2] on each cross section	A-A’: 2 of 4 (50%) P-P’: 1 of 14[3] (7%)	A-A’: 2 of 6 (33%) B-B’: 3 of 6 (50%) C-C: 8 of 8 (100%) O-O’: 1 of 4 (33%)	C-C’: 2 of 4 (50%) D-D’: 2 of 11 (9%) E-E’: 0 of 4 (0%) L-L’: 0 of 7 (0%) M-M’: 0 of 1 (0%)	E-E’: 3 of 4 (75%) F-F’: 7 of 15 (47%) L-L’: 1 of 5 (20%) M-M’: 0 of 0 N-N’: 3 of 3 (100%)	G-G’: 3 of 8 (38%) H-H’: 2 of 2 (100%) L-L’: 1 of 10 (10%) M-M’: 1 of 2 (50%) N-N’: 3 of 3 (100%)	H-H’: 1 of 5 (20%) L-L’: 0 of 5 (0%) M-M’: 2 of 5 (40%)	I-I’: 3 of 7 (43%) J-J’: 0 of 3 (0%) L-L’: 1 of 9 (11%) M-M’: 0 of 2 (0%) N-N’: 2 of 2 (100%)	K-K’: 0 of 4 (0%) L-L’: 1 of 5 (20%) M-M’: 0 of 1 (0%)	F-F’: 0 of 1 (0%) G-G’: 1 of 1 (100%)
Approximate wellfield pattern area (acres)	30	74	122	143	169	110	132	118	186
Minimum number of DM penetrations in future wellfield data package(s)	8	19	31	36	42	28	33	30	47

[1] Values for cross sections that intersect multiple proposed mine units are specific to each KEA mine unit.
[2] DM penetrations for listed cross sections include duplicate drill holes where cross sections intersect.
[3] The DM interval appears to be largely absent from the northern portion of proposed Mine Unit A; geophysical logs in this area penetrated up to 100 feet below the bottom of the ore zone without intercepting any notable sand intervals.
[4] Mine Unit 3 Ext overlaps into the southern portion of the current Ross license area; values shown are for the KEA portion only.



ROSS ISR PROJECT
CROOK COUNTY, WY
LICENSE NO. SUA-1601
P.O. BOX 2318, 1900 W WARLOW UNIT A
GILLETTE, WY 82717
STRATA ENERGY INC
KENDRICK EXPANSION AREA
TR RAI RESPONSE
FIGURE TR RAI 2.6-1-1
PERIMETER MONITOR WELL RINGS, DM TRANSITION LINE, LOCATIONS OF GEOLOGIC CROSS SECTIONS AND ISOPACH OF CONFINING LAYER BELOW ORE ZONE
REVISIONS
Date | Description
10/16 | Update DM transition and isopach contours
Drawn By: MBM
Checked By: WCF
Date: 02-15
FILE: KPA1_OZ_DM_CONFINE_ISOPACH
WWC ENGINEERING
www.wwcengineering.com
K:\Sheridan\Strata\12145_ACAD_WY83E\DWGS_RAI_NRC_COMMENTS\KPA1_OZ_DM_CONFINE_ISOPACH.dwg 11/3/2016 3:31:05 PM mal mcgill
Drawing Coordinates: WY83EF
0 1,500 3,000 4,500 6,000
GRAPHIC SCALE (FEET)
LEGEND
ROSS LICENSE NO. SUA-1601 BOUNDARY
KENDRICK EXPANSION AREA BOUNDARY
APPROXIMATE PERIMETER MONITOR WELL RING
ISOPACH CONTOUR BFH 1 DASHED WHERE INFERRED 10' CONTOUR INTERVAL
ISOPACH CONTOUR BFH 2 DASHED WHERE INFERRED 10' CONTOUR INTERVAL
INFERRED DM TRANSITION FROM BFS 2 TO THE EAST TO BFS 1 TO THE WEST (BFH 2 CONFINING LAYER PINCH OUT)
CROSS SECTION LOCATION AND ID
DRILLHOLE AND THICKNESS OF CONFINING LAYER
MONITOR WELL CLUSTER
PROJECTED OUTCROP/SUBCROP OF CONFINING UNIT BELOW ORE ZONE
THICKNESS OF CONFINING UNIT BELOW ORE ZONE UNDETERMINED DUE TO STEEPLY DIPPING BEDS
PROPOSED MINE UNIT BOUNDARY
PROPOSED MINE UNIT ID
NOTES:
1. SEE FIGURE 3.3-4 FOR BEDROCK GEOLOGY MAP UNITS. BEDROCK GEOLOGY MAPPING ADAPTED FROM SUTHERLAND (2008).
2. SURFACES SHOWN DERIVED FROM GEOLOGIC CROSS SECTIONS AND ROCKWORKS© SOFTWARE.
CONFINING UNIT
SM
CONFINING UNIT
OZ
CONFINING UNIT
DM
ISOPACH DEPICTED THIS SHEET
R. 68 W. R. 67 W.
T. 54 N.
T. 53 N.
T. 52 N.
E. 700000
E. 710000
N. 1500000
N. 1490000
N. 1480000
N. 1470000
N. 1460000
Mine Unit 3 EXT

Section 2.7

RAI 2.7-1

Description of Deficiency

The area encompassing the wellfields depicted for the Ross area on Kendrick TR Addendum 2.7-I Figure 17 differs from that depicted on Ross TR Figure 3.1-1, and Section 7.3.6 of the Kendrick TR discusses four mine units at the Ross area whereas the Ross application describes only two mine units.

Basis for Request

Acceptance criterion 5.2.3(6) of the SRP states that "[t]he licensee has agreed to administer a cultural resources inventory before engaging in any development activity not previously assessed by NRC." Acceptance criterion 5.2.3(8)(d)(iii) of the SRP states that "[r]ecords containing information important to decommissioning and reclamation, including …. [a]s-built drawings … [of] wellfields … an any modifications … through time." If the area of impacts changed from the Ross application, describe why an amendment request is not required because the impacts assess for the Ross site were based on the earlier figure.

Request for Additional Information

Please explain the changes from the Ross application and the method of how those changes are to be incorporated into the approved license application.

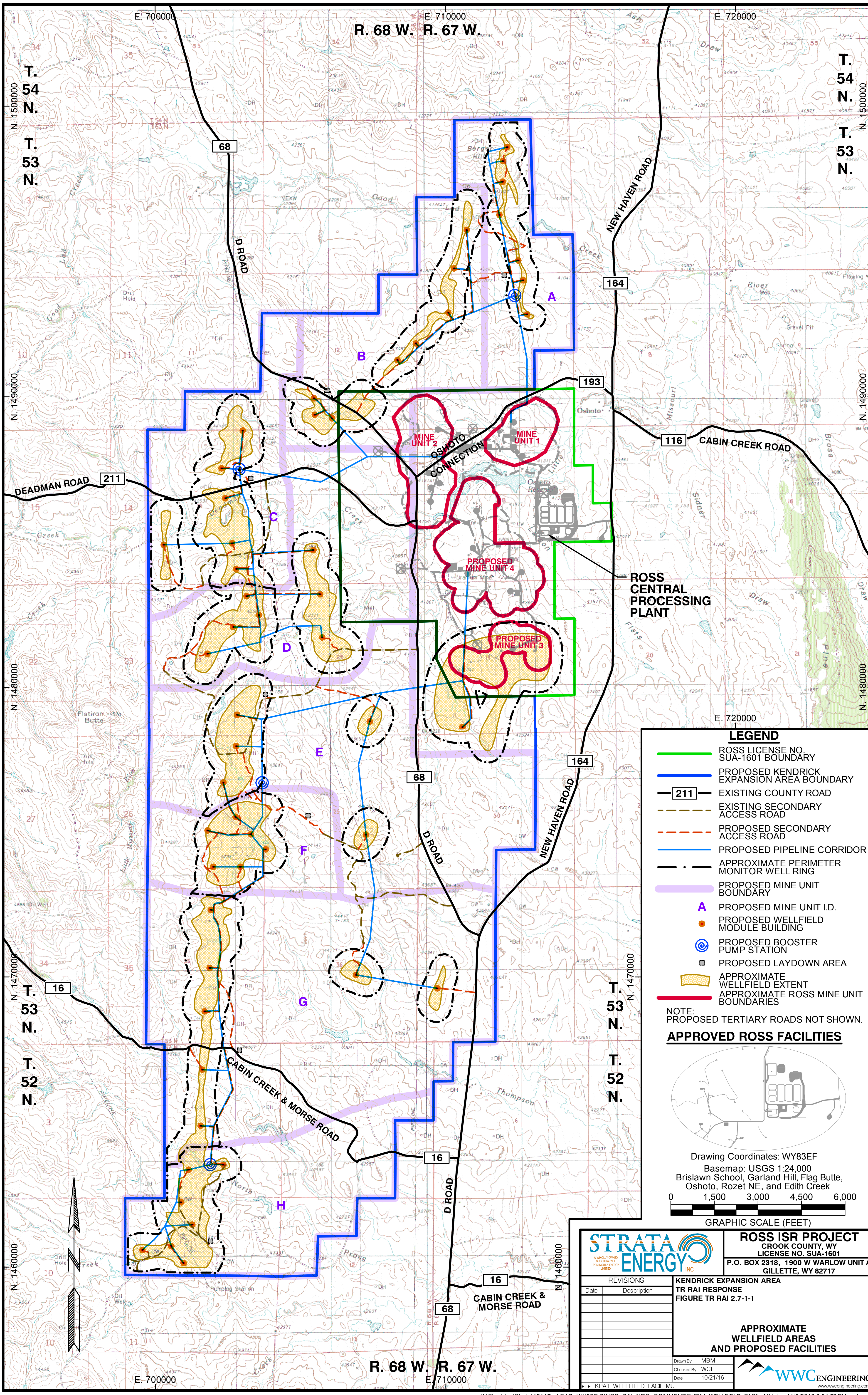
TR RAI 2.7-1 Response

Section 3.0 of the approved Ross TR discussed two potential mine unit development areas, which were depicted on Ross TR Figure 3.1-1. The wellfield area north of the Little Missouri River was designated Mine Unit 1, and that south of the river was designated Mine Unit 2. Ross TR Section 3.0 estimated that 15 to 25 modules were expected, while noting that ongoing delineation and development drilling were "expected to increase the total size of the wellfields and number of modules."

Development of wellfields within the current Ross license area is now expected to be divided into four mine units occupying approximately the same total area as the original two mine units. Based on further delineation and development drilling since submittal of the approved Ross application, Strata has determined that the original mine units were too large to be reasonably developed as only two units. Therefore, the originally designated Mine Unit 1 was split to form Mine Units 1 and 2, as depicted in the respective wellfield data packages developed pursuant to SUA-1601 LC 10.13 (ML15209A703 and ML16243A163).

Strata similarly plans to divide the originally designated Mine Unit 2 (south of the Little Missouri River) into Mine Units 3 and 4. Importantly, dividing the original two mine units into four existing or proposed mine units will not increase the overall wellfield area; the currently designated Mine Units 1 through 4 are located within the wellfield area shown on Ross TR Figure 3.1-1. Figure TR RAI 2.7-1-1 depicts the existing and planned Ross and KEA mine units. Following approval of these RAI responses by NRC

staff, Strata will provide an updated KEA TR Figure 3.1-1 that depicts the existing and planned Ross mine units in relation to the planned KEA mine units.



R. 68 W. R. 67 W.
T. 54 N.
T. 53 N.
T. 52 N.
E. 700000
E. 710000
E. 720000
N. 1500000
N. 1490000
N. 1480000
N. 1470000
N. 1460000
NEW HAVEN ROAD
D ROAD
DEADMAN ROAD
CABIN CREEK ROAD
CABIN CREEK & MORSE ROAD
OSHOTO CONNECTION
MINE UNIT 1
MINE UNIT 2
PROPOSED MINE UNIT 3
PROPOSED MINE UNIT 4
ROSS CENTRAL PROCESSING PLANT
A
B
C
D
E
F
G
H
LEGEND
ROSS LICENSE NO. SUA-1601 BOUNDARY
PROPOSED KENDRICK EXPANSION AREA BOUNDARY
EXISTING COUNTY ROAD
EXISTING SECONDARY ACCESS ROAD
PROPOSED SECONDARY ACCESS ROAD
PROPOSED PIPELINE CORRIDOR
APPROXIMATE PERIMETER MONITOR WELL RING
PROPOSED MINE UNIT BOUNDARY
PROPOSED MINE UNIT I.D.
PROPOSED WELLFIELD MODULE BUILDING
PROPOSED BOOSTER PUMP STATION
PROPOSED LAYDOWN AREA
APPROXIMATE WELLFIELD EXTENT
APPROXIMATE ROSS MINE UNIT BOUNDARIES
NOTE: PROPOSED TERTIARY ROADS NOT SHOWN.
APPROVED ROSS FACILITIES
Drawing Coordinates: WY83EF
Basemap: USGS 1:24,000 Brislawn School, Garland Hill, Flag Butte, Oshoto, Rozet NE, and Edith Creek
0 1,500 3,000 4,500 6,000
GRAPHIC SCALE (FEET)
STRATA ENERGY INC
ROSS ISR PROJECT
CROOK COUNTY, WY
LICENSE NO. SUA-1601
P.O. BOX 2318, 1900 W WARLOW UNIT A
GILLETTE, WY 82717
REVISIONS
Date Description
KENDRICK EXPANSION AREA
TR RAI RESPONSE
FIGURE TR RAI 2.7-1-1
APPROXIMATE WELLFIELD AREAS AND PROPOSED FACILITIES
Drawn By: MBM
Checked By: WCF
Date: 10/21/16
FILE: KPA1_WELLFIELD_FACIL_MU
WWC ENGINEERING
K:\Sheridan\Strata\12145_ACAD_WY83E\DWGS_RAI_NRC_COMMENTS\KPA1_WELLFIELD_FACIL_MU.dwg 11/3/2016 3:04:59 PM mal mcgill

RAI 2.7-2

<u>*Description of Deficiency*</u>

Strata is proposing to reduce or eliminate the sampling requirement for the DM unit as the underlying aquifer and proposes its criteria for the propose sampling plan. In some cases, the proposed criteria are not consistent with established criteria (e.g., minimum well yield of 5 gpm). In addition, Strata is proposing two different units for the DM aquifer. The information as presented in the application needs clarification.

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Request for Additional Information

Please clarify the following aspects of the DM unit:

(1) *On Table 2.7-21, Strata provides the nomenclature used in this request for the stratigraphy underlying the ore zone aquifer. From youngest to oldest, the stratigraphic units are defined as BFH2, BFS 2, BFH 1 and BFS 1. On Addendum 2.6-B Figure 1 "Structure Contour of Top of Deep Monitoring Surface", Strata depicts a line in which is described as the BFH 2 confining layer pinch out. Thus, east of that line (which includes the Ross area), the DM unit is defined as the BFS 2 unit and, west of the line, the DM unit is defined as the BFS 1 unit.*

    a) *The line bifurcates Mine Unit D and a portion of Mine Unit B. Assuming that the DM unit is to be monitored for those mine units, how is the DM unit to be defined especially if, as stated, on page 2-164 that the BFS 2 unit coalesces with the upper Fox Hills Sandstone (ore zone)?*

TR RAI 2.7-2(1)(a) Response

Section 3.1.6 of the KEA TR discusses Strata's approach to defining and assessing the underlying interval in each mine unit prior to operations. To summarize, if the thickness of the BFH 1 or BFH 2 aquitard exceeds 50 feet, then no monitoring would be necessary. As discussed with NRC staff, this would also apply where the combined thickness of the two confining intervals, if both present, exceeds 50 feet. If the thickness were less than 50 feet, Strata would drill delineation holes at a density of not less than one per 4 acres to assess the potential water-bearing interval for thickness and lithology based on geophysical logs and drill cuttings. If the thickness of the potential water-bearing interval is greater than 15 feet and the lithology is sufficiently permeable that it may produce water, a well would be installed to ascertain estimated yield and determine whether representative samples can be collected from the well in a timely manner. Should the well demonstrate low yield or an inability to provide sufficient water to remove residual cement and fine materials, as determined through field water quality measurements, a short-duration, single well aquifer test would be conducted to confirm hydraulic parameters and expected yield. One of the most critical criteria to be used in evaluating the single-well aquifer tests would be the duration of time to achieve 90% recovery of the water level consistent with Criterion #5 in Section 3.1.6 of the KEA TR. If a DM well demonstrates sufficient water-bearing interval thickness, sufficient yield to provide representative samples, and recovers in a reasonable time following a stress period, then the well would be included in the excursion monitoring program as a point of compliance. The wellfield data packages submitted for proposed Mine Units B and D would include the definition of the DM interval (including thickness and stratigraphic horizon), based on geophysical logs and drill cuttings, and the results of all tests used to estimate yield, aquifer parameters and water quality representativeness.

Figure TR RAI 2.6-1-1, provided in response to TR RAI 2.6-1, depicts the geologic cross section locations, approximate wellfield extents, and approximate perimeter monitor well rings along with the DM transition line. As shown on the revised cross sections provided in Appendix A and Figure TR RAI 2.6-1-1, the DM transition line was incorrectly mapped in the vicinity of Mine Unit B and actually lies west of the proposed perimeter monitor well ring for Mine Unit B. If it is assumed that the DM unit would be monitored in Mine Unit B, as stated in the RAI, monitoring would occur within the

BFS 2 interval. Within proposed Mine Unit B, the thickness of the BFH 2 confining interval is anticipated to range from less than 10 feet to more than 20 feet, such that the DM interval would be hydrologically isolated from the ore zone aquifer.

Within the eastern portion of proposed Mine Unit D, the BFH 2 confining interval may pinch out. In the limited area along the DM transition line, there is little or no hydrologic separation between the BFS 2 sand and the ore zone sands. This is shown in revised cross sections E-E' and F-F' as provided in Appendix A. If it assumed that the DM unit would be monitored in Mine Unit D within the BFS 1 sand. This would ensure hydrologic separation between the ore zone and underlying monitoring interval.

RAI 2.7-2

<u>*Description of Deficiency*</u>

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b) *The argument is made that in the Ross area, the BFS 2 unit is the first sand unit underlying the ore zone and thus should be that monitored as the underlying aquifer. Then the argument is made that the BFS 2 unit does not meet the definition of an aquifer and should not be monitored. If the BFS 2 unit coalesces with the Ore Zone west of the BFH 2 confining unit pinch out, why was not the BFS 2 unit considered part of the ore zone east of the pinch out and thus the BFS 1 unit would be the first underlying sand unit?*

TR RAI 2.7-2(1)(b) Response

The previous response describes how the BFS 1 unit would be considered the first underlying sand unit in areas proximal to and west of the DM transition zone, where the BFH 2 confining layer pinches out. This reflects the updated site conceptual geologic model presented in Section 2.6 of the KEA TR. Ross TR Section 2.6.4 discusses the exploration history of the project into 2010. The Ross license application reflects the level of understanding at that time based on exploration and delineation drilling conducted by Strata and its predecessor, Nubeth. The majority of the drilling through 2010 occurred within the current Ross license area and, to a lesser extent, portions of the KEA to the north and south. Mineralized trends within the KEA that were known at the time of the Ross license application only included portions of currently proposed Mine Units A and B, with virtually no drilling or geologic interpretation of the remaining six proposed mine units. Within the current Ross license area and proposed Mine Unit A, the BFS 2 interval is consistently isolated from the overlying uranium host sands of the Fox Hills and Lance Formation and was considered to be the first underlying water-bearing interval. Exploration drilling conducted by Nubeth and Strata targeted the uranium host intervals and infrequently penetrated to either the BFS 2 or BFS 1 intervals (see the response to TR RAI 2.6-1). The primary purpose of historical drilling was to delineate sufficient resources to support the project, such that characterization of non-uranium-bearing intervals below the ore zone was a much lower priority. To summarize, at the time that the Ross license application was developed, Strata's understanding of the stratigraphy outside of the then proposed license area and below the uranium mineralization was insufficient to accurately characterize the underlying stratigraphy.

With the data provided in the KEA TR and as supplemented in this RAI response package, the composite thickness of the BFH 2, BFS 2, and BFH 1 intervals exceeds industry standard of 50 feet of confining material below a uranium production zone. Therefore, should Strata demonstrate in future wellfield data packages that the BFS 2

interval is clearly not an aquifer, a similar definition would not be necessary for the BFS 1 interval.

RAI 2.7-2

Description of Deficiency

Strata is proposing to reduce or eliminate the sampling requirement for the DM unit as the underlying aquifer and proposes its criteria for the propose sampling plan. In some cases, the proposed criteria are not consistent with established criteria (e.g., minimum well yield of 5 gpm). In addition, Strata is proposing two different units for the DM aquifer. The information as presented in the application needs clarification.

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Request for Additional Information

Please clarify the following aspects of the DM unit:

(2) *On pages 2-223 through 2-224, Strata uses arguments from the Ross Safety Evaluation Report supplemented with additional information to support the contention that DM unit is not an aquifer in portions of the Ross and Kendrick areas. On page 3-11 to 3-12, Strata proposes criteria to be used in determining whether or not the DM unit is to be monitoring at a specific mine unit.*

   a) *Currently, Strata has a similar yet separate amendment request for monitoring of the DM unit specific to the Ross area. Please clarify whether or not the proposed criteria are to be applied to the Kendrick area or to both Kendrick and Ross areas.*

TR RAI 2.7-2(2)(a) Response

KEA TR Table 1.1-1 requested amendment of LC 11.3(C) to accommodate a lower density of underlying wells. It was intended that this would apply to both the Ross and KEA areas. Strata acknowledges that the separate amendment request submitted to NRC staff on July 16, 2015 (ML15205A337) contains additional language regarding characterization of the DM interval. Since that amendment request was submitted later, following the collection of mine unit-specific hydrologic information regarding the underlying interval, the proposed criteria in that amendment request are the preferred language should NRC staff amend SUA-1601. Strata proposes to update KEA TR Section 3.1.6 such that the criteria to determine whether the DM unit is an aquifer within each monitor well or mine unit are consistent with those in the July 16, 2015 license amendment request. This may include additional emphasis on the recovery criteria following a stress as discussed in Criterion #5 (page 3-12) of the KEA TR.

RAI 2.7-2

Description of Deficiency

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b) *Please specify how the resolution of these proposed criteria should staff not approve them (i.e., should the Kendrick amendment request be denied in its entirety or will the pages be stricken from the application).*

TR RAI 2.7-2(2)(b) Response

In the event that NRC staff does not approve the July 16, 2015 license amendment request, Strata will revise Section 3.1.6 of the KEA TR for consistency with the approved Ross license application.

RAI 2.7-2

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a) *Well construction diagrams were not included in the application. Please verify that the drill hole below the screened horizon was properly backfilled.*

TR RAI 2.7-2(3)(a) Response

As described in Section 2.7.3.1.2 of the KEA TR, the KEA regional baseline monitor wells were installed using conventional mud rotary methods. These included: pilot, log, ream, top set casing, underream completion, and screen. They are consistent with the methods described in Section 3.1.2.1 and depicted in Figure 3.1-5 of the Ross TR. The initial pilot hole depth was determined based on depths of nearby historical drill holes. The deepest well at each monitor well cluster was installed first and used to establish the local hydrogeology based on geophysical log signatures. Penetrations beyond the bottom of the water-bearing interval for each successive well were therefore minimized, and, in no case, did they penetrate through a lower confining interval into an underlying water-bearing interval. Therefore, the minimal drill hole below the screened horizon was simply backfilled with the cuttings generated during the underream process, as depicted on Figure 3.1-5 of the approved Ross TR. Figures 2.7-15 through 2.7-26 of the KEA TR depict the geophysical logs of the DM monitor wells installed in the KEA. The amount of drill hole below the DM completions was typically less than 20 feet with no suggestions via resistivity curves that other water-bearing intervals below the monitored interval were intercepted.

RAI 2.7-2

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b) *Please verify that "(ft-bmp)" in the header for the third column in Table 2.7-23 means feet below the measuring point.*

TR RAI 2.7-2(3)(b) Response

NRC staff are correct; "ft-bmp" means "feet below the measuring point."

RAI 2.7-2

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Request for Additional Information

Please clarify the following aspects of the DM unit:

(3) On Page 2-213, Strata states that due to the poor yields and slow rate of recovery, the hydraulic conductivity of the [BSF 2 unit] is lower than the ore zone. Strata refers to hydrographs in Addendum 2.7-H for support but the hydrographs are comprised of only four data points typically over a one-year period which is not useful to demonstrate low yields and slow rate of recovery. On Table 2.7-22, Strata presents the Kendrick monitoring wells construction summary. On Table 2.7-23, Strata presents information on water levels, estimated yields and volumes purged during development of the DM wells. On Table 2.7-39, Strata presents field-measured conductivity, pH and turbidity which reportedly is at the conclusion of DM well development. On page 2-232, Strata states that the water quality of the DM interval is similar in gross salinity concentration as that measured at the Ross DM wells.

c) The first data point on the DM wells hydrographs correlates with the date and the static water level as reported during well development on Table 2.7-23. Please provide rationale as to why that static water level, presumably prior to development and immediately after well construction, is representative of the aquifer conditions.

TR RAI 2.7-2(3)(c) Response

Section 2.7.3.2.5.1 of the KEA TR discusses the water level measurements recorded from the DM wells, which are depicted on the hydrographs in Addendum 2.7-H of the KEA TR. To summarize, the DM wells generally showed a small increase in water elevation of 2 to 4 feet over the approximate 1-year monitoring period, with the slow increase attributed to poor hydraulic characteristics of the interval and prolonged recovery from well installation and development. The small magnitude of change over the monitoring period supports the conclusion that the first measurements in each well were representative of DM interval conditions.

Section 2.7.3.1.2 of the KEA TR discusses the modified development program used on the DM wells. Because the initial air-lift development by the drilling rig was insufficient to remove residual well construction materials, additional work was undertaken on most of the DM wells with extraordinary effort on six wells. The additional work included at least one air-lift session with a portable compressor. This additional air-lift session typically followed the initial air-lifting conducted by the drilling rig by several days to several weeks. Table 2.7-22 in the KEA TR provides the completion date range from initial piloting and air-lift by drilling rig to the 1st additional air-lift session using a portable compressor. The dates of the static water level measurements in Table 2.7-23 are provided in Addendum 2.7-H and correlate to the date of the 1st additional air-lift session, when a water level was measured prior to re-entering the well for this portion of the well development. Therefore, the water level elevations reflect at least one development by drilling rig using air-lift methods followed by several days to several weeks for recovery prior to the 1st additional air-lift session using a portable compressor. Based on the small magnitude of change in the hydrographs and the clarification provided by this RAI response, the initial static water levels are considered representative of the DM interval conditions.

RAI 2.7-2

<u>*Description of Deficiency*</u>

Strata is proposing to reduce or eliminate the sampling requirement for the DM unit as the underlying aquifer and proposes its criteria for the propose sampling plan. In some cases, the proposed criteria are not consistent with established criteria (e.g., minimum well yield of 5 gpm). In addition, Strata is proposing two different units for the DM aquifer. The information as presented in the application needs clarification.

<u>*Basis for Request*</u>

In the introductory paragraph of Section 2.7.2, the SRP states that "… the reviewer should evaluate whether Strata has developed an acceptable conceptual model of the site hydrology and whether the conceptual model is adequately supported by the data presented in the site characterization." Review Procedure 2.7.2(3) states that "[t]he applicant's interpretation of ground-water hydraulic gradients (used to infer flow direction), horizontal hydraulic conductivity, and the thickness, areal extent, and vertical hydraulic conductivity of confining formations should be evaluated."

In the introductory paragraph of Section 2.7.3, the SRP states that a "… conceptual model provides a framework for Strata to make decisions on the optimal methods for extracting uranium from the mineralized zones, and to minimize environmental and safety concerns caused by in situ leach operations. Hydrologic characterizations that accomplish this objective are considered acceptable." Review Procedure 2.7.3(3) states that "[t]he applicant should describe all hydraulic parameters used to determine expected operational and restoration performance. Aquifer and aquitard hydraulic properties may be determined using aquifer pumping tests for parameters such as hydraulic conductivity, transmissivity, and specific storage. Any of a number of commonly used aquifer pumping tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells. The methods or standards used to analyze pumping test data should be described and referenced: acceptable methods of analysis include use of curve fitting techniques for drawdown or recovery curves that are referenced to peer-reviewed journal publications, texts, or American Society for Testing and Materials Standards."

Acceptance Criterion 5.7.8.3(3) states that "[i]t may be appropriate to exclude the requirement to monitor water quality in the underlying aquifer if (i) the underlying aquifer is a poor producer of water, (ii) the underlying aquifer is of poor water quality, (iii) there is a large aquitard between the production zone and the underlying aquifer and few boreholes have penetrated the aquitard, or (iv) deep monitor wells would significantly increase the risk of a vertical excursion into the underlying aquifer." Acceptance Criterion 5.7.8.3(4) states that "[t]he applicant establishes well field test procedures. Once a well field is installed, it should be tested to establish that the production and injection wells are hydraulically connected to the perimeter horizontal excursion monitor wells and are hydraulically isolated from the vertical excursion monitor wells. Such testing will serve to confirm the performance of the monitoring system and will verify the validity of the site conceptual model reviewed in Section 2 of this standard review plan. The reviewer should verify that well field test approaches have sound technical bases."

Request for Additional Information

Please clarify the following aspects of the DM unit:

(3) *On Page 2-213, Strata states that due to the poor yields and slow rate of recovery, the hydraulic conductivity of the [BSF 2 unit] is lower than the ore zone. Strata refers to hydrographs in Addendum 2.7-H for support but the hydrographs are comprised of only four data points typically over a one-year period which is not useful to demonstrate low yields and slow rate of recovery. On Table 2.7-22, Strata presents the Kendrick monitoring wells construction summary. On Table 2.7-23, Strata presents information on water levels, estimated yields and volumes purged during development of the DM wells. On Table 2.7-39, Strata presents field-measured conductivity, pH and turbidity which reportedly is at the conclusion of DM well development. On page 2-232, Strata states that the water quality of the DM interval is similar in gross salinity concentration as that measured at the Ross DM wells.*

   d) *The yield estimated from the development of several DM wells greatly exceeded that for the DM wells at the Ross area (based on the hydrographs during sampling) suggesting that the BFS 1 unit differs, at least hydraulically, from the BFS 2 unit. Therefore, in the event that monitoring is required, pre-operational sampling would be required for the BFS 1 prior to any major site construction. Please verify whether or not that sampling has been performed.*

TR RAI 2.7-2(3)(d) Response

Additional monitoring of the DM wells completed in the BFS 1 unit has not been performed. Guidance in the SRP (Section 2.7.3, Acceptance Criterion 4) suggests that the reviewer confirm that "[r]easonably comprehensive chemical and radiochemical analyses of water samples, obtained within and at locations away from the mineralized zone(s), have been made to determine pre-operational baseline conditions. Baseline water quality should be determined for the **mineralized and surrounding aquifers**" [emphasis added]. Figure TR RAI 2.6-1-1, provided with the response to TR RAI 2.6-1, depicts the locations of the 12 regional baseline monitor well clusters in relation to the DM transition zone. Seven clusters are located west of the DM transition, and six of these include a DM well completed in the BFS 1 interval. These include wells 5368-33-14DM, 5368-32-23DM, 5368-31-35DM, 5368-12-25DM, 5268-21-11DM, and 5268-12-01DM. Well 5368-41-23DM was incorrectly completed in the BFS 2 interval as at the time of the regional baseline well installation program, the BFS 2 interval was thought to be isolated from the ore zone across the KEA. Table TR RAI 2.7-1-2 summarizes the development efforts of the DM monitor wells within the KEA. Table TR RAI 2.7-2-1 is a modified version of KEA TR Table 2.7-23 that includes the specific completion interval. Wells completed in the BFS 1 interval yielded between 0.5 and 1.0 gpm, averaging 0.71 gpm. This is well below the average of all 12 wells calculated at 1.23 gpm. These six wells were developed for up to 22 hours without an observed increase in the well yields. The six remaining DM wells, completed in the BFS 2 interval, yielded from 0.25 to 5.0 gpm, with an average of 1.75 gpm. Both the average and median yield of the wells completed in the BFS 2 interval exceed those in the BFS 1 interval. Therefore, there is no indication that the BFS 1 interval may yield a usable quantity of water at locations where the BFS 2 interval has been designated as the underlying

water-bearing interval. This response and Table TR RAI 2.7-2-1 provide additional evidence that neither the BFS 1 nor BFS 2 are aquifers and that further water quality monitoring is neither suggested by guidance nor required by regulation.

No revisions to the license amendment application are proposed in response to this RAI.

Table TR RAI 2.7-2-1. Development Summary of DM Regional Baseline Monitor Wells within the Proposed KEA, Including Completion Interval

Well	Completion Interval	Packer Depth (ft-bgs)	Static Water Level (ft-bmp)	Yield (gpm)	Total Development Time (hrs)	Total Development Volume (gal)[1]
5367-34-06DM	BFS 2	490	87.5	0.25	6.0	90
5368-43-12DM	BFS 2	728	254.3	0.5	8.5	255
5368-33-14DM	BFS 1	869	227.4	0.5	7.5	225
5368-41-23DM[2]	BFS 2	893	305.9	5	11.0	3,300
5368-24-12DM	BFS 2	854	316	2.5	22.5	3,375
5368-43-24DM	BFS 2	671	233	2	17.0	2,040
5368-32-23DM	BFS 1	1,045	371.5	0.75	22.0	990
5368-41-36DM	BFS 2	919	411	0.25	7.0	105
5368-31-35DM	BFS 1	1,135	448	0.5	4.5	135
5368-12-25DM	BFS 1	1,039	390	1	17.0	1,020
5268-21-11DM	BFS 1	1,131	401	1	17.0	1,020
5268-12-01DM	BFS 1	1,008	329	0.5	19.5	585

[1] Based on periodic measurements of instantaneous yield and total development time.
[2] Well completed incorrectly in the BFS 2 interval.

RAI 2.7-3

Description of Deficiency

In the model report, Strata uses yields for livestock water supply wells of less than 0.8 gallons per minute (gpm) and ignores most livestock water supply wells in the overlying aquifer (SM aquifer). However, on page 2-225 of the Kendrick application, Strata argues that a minimum yield of 5 gpm is needed for a rancher with an average size herd relying on a single well. The difference in yields may affect the model predictions.

Basis for Request

In the introductory paragraph of Section 2.7.1, the SRP states that "[c]haracterization of the hydrology at in situ leach uranium extraction facilities must be sufficient to establish potential effects of in situ leach operations on the adjacent surface-water and ground-water resources and the potential effects of surface-water flooding on the in situ leach facility."

Review Procedure 2.7.2(3) states that a reviewer should "[e]Evaluate the site hydrogeologic conceptual model for ground-water flow in potentially affected aquifers. Review available data from well logs and hydrologic tests and measurements to obtain confidence that sufficient data have been collected and that the data support Strata's hydrologic conceptual model for ground- water flow within and around the permit boundary." Acceptance Criterion 2.7.3(3) states that "[t]he applicant should describe all hydraulic parameters used to determine expected operational and restoration performance."

Request for Additional Information

Please provide rationale for the pumping rates of up to 0.8 gpm for livestock wells in the numerical flow model

TR RAI 2.7-3 Response

This RAI response provides justification for the estimated flow rates of 0.4 to 0.8 gpm for domestic and stock watering wells in the KEA groundwater model. As discussed in detail in the response to TR RAI 2.7-5, the SM wells were not ignored. Strata only included the stock and domestic wells potentially completed in the OZ interval in the groundwater model because no stock or domestic wells completed in the SM interval were identified within the KEA. All of the stock and domestic wells evaluated in the KEA were completed in aquifers shallower than the SM interval. As discussed in Appendix A of KEA TR Addendum 2.7-I, the estimated flow rates for the stock and domestic wells within the model domain were based on average annual usage rates, which were converted to average continuous flow rates. The actual pumping rate (instantaneous usage rate) at each of the wells is higher. The 5 gpm minimum pumping rate referenced on page 2-225 of the KEA TR is an instantaneous usage rate. When the wells are in operation, the typical pumping rates range from 5 to 20 gpm per well; however, based on discussions with local ranchers, the stock wells are only used seasonally and domestic wells intermittently. By simulating the average annual flow rates, the model accounts for the net water withdrawals from the aquifer without the complication of modeling seasonal or intermittent withdrawals. The stock wells within the KEA are only

used for a portion of the year when cattle are present and/or when insufficient surface water is available. For example, a typical stock well may be used for one or two months in the summer without being used the rest of the year. Similarly, domestic wells are typically connected to pneumatic pressure tanks and only operate intermittently to satisfy domestic demands. Since the stock and domestic wells are not pumped continuously throughout the year, a higher modeled continuous flow rate of 5 to 20 gpm would overestimate the net withdrawal from the aquifer.

The estimated flow rates of stock and domestic wells in the KEA groundwater model were based on those used in the Ross groundwater model to maintain consistency. As described in Appendix A of Addendum 2.7-H of the approved Ross TR, the flow rates used in the model simulations for the stock and domestic wells were calculated from typical usage rates. Of the four stock and domestic wells in the KEA groundwater model, three are permitted for both domestic and stock water use (the Strong Wells, Wesley #1, and Reynolds #6) and the other well (AR-1) is permitted for stock water use only. The Strong Wells, Reynolds #6 and AR-1 were assigned a flow rate of 0.4 gpm while Wesley #1 was assigned a flow rate of 0.8 gpm. The typical domestic water usage rate for an average family of four is approximately 400 gallons per day (gpd) (EPA 2016). A withdrawal of 400 gpd is equivalent to a continuous flow rate of 0.28 gpm. Therefore, the modeled annualized flow rate for the domestic and stock wells of 0.4 to 0.8 gpm allows for both domestic as well as some stock water use which is reasonable considering that the domestic wells are primarily used to supply water for household use. Wesley #1 was assigned a higher flow rate because it supplies water to a residence as well as to a set of corrals. To account for the possibility for a higher water usage from the combined use at the residence and corrals, the projected flow rate was increased to 0.8 gpm at Wesley #1. A flow rate of 0.4 gpm equates to 210,240 gallons per year. At 20 gallons per day per cow/calf pair (as specified on page 2-225 of the KEA TR), 210,240 gallons per year would provide 10,512 animal-days of water per year. Based on Strata's understanding of current cattle operations in the vicinity, this is a reasonable approximation of the amount of water that would conceivably be used for livestock water within the KEA, and is a reasonable approximation of the water that may be used at AR-1. Review of the statements of completion (SEO Form UW-6) for the stock and domestic wells completed in the OZ interval (the Strong Wells, Wesley #1, Enlargement of the Reynolds #6, and AR-1, as listed in Appendix A of KEA TR Addendum 2.7-I) shows that the maximum allotted flow rates per year for each well are similar to the modeled withdrawals of 0.4 to 0.8 gpm (WSEO 2016).

No revisions to the license amendment application are proposed in response to this RAI.

RAI 2.7-4

<u>Description of Deficiency</u>

For the Kendrick amendment, Strata conducted a total of three single-well pumping tests in the ore zone aquifer at three different well-clusters. The pumping rates and durations for the pumping tests were similar to those conducted at the Ross area. No responses to the pumping were detected at wells screened in the overlying and underlying aquifers which Strata interpreted as indicating that the ore zone was confined consistent with results of the earlier pumping tests conducted in the Ross area. Further, Strata states that the laboratory core data for shale samples indicate extremely low permeabilities thus indicating the upper and lower confining units can serve as aquitards for ISR operations.

As noted by Strata, single-well tests are specifically listed in acceptance criterion (3) of Section 2.7.3 of NUREG-1569 for determining aquifer properties. However, single-well pumping tests as performed by Strata generally do not yield sufficient data to estimate aquifer properties of the confining units. The problem is exacerbated because the pumping wells for the tests at the Kendrick area were only partially penetrating. As a result the separation between the pumping well and the underlying DM well was over 95 feet. The only DM wells that exhibited a response to the pumping tests conducted at the Ross area were separated by less than 45 feet.

The underlying confining unit for the Kendrick area is the BFH 1 which is new. On the geologic cross sections, the geophysical signature on the majority of borings for the underlying confining unit appears to be consistent with shale lithologies. However, many boring logs for wells which will incorporate the BFH 1 unit as the underlying confining unit are missing data over that interval. Based on the isopach mapping, the thickness for BFH 1 unit is generally less than 40 feet in the Kendrick area. Therefore, staff needs to have additional data to have reasonable assurance that the BFH 1 can act as an aquitard especially in the areas where the ore is found near the bottom of the OZ aquifer.

<u>Basis for Request</u>

The SRP Acceptance Criterion 2.7.3(3) states that "[t]he applicant should describe all hydraulic parameters used to determine expected operational and restoration performance. Aquifer and aquitard hydraulic properties may be determined using aquifer pumping tests for parameters such as hydraulic conductivity, transmissivity, and specific storage. Any of a number of commonly used aquifer pumping tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells. The methods or standards used to analyze pumping test data should be described and referenced: acceptable methods of analysis include use of curve fitting techniques for drawdown or recovery curves that are referenced to peer-reviewed journal publications, texts, or American Society for Testing and Materials Standards."

<u>Request for Additional Information</u>

Please provide any additional information on the hydraulic properties for the BFH 1 unit.

TR RAI 2.7-4 Response

This RAI response provides justification that the hydraulic properties of the BFH 1 unit are adequate for the unit to serve as an aquitard. Additionally, please refer to the response to TR RAI 2.6-1 for a discussion regarding the nature of the underlying confining intervals within the KEA, and the nature of the BFH 1 shale unit.

Though the BFH 1 unit is new for the KEA, it has the same depositional environment as the BFH 2 unit overlying the DM interval in the current license area. The resistivity logs for the shales between the OZ interval and first underlying sand in the Ross TR Addendum 2.6-C are similar to the resistivity logs for the shales between the OZ and BFH 1 intervals in the KEA TR Addendum 2.6-A. Therefore, it is reasonable to assume the hydraulic conductivities of the units are similar. Section 2.5.1.2 of Ross TR Addendum 2.7-H (page 22, second paragraph), which is referenced in Section 2.5.1 of the KEA TR for hydraulic conductivity values, states the vertical hydraulic conductivity of the OZ basal confining unit is expected to be comparable to the Pierre Shale, which is estimated to range from 5×10^{-8} to 5×10^{-4} ft/day. Figure TR RAI 2.6-1-1 of this response package provides an updated isopach map of the confining units below the OZ. The isopach shows that the BFH 2 basal confining unit in the current license area ranges from 10 to 30 feet thick. This is comparable to the thickness of the BFH 1 unit range of 10 to 50 feet in the KEA, as shown in Figure TR RAI 2.6-1-1. The similarity in thickness demonstrates the confining nature of the BFH 2 shale in the current license area is similar to that of the BFH 1 unit found within the KEA.

Additional evidence to the confining nature of the BFH 1 unit is provided in comparing OZ and DM water levels, which are shown in KEA TR Addendum 2.6-A. In comparing the OZ and DM water levels, the OZ water levels are typically higher than the DM water levels by 5 feet or more. However, three well clusters (5368-43-24, 5268-12-01, and 5268-21-11) had DM water levels higher than OZ water levels due to pumping in the OZ aquifer. The water levels in the DM wells at well clusters 5368-43-24, 5268-12-01, and 5268-21-11 were 1.8, 8.2 and 16.7 feet higher, respectively, than the water levels in the OZ well wells. The 5268-12-01 and 5268-21-11 well clusters are in the southern portion of the KEA near two enhanced oil recovery (EOR) water supply wells (Mellott Ranch WS #3 and Federal Schuricht #2). Pumping from the EOR water supply wells have decreased the water levels in the OZ aquifer such that the water level in the OZ aquifer is now lower than the water level in the DM interval. Similarly, EOR water supply wells near well cluster 5368-43-24 have also reduced the water levels in the OZ aquifer such that they are now lower than the DM interval. This withdrawal of water has effectively served as a long-term aquifer test providing evidence to the confining nature of BFH 1 unit. Even with long-term withdrawals, the water level in the OZ aquifer is different than the water level in the DM interval. If the BFH 1 was not an effective confining unit, the water levels would be expected to be the same in both the OZ aquifer and the DM interval. The following paragraph discusses the EOR water supply wells in the vicinity of well clusters 5268-12-01, 5268-21-11, and 5368-43-24.

Figure 15 of KEA TR Addendum 2.7-I shows that the Mellott Ranch WS #3 and Federal Schuricht #2 EOR water supply wells are located near the southern portion of the KEA. Mellott Ranch WS #3 (discussed in Appendix A of KEA TR Addendum 2.7-I) was in operation from 1981 to 2006 with a maximum flow rate of 81.6 gpm, and Federal Schuricht #2 has been in operation from 2004 to 2015 with a maximum flow rate of

81.0 gpm. Pumping from these EOR water supply wells in the southern portion of the KEA have drawn the water levels in the OZ aquifer below the level of the DM interval as measured in well clusters 5267-12-01 and 5268-21-11. With the exception of well cluster 5368-43-24, the other well clusters further north are sufficiently distant from the EOR water supply wells that water levels in the OZ aquifer have been minimally affected. These well clusters demonstrate the OZ water levels are typically higher than DM water levels where water levels in the OZ aquifer have not been influenced by EOR water supply wells. Well cluster 5368-43-24 is near the southwestern portion of the current license area. As shown on Figure 15 of KEA TR Addendum 2.7-I, EOR water supply wells 789V State, 19XX State, and 22X-19 are located in the southern portion of the current license area near well cluster 5368-43-24. Long-term EOR withdrawals from these wells (discussed in Appendix A of Addendum 2.7-I) have drawn down OZ water levels. In this case, the BFH 2 unit has served as an aquitard between the OZ and DM intervals. As shown on Figure TR RAI 2.6-1-1, the thickness of the BFH 2 unit in the area of the 5368-43-24 well cluster is 10 to 20 feet, which is comparable to thicknesses of the BFH 1 unit. This provides additional evidence to the similar confining natures of the BFH 1 and BFH 2 units.

Given the similarity of the depositional environment, similarities in Ross and KEA resistivity logs, and difference between the OZ and DM water levels in the KEA well clusters, the BFH 1 unit will serve as an aquitard during operations. Strata will confirm this conclusion for each mine unit prior to operations. In accordance with SUA-1601 LC 10.13, which requires that a wellfield package will be submitted prior to conducting principal activities in a new wellfield, Strata will conduct additional analyses to demonstrate the BFH 1 unit will serve as an aquitard prior to operations in the KEA. Strata has already met this license condition for the first two mine units in the Ross Project through the submission of the wellfield data packages for Mine Unit 1 (ML15209A703) and Mine Unit 2 (ML16243A163). Attachment 5 of the Mine Unit 1 report provides the hydrographs for all DM monitor wells during the aquifer tests. The hydrographs clearly show no response in the DM interval during the aquifer test. The Mine Unit 2 report also provides evidence of the isolation of the DM interval by the BFH 2 unit. Aquifer tests in the KEA for future mine units are expected to provide the same evidence of the confining nature of the BFH 1 unit.

No revisions to the license amendment application are proposed in response to this RAI.

RAI 2.7-5

<u>*Description of Deficiency*</u>

On Table 17 of Addendum 2.7-I, Strata provides estimates of the "Estimated Maximum Available Head" and "Drawdown" for various water supply wells in the area. The information is insufficient for staff to review because: (a) the wells do not include those in the Shallow Monitor (SM) aquifer; (b) the "Estimated Maximum Available Head" is based on data not supplied to NRC in this application; and (c), the drawdown is calculated from the estimated 2015 potentiometric surface. For (a), Strata ignores wells in the overlying aquifer by the assumption that the operations only impact the ore zone aquifer. However, the model predicts over 30 feet of drawdown in the SM aquifer during operations. For (b), the well completion data needs to be summarized for staff's review of the information (either staff will take time to duplicate the information gathering or Strata should provide the information). For (c), the reported drawdown is only attributed to operations; however, in 2015, drawdown may have occurred due to the existing wells and may have affected the available water head.

<u>*Basis for Request*</u>

In the introductory paragraph of Section 2.7.2, the SRP states that "… the reviewer should evaluate whether the applicant has developed an acceptable conceptual model of the site hydrology and whether the conceptual model is adequately supported by the data presented in the site characterization." Review Procedure 2.7.2(3) states that "[t]he applicant's interpretation of ground-water hydraulic gradients (used to infer flow direction), horizontal hydraulic conductivity, and the thickness, areal extent, and vertical hydraulic conductivity of confining formations should be evaluated."

In the introductory paragraph of Section 2.7.3, the SRP states that a "conceptual model provides a framework for the applicant to make decisions on the optimal methods for extracting uranium from the mineralized zones, and to minimize environmental and safety concerns caused by in situ leach operations. Hydrologic characterizations that accomplish this objective are considered acceptable." Review Procedure 2.7.3(3) states that "[t]he applicant should describe all hydraulic parameters used to determine expected operational and restoration performance. Aquifer and aquitard hydraulic properties may be determined using aquifer pumping tests for parameters such as hydraulic conductivity, transmissivity, and specific storage. Any of a number of commonly used aquifer pumping tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells. The methods or standards used to analyze pumping test data should be described and referenced: acceptable methods of analysis include use of curve fitting techniques for drawdown or recovery curves that are referenced to peer-reviewed journal publications, texts, or American Society for Testing and Materials Standards."

<u>*Request for Additional Information*</u>

Please provide the information noted above as deficient for this table.

TR RAI 2.7-5 Response

This RAI response provides (a) a discussion regarding SM wells within the KEA groundwater model, (b) the calculations behind "Estimated Maximum Available Head" in Table 17 of KEA TR Addendum 2.7-I, and (c) a discussion regarding the estimated 2015 potentiometric surface.

(a) Strata did evaluate the wells in the SM aquifer within the KEA. Two EOR water supply wells were identified within the KEA model domain that, based on SEO well completion data, are assumed to be completed in the SM aquifer. One of the wells, Kiehl Water Well #2, is completed in both the SM and the OZ aquifers. As noted in Table 17 of KEA TR Addendum 2.7-I, the maximum predicted drawdown in the SM interval in this well is 24.2 feet. The other well completed in the SM and included in the model is Mellott Ranch WS-2. The maximum drawdown predicted by the model for this well is 11.9 feet. As discussed in Appendix A of KEA TR Addendum 2.7-I, available records indicate that Mellott Ranch WS-2 has never actually been used as a water supply well, while it is estimated that Kiehl Water Well #2 has historically been pumped at rates ranging between approximately 2 and 20 gpm. In addition to the two wells identified as having been completed in the SM interval, other EOR wells (such as Edsel WSW #2) have multiple completions in the overlying lance aquifers and may also have SM completions (as discussed in Appendix A of KEA TR Addendum 2.7-I). However, the EOR wells with potential completions in the SM interval are also completed in the OZ interval where modeled impacts were much greater; therefore, the impacts were reported based on impacts to the OZ interval. Strata did not identify any additional wells completed within the SM aquifer within the KEA other than the two wells provided in Table 7 of KEA TR Addendum 2.7-I. While a number of shallow wells in the KEA are used for stock water, these are completed shallower than the SM interval. As shown in Appendix C of KEA TR Addendum 2.7-I, the maximum estimated drawdown in the SM aquifer is approximately 30 feet. The SM interval is a confined aquifer and drawdowns of 30 feet or less are not expected to significantly impact yields. As such, due to the limited impacts, the SM wells within the KEA were not prioritized over the OZ wells, which are much more likely to be impacted.

(b) The estimated maximum available head was calculated based on SEO well completion data presented in KEA TR Table 2.7-27, as well as statement of completion information derived from the SEO database. Table TR RAI 2.7-5-1 summarizes the information used to estimate the maximum available head in each well as provided in KEA TR Addendum 2.7-I, Table 17.

(c) It is correct there may be drawdown due to existing wells in 2015. As shown in Appendix A of KEA TR Addendum 2.7-I, the model-simulated 2015 discharge from the active wells in the KEA model domain is equivalent to stress period 37 (the last stress period) of the pre-operation simulation. The 2015 potentiometric surface is the potentiometric surface output at the end of stress period 37, which is then utilized as the model's potentiometric surface for stress period 1 of the operational simulation; therefore, the potentiometric surface used by the model prior to the start of modeled operations includes the effects of any drawdown that may have occurred due to active wells in 2015. Most of the existing water supply wells in the KEA have been in operation for several years. As such, the water

levels in the aquifer near the water supply wells are at a quasi-steady state (meaning drawdown is likely still occurring, but is limited). For this reason, the drawdowns due to existing EOR water supply wells and domestic/stock wells are expected to be limited, but were accounted for in operational simulations.

Table TR RAI 2.7-5-1. Information Used to Estimate the Maximum Available Head in KEA TR Addendum 2.7-I, Table 17

Well ID	Model Layer	SEO Use	Top of Completion (or water bearing formation)[1] (ft below measuring point)	Depth to Water (from KEA TR Table 2.7-27)[2] (ft below measuring point)	Estimated Maximum Available Head (ft)
Strong Wells[3]	6 (OZ)	Domestic/stock	265	27	238
Enl Reynolds #6	6 (OZ)	Domestic/stock	140	48	92
Enl Sophia 1A	6 (OZ)	EOR	776	250	526
Kiehl Water Well #2[4]	4 (SM) 6 (OZ)	EOR	320 (SM) 454 (OZ)	272	48 (SM) 182 (OZ)
22X-19	6 (OZ)	EOR	458	150	308
19XX State	6 (OZ)	EOR	516	145	371
789V State	6 (OZ)	EOR	430	113	317
Alt Supply Deadman[5]	6 (OZ)	EOR	N/A	N/A	350
Enl Kiehl Water Well #1	6 (OZ)	EOR	390	220	332
WSW#1 West Kiehl Unit	6 (OZ)	EOR	730	460	270
Wesley #1	6 (OZ)	Domestic/stock	100	22	78
Edsel WSW #2[6]	6 (OZ)	EOR	106-873	8	400
Cambridge WSW #1	6 (OZ)	EOR	1208	558	650
Lily WSW #1[7]	6 (OZ)	EOR	560 to 900	219	400
Brislawn Water Source Well #1[8]	6 (OZ)	EOR	382 to 600	350	400
AR-1	6 (OZ)	EOR	482	318	164
Federal Schuricht #2	6 (OZ)	EOR	1090	300	790
Mellott Ranch WS #3	6 (OZ)	EOR	940	259	681
Mellott Ranch WS-2	4 (SM)	EOR	545	105	440

1 Top of completion (or water bearing formation) is estimated from SEO statement of completion (SOC) forms prepared for each well. Available at (http://seoweb.wyo.gov).

2 Depth to water is estimated from SEO well completion data (KEA TR Table 2.7-27) for constructed wells.

3 "Strong Wells" refers to Robinson #4 and Strong #1. Both are used for alternate supply for the same ranch, and were combined. SOC data for the Strong #1 well were used in these calculations.

4 Kiehl Water Well #2 is screened in both the SM and OZ aquifers. Based on projected potentiometric contours from the SM cluster wells, the available head in the SM aquifer may be as much as 140 feet. However, the more conservative value is presented here.

5 The estimated maximum available head for Alt Supply Deadman was obtained from the isopach contours in KEA TR Addendum 2.7-I Figure 16 for the approximate proposed location of Alt Supply Deadman (as modeled).

6 According to the SEO SOC, this well is perforated between 50 and 910 feet. The static water surface reported by the SEO is likely for a higher sand interval, and thus overestimates the available head in the OZ aquifer. Instead, a conservatively low estimate of available head was developed based on the trends in the maximum available head isopach presented in KEA TR Addendum 2.7-I Figure 16.

7 According to the SEO SOC, this well is perforated between 560 and 900 feet. Based on the perforation depths, it is likely that aquifers above the OZ aquifer are also contributing water; therefore, the static water level reported by the SEO is high. Instead of using SEO water levels, a conservatively low estimate of available head was used based on the maximum available head isopach presented in KEA TR Addendum 2.7-I Figure 16.

8 According to the SEO SOC, this well is perforated between 382 and 600 feet. The pump is set at 754 feet. The maximum available head was estimated at 400 feet from the difference between the pump setting depth and the top perforation interval. This is conservative because the water level is likely higher than the top perforation interval.

RAI 2.7-6

Description of Deficiency

The reported residual statistics for the calibration/verification simulation for the numeric groundwater flow model in Addendum 2.7-I indicate discrepancies between the observed and model-predicted water levels of up to 87 feet for one well and discrepancies of over 30 feet are reported for 11 of 44 the target wells. Strata stated that, because the model started from the "calibrated Ross model", calibration of the Kendrick model consisted of a "structured sensitivity" approach. This approach was designed to retain to a large degree the parameter values used in the Ross model for the Kendrick model.

Expanding to a larger Kendrick model exposed some potential biases that were not readily apparent in the smaller Ross model. For example, the calibration/verification residuals for the larger-model, model-predicted heads at wells in the Ross area are significantly different from the calibration/verification residuals reported for those wells in the smaller model. This change suggests that the calibration of the smaller model incorporated some bias due to the proximity of the boundary conditions, specifically, the general head boundary conditions may have affected the predicted drawdown. Therefore, wholesale expansion of the model with the same parameter values may not be appropriate.

Basis for Request

In the introductory paragraph of Section 2.7.1, the SRP states that "[c]haracterization of the hydrology at in situ leach uranium extraction facilities must be sufficient to establish potential effects of in situ leach operations on the adjacent surface-water and ground-water resources and the potential effects of surface-water flooding on the in situ leach facility." Review Procedure 2.7.2(3) states that a reviewer should "[e]Evaluate the site hydrogeologic conceptual model for ground-water flow in potentially affected aquifers. Review available data from well logs and hydrologic tests and measurements to obtain confidence that sufficient data have been collected and that the data support the applicant's hydrologic conceptual model for ground- water flow within and around the permit boundary." Acceptance Criterion 2.7.3(3) states that "[t]he applicant should describe all hydraulic parameters used to determine expected operational and restoration performance."

SRP Review Procedure 6.1.2(1) states that "[i]f numerical ground-water flow or transport modeling is used to support or develop the ground-water restoration plans, examine the descriptions of features, physical phenomena, and the geological, hydrological, and geochemical aspects of the modeled aquifers. The staff should verify that the descriptions are adequate and that the conditions and assumptions used in the modeling are realistic or reasonably conservative and supported by the body of data presented in the descriptions."

Request for Additional Information

Please verify that the Kendrick model is properly calibrated and that the boundary conditions are not affecting the model-predicted drawdown.

TR RAI 2.7-6 Response

As discussed in Sections 1.0, 2.6, 4.9, and 4.12 of KEA TR Addendum 2.7-I, the objective of the KEA groundwater model was to evaluate regional impacts of ISR operations in the KEA. This consisted of evaluating cumulative impacts of ISR operations at existing wells due to ISR operations in both the current license area and in the KEA. Considering that the goal of the KEA groundwater model was to evaluate regional impacts, the model is properly calibrated. The large residuals cited in the RAI do not necessarily indicate the model needs further calibration to provide an estimate of regional impacts. The largest residuals were observed in layer 4, which represents the SM interval. As discussed in Section 4.7.2 of KEA TR Addendum 2.7-I, the SM wells in the eastern and western portions of the KEA have limited hydraulic connection. Within the Lance formation, multiple sands exist above the OZ confining interval. In some locations, the sands split and intervening shales isolate the sands from each other. These occurrences are demonstrated in the geologic cross sections found in KEA TR Addendum 2.6-A. As shown in the geologic cross sections, the regional SM monitor wells in the western portion of the KEA are not always completed in the same sand interval as the wells in the eastern portion of the KEA. As described in the following paragraphs, since the SM intervals in the western and eastern portions of the KEA are not the same and are not necessarily hydraulically connected, it is reasonable that the residuals in the KEA groundwater model are higher for the SM wells in the western portion of the model.

The SM interval was modeled as one continuous aquifer using an average hydraulic conductivity. To model the SM interval(s) in more detail, it would have been necessary to incorporate additional layers into the model and/or additional variability to the hydraulic conductivity within the SM interval. Adding additional layers and/or variability to the hydraulic conductivity complicates and increases the size of the model. In addition, very little data is available outside of the KEA, and available hydraulic conductivity information is relatively sparse. Therefore, adding additional variability to the hydraulic conductivity would be futile considering the goal of the model was to evaluate regional impacts.

Most importantly, the most potential for impacts in the SM interval would primarily occur in the eastern portion of the KEA where the SM interval is shallowest and most accessible as a source of stock water, and the available head in the interval is the lowest. In the western portion of the KEA, the SM interval is deeper than typical stock well completions. The only SM well completions identified in the KEA were EOR water supply wells. As discussed in Appendix A of KEA TR Addendum 2.7-I, there is no indication that the only EOR water supply well (Mellott Ranch WS-2) completed in the SM interval on the west side of the KEA is (or has been) used. Additionally, further research regarding Mellott Ranch WS-2 has shown it is likely completed above the SM interval. The total completion depth is 679 feet, as shown in KEA TR Table 2.7-27 (page 2-276). Referring to cross sections K-K', L-L', and M-M' provided in KEA TR Addendum 2.6-A, the SM interval in the area of Mellott Ranch WS-2 is approximately 750 to 800 feet below ground surface (key logs to refer to on cross section K-K' for the depth to the SM interval include RMR 2387, RMR 2382, and RMR 2365). Therefore, Mellott Ranch WS-2 is completed approximately 70 feet above the SM interval, and the model is providing conservative estimates of potential drawdown in Mellott Ranch WS-2 due to KEA operations. Due to the lack of impacted wells in the western portion of the KEA, calibration efforts focused on the eastern portion of the KEA. As such, the residuals for

the eastern SM monitor wells are much smaller than the residuals for the western monitor wells. Since the SM monitor wells in the west side of the KEA are actually completed in a lower sand zone than the SM monitor wells on the east side of the KEA, the predicted water levels in these wells are overestimated in the model. In the western portion of the KEA, the model is essentially predicting impacts to an aquifer stratigraphically higher than where the SM monitor wells are actually completed. Again, due to the lack of potentially impacted SM wells in the western portion of the KEA, further calibration or more complicated modeling techniques were not deemed necessary to meet the goals of the model. Modeling the SM interval as one continuous aquifer provides a conservative estimate of the impacts because the drawdowns in the SM interval propagate further than if the aquifer was modeled with limited hydraulic communication or multiple intervals. As a result, the model-predicted impacts are more widespread across the model, and are conservatively high.

The RAI discussion suggests that the expansion from a smaller (Ross) to larger (KEA) model may have exposed biases due to the proximity of the boundary conditions because the residuals were higher in the KEA model. As discussed in KEA TR Addendum 2.7-I, Section 4.8.5, the model was not particularly sensitive to changes in the general head boundary conditions; the sensitivity observed in the sensitivity analysis was a result of the large residuals discussed previously. However, the boundary conditions were not the only changes to the model. The larger KEA model also had greater grid spacing, which also affected the model residuals. Groundwater Vistas uses an average elevation calculated at the center of the cell for calculating model elevations. Larger cell sizes result in more disjointed elevations throughout the model, especially where the layers are steep (such as along the Black Hills monocline). In addition, combining cells also results in multiple cells with various hydraulic conductivities being combined into one cell with one combined hydraulic conductivity. This resulted in slight changes to the distribution of the hydraulic conductivity of the aquifers, which also affected the residuals.

The hydraulic conductivity estimates outside of the original Ross model were also different in the KEA model. This had additional impact on the residuals. In the Ross model, supplementary data points were available which were used to calibrate the hydraulic conductivity. For example, within the Ross Project, there were data from hydraulic parameters from the historic Nubeth operations, Strata's regional monitor wells, and, most importantly, the EOR water supply wells were surrounded by the regional monitor wells. With the proximity of the regional monitor wells to the EOR water supply wells, drawdowns from the EOR water supply wells could be evaluated, much like a large-scale 30-year aquifer test. Within the KEA, there were no historic hydraulic data from previous mining operations, and the EOR water supply wells were not in proximity to multiple regional monitor wells. As such, it was not possible to define the variability in hydraulic conductivity as well in the expanded KEA model. Instead, average values were used throughout the model. Subsequent mine unit scale aquifer tests conducted for Mine Unit 1 (ML15209A703) and Mine Unit 2 (ML16243A163) have demonstrated the hydraulic conductivity distribution used in the Ross model was generally reasonable. It is very likely that additional variability in the hydraulic conductivity exists in the KEA similarly to the current license area. With additional definition of the hydraulic conductivity, the model calibration may have been improved; adjustments in the hydraulic conductivity distribution would have had a greater impact than adjustments in the general head boundaries.

Again, as discussed, the goal of the model was to evaluate regional impacts. The model is sufficiently calibrated to provide a reasonable estimate of regional impacts. While additional calibration might be necessary for further modeling efforts for finite areas with more information available regarding hydraulic parameters (such as wellfield scale modeling), the predictions from the KEA model provide a best estimate of regional impacts.

Section 2.9

RAI 2.9-1

Description of the Deficiency

Section 2.9.1 of the KEA TR states that the pre-operational monitoring program did not include local vegetation, animal tissue, or radon flux. Strata stated that vegetation and animal tissue samples collected as part of the Ross ISR Project pre-operational monitoring program is representative of the KEA. Local vegetation and animal tissue were sampled as part of the Ross preoperational monitoring program, which included one grazing vegetation sample within the KEA and one beef sample that was considered representative of the Ross ISR Project and KEA sites. Furthermore, Strata stated that, according to Section 6.2.3 of the Final Supplemental Environmental Impact Statement for the Ross ISR Project, vegetation and food sampling is not required because Strata demonstrated that a significant pathway to humans does not exist from these sources. For the Ross ISR Project, Strata estimated that the maximum impacts to the public through all pathways would be less than 1 percent of the applicable radiation-protection standard.

The Safety Evaluation Report (SER) for the Ross ISR Project stated that Strata should specify, in its airborne effluent and environmental monitoring program, particular conditions that will trigger the need for Strata to conduct livestock and vegetation sampling during operations. In a letter to the NRC, dated March 1, 2015, Strata stated it would start vegetation and cattle sampling, as described in Regulatory Guide 4.14, if air sampling results for particulate radionuclides (natural U, Th-232, Ra-226, and/or Pb-210) at any air sampling station in unrestricted areas was greater than 25% of the applicable effluent concentrations in 10 CFR 20, Appendix B, Table 2, for at least two quarters in any year. The staff evaluated Stata's proposal, and in a letter dated July 23, 2015, commented that Strata should clarify its description of operational livestock and vegetation sampling in view of commitments already made and staff guidance in Regulatory Guide 4.14 regarding acceptable trigger levels.

By letter dated July 30, 2015, Strata stated it would follow the commitments outlined in Section 5.7.7.1.3 of its December 2010 TR, and not those commitments made in Table 5.7-1 of its December 2010 TR or its letter dated March 1, 2015. Instead, Strata stated that it would update Table 5.7-1 of its December 2010 Technical Report to reflect changes after NRC approval of Strata's airborne and environmental monitoring program. In a letter dated November 19, 2015, the staff agreed with Strata that is should revise its TR to reconcile differences in the descriptions of the environmental monitoring program with regard to vegetation and forage sampling.

Based on the above information, the application narrative is conflicting with regard to performing vegetation, food, or fish sampling during operations because Strata committed to conduct such monitoring if certain trigger levels were exceeded. Also, Strata proposed to follow the protocol used during preoperational characterization to collect vegetation, food, or fish samples during operations, if needed.

Basis for Request

NUREG-1569 Acceptance Criterion 2.9.3 (1) states "Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980).

Regulatory Guide 4.14 recommends the collection of three vegetation samples, three food samples of each type (crops, livestock, etc) within 3 kilometers of the site, and fish samples from each body of water.

Request for Information

Please provide additional information on how one sample of grazing vegetation and one beef sample satisfies the sample collection recommendations of Regulatory Guide 4.14.

Please provide an update on the revision of Section 5.7.7.1.3 of the TR for the Ross ISR Project airborne and environmental monitoring program, if it is to be applied to the proposed Kendrick Expansion Area.

The NRC staff notes that any revision of Strata's environmental monitoring program could include specific mention of the 5 percent trigger value contained in footnote (o) of Table 2 of Regulatory Guide 4.14

TR RAI 2.9-1 Response

Regulatory Guide (RG) 4.14 recommends sampling for three vegetation samples during the grazing season from three grazing areas near the site in different sectors that will have the highest predicted air particulate concentration during milling operations. Eleven vegetation sites were sampled three times during the grazing season as part of the Ross baseline radiological vegetation sampling. One of the sites (Site 3) was located within the KEA. The results for the three samples collected during the grazing season are provided in Ross TR Tables 2.9-18 through 2.9-20. In addition, the primary vegetative communities and their distribution are very similar between the current license area and KEA. As shown in KEA TR Table 2.8-1 and in Table 3.5-1 of the Ross ER, the primary vegetative communities in both project areas consist of Upland Grassland (53.3% of the Ross area and 56.3% of the KEA area) and Sagebrush Shrubland (21.9% of the Ross area and 30.5% of the KEA area). Due to the similarities in vegetation, the samples collected in the Ross area would be representative of vegetation in the KEA.

One beef and two venison samples were analyzed as part of the Ross baseline radiological study, which meets the recommendations of RG 4.14. The beef sample was taken from a ranch several miles to the northwest of the proposed KEA license boundary and the venison samples were obtained from a local landowner which harvested a deer in the general area. Both the animals from which tissue sampling was conducted would have spent a large majority of their lives within and near the KEA.

In addition, the revised MILDOS model for the KEA conducted in response to TR RAI 7.3-1 confirmed that ingestion is not a significant pathway to humans. Table TR RAI 7.3-1-6 shows the dose from the ingestion pathway at the Wesley residence (the maximally exposed member of the public in the study) would be nearly negligible (vegetation ingestion would contribute 0.02% and meat ingestion would contribute 0.01%).

Based on the above information, Strata believes that the baseline vegetation and animal tissue samples collected as part of the Ross baseline monitoring program are representative of the KEA and meet the recommendations of RG 4.14.

Strata conducted a Safety and Environmental Review Panel (SERP) on December 2, 2015 to update the sampling commitments in the Ross TR. SERP 15-19 determined that Table 5.7-1 of the Ross TR could be updated to reflect the commitments outlined in the Ross TR Section 5.7.7.1.3 and the guidance specified in RG 4.14. The current commitment for operational monitoring of vegetation at the Ross Project is sampling three times during the grazing season, if required. The current commitment for animal tissue monitoring at Ross is that operational monitoring would be performed according to the recommendation of RG 4.14, if required. The condition that Strata would use to stipulate the necessity of monitoring is specified in Table 2, Footnote (o) of RG 4.14 as follows:

> *Vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway.*

A significant exposure pathway is defined by RG 4.14 as a pathway which would expose an individual to a dose in excess of 5 percent of the applicable radiation protection standard. As discussed above, pathways were evaluated by the revised MILDOS model conducted in the response to TR RAI 7.3-1 of this response package and found to be insignificant. In the event that monitoring is required in the future, sample collection would be conducted similar to the pre-operational baseline monitoring described in the Ross TR Section 2.9 and will meet the recommendations of RG 4.14.

The procedures for operational vegetation and animal tissue monitoring for the KEA would be identical to those outlined above for the Ross Project, namely that vegetation and animal tissue monitoring would be conducted if the 5 percent trigger value specified by footnote (o) of Table 2 of RG 4.14 was exceeded. Section 5.7.7.1.3 and Table 5.7-1 of the KEA TR would be revised to reflect the information above following acceptance of this response by NRC.

RAI 2.9-2

Description of the Deficiency

Sediment samples were collected at five surface water monitoring stations, four grab sample sites, and seven reservoirs within the proposed area. Strata collected sediment samples in late summer (September 2014), but did not collect samples following spring runoff because the streams within the area are ephemeral. Also, sediment samples were collected in the thalweg portion of the stream channel instead of a traverse across the body of water. Strata attributed this collection method to the ephemeral nature of the stream channels.

Basis for Request

NUREG-1569 Acceptance Criterion 2.9.3 (1) states "Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980)."

Regulatory Guide 4.14 recommends sediment sampling at two locations in each surface water location (e.g., streams, rivers, drainages) following spring runoff and in late summer, preferably following an extended period of low flow. It also recommends several sediment samples should be collected in a traverse across the body of water and composited for analysis, at each location.

Section 2.6.3.6 of the SER for the Strata Ross ISR Project (ADAMS accession number ML14002A107) states that specific streams located on the Strata Ross ISR project were ephemeral and dry at the time of sampling, and that sediment samples were collected from the deepest portion of the channel from those streams. Based on the information provided, the NRC staff considered the justification reasonable for the sampling sediment method in those streams. However, it is not clear from the information presented in section 2.9.2.3 of the TR for the Kendrick Expansion Area that, other than the seven reservoirs, each of the nine sediment sampling locations was ephemeral and dry at the time of sampling.

Request for Additional Information

Please provide additional justification for collecting sediment samples only in the late summer, when water levels are expected to be lower than average, and not collecting sediment samples following spring runoff, when water levels are expected to be higher than average.

For each of the nine sediment sampling locations (other than the seven reservoirs), please explain why sediment samples were not collected in a traverse across the body of water and composited for analysis at each sampling location.

TR RAI 2.9-2 Response

As described in KEA TR Section 2.9.2.3, Strata collected sediment samples from five ephemeral stream channel surface water monitoring stations, four grab sample sites

(including three within reservoirs and one in an ephemeral stream channel), and seven reservoir sites. Table TR RAI 2.9-2-1 summarizes the sediment sampling locations in relation to KEA wellfields. The table indicates the type of site (ephemeral stream channel or reservoir), the location of the site relative to planned facilities (i.e., ephemeral stream channel upstream or downstream of KEA wellfields or a reservoir with potential to be subject to direct runoff from KEA wellfields), and the number of baseline sediment samples collected. Figure TR RAI 2.9-2-1 depicts the baseline sediment sample locations in relation to KEA wellfields.

The ephemeral stream channel surface water monitoring station and grab sample sites were the same as those established as part of the surface water monitoring network. Three of the surface water monitoring stations (SW-1, SW-2, and SW-3) were previously used in baseline characterization and are currently part of the operational monitoring network of the Ross ISR Project. The two additional surface water monitoring stations were established at sites meeting the criteria established in the Kendrick Amendment Baseline Sampling and Analysis Plan (SAP), which included a straight channel reach close to an elevated bank with a fairly steep grade. Grab sample sites were established at locations not conducive to the installation of a surface water monitoring stations. Three of the four grab sample sites were located at reservoirs at the request of WDEQ/LQD staff as part of approval of the SAP. In October 2012, the WDEQ/LQD approved and field verified the substitution of reservoirs instead of surface water stations due to remoteness and access within ephemeral stream channels. Site GS-2 was located on Deadman Creek (ephemeral) within the KEA boundary both above and below KEA wellfields.

The reservoir sites were selected based on their potential to be directly impacted by surface runoff from KEA wellfields. Figure TR RAI 2.9-2-1 depicts the reservoir sampling sites in relation to the approximate wellfield extents. If more than one reservoir was located on the same drainage, the most downstream reservoir was selected for sediment sampling.

Table TR RAI 2.9-2-1 indicates the number of samples collected at each site. Sediment sampling at sites SW-1, SW-2, and SW-3 met the RG 4.14 recommendation to collect two samples, including one during spring runoff and one in late summer. Since grab sample sites GS-1, GS-3, and GS-4 were established at reservoirs, only one sample was collected at each of these locations, which is consistent with the guidance in RG 4.14. Sediment sampling at sites SW-4, SW-5, and GS-2 was limited to one sample from each site in the late summer. However, the concentrations of uranium and radionuclides in sediments were consistent across the KEA and consistent with previous results from sites SW-1, SW-2, and SW-3, as shown in KEA TR Table 2.9-6. Therefore, Strata believes that background characterization of the radiological composition of stream sediments has been demonstrated.

As described in KEA TR Section 2.9.2.3, sediment samples were collected from the thalweg portion of the stream channel at each surface water monitoring station and grab sample site GS-2. This sampling methodology was consistent with what was approved for the Ross ISR Project. Due to the ephemeral nature of the streams and the steep grade of the channels, the thalweg portion was determined to be more appropriate for sediment sampling than collecting multiple samples in a traverse across the sediment channel. Figures TR RAI 2.9-2-2 and 2.9-2-3 depict the channel cross sections

of sites SW-4 and SW-5. These figures demonstrate that the narrow channel geometry of the sampling sites was not conducive to transect sampling. If sediment samples were collected along the transect outside of the thalweg portion of the stream channel, they may not have been representative of baseline conditions and may have skewed background sediment results, since these portions of the channels rarely experience stream flow. KEA TR Section 2.7.1.6.3 describes the surface water quantity for each site from May through October 2013. Site SW-4 only measured flow during a precipitation event that occurred during late May to early June. Site SW-5 measured no flow for approximately 86% of the continuous stage recording season. The only sustained flow recorded at that site occurred from October 7-23 as a result of precipitation. The methodology used by Strata was also consistent with that used by another recent license applicant (AUC) for the Reno Creek Project located within the Belle Fourche watershed (Docket #040-09092).

No revisions to the license amendment application are proposed in response to this RAI.

Table TR RAI 2.9-2-1. Sediment Sampling Location Details

Sediment Sample Site	Reservoir/Ephemeral Stream Channel	Upstream or Downstream of KEA Wellfields or Subject to Surface Runoff	Number Sediment Samples Collected	Meet RG 4.14 Recommendation
SW-1	Ephemeral channel	Downstream	2	Yes
SW-2	Ephemeral channel	Downstream	3	Yes
SW-3	Ephemeral channel	Downstream	3	Yes
SW-4	Ephemeral channel	Upstream	1	No
SW-5	Ephemeral channel	Upstream	1	No
GS-1	Reservoir	Downstream	1	Yes
GS-2	Ephemeral channel	Upstream	1	No
GS-3	Reservoir	Upstream	1	Yes
GS-4	Reservoir	Upstream	1	Yes
P4010S	Reservoir	Subject to surface runoff	1	Yes
P514S	Reservoir	Subject to surface runoff	1	Yes
P4869S	Reservoir	Subject to surface runoff	1	Yes
P8531R	Reservoir	Subject to surface runoff	1	Yes
SCHRES01	Reservoir	Subject to surface runoff	1	Yes
SCHRES03	Reservoir	Subject to surface runoff	1	Yes
TSRES03	Reservoir	Subject to surface runoff	1	Yes

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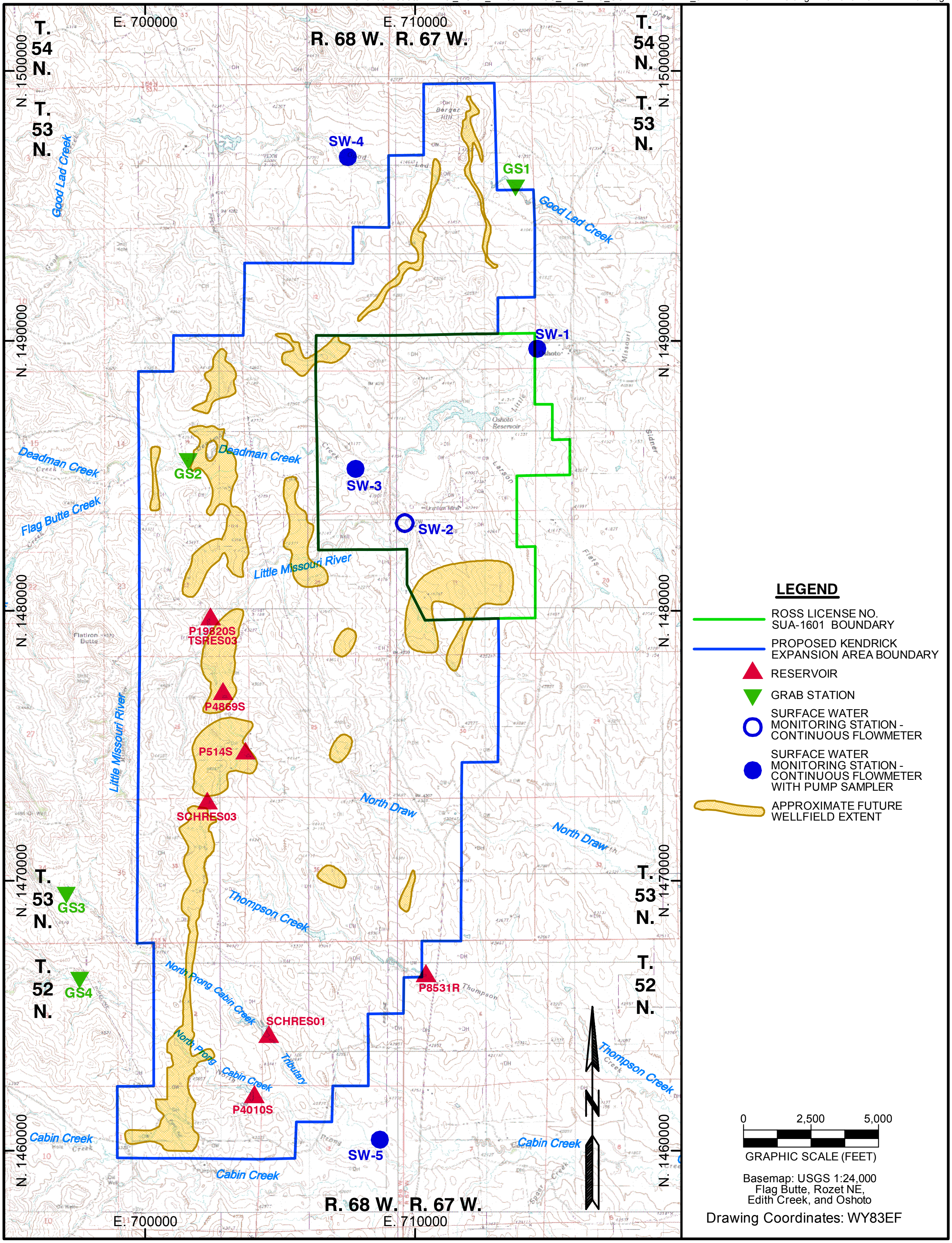


Figure TR RAI 2.9-2-1 Sediment Sampling Locations.

Figure TR RAI 2.9-2-2. Cross Section of Surface Water Monitoring Station SW-4

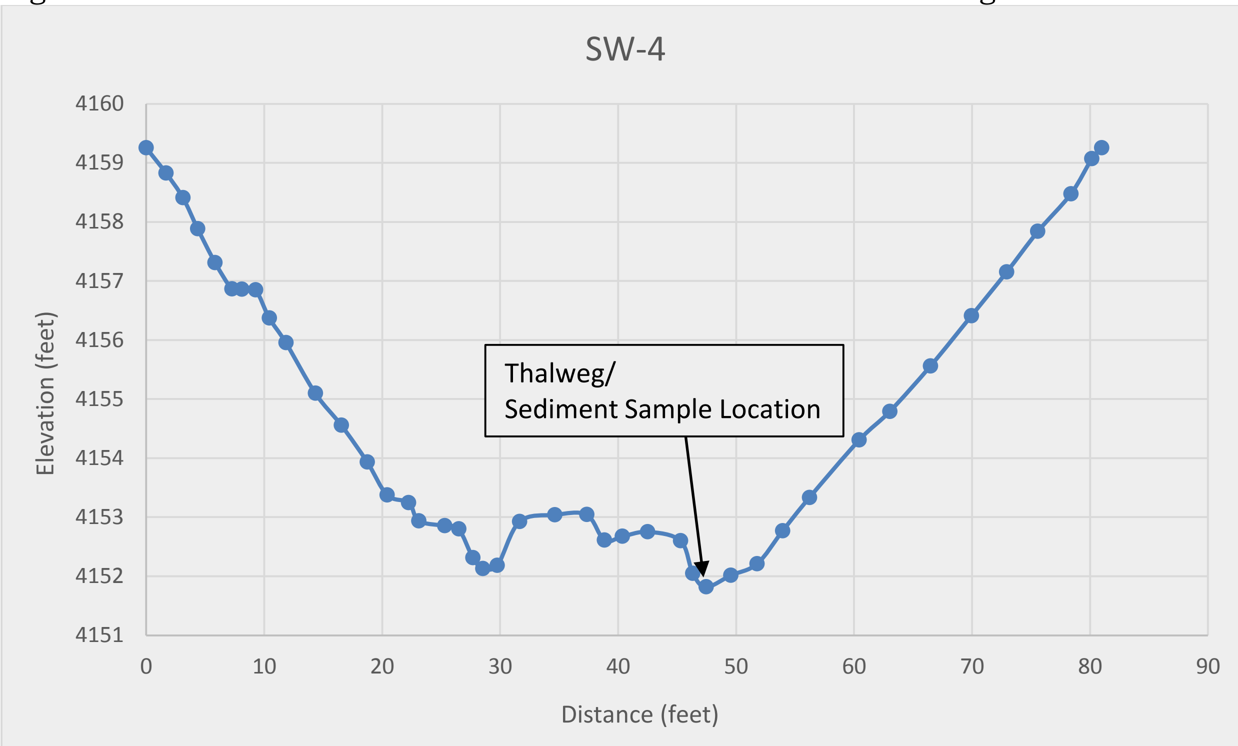
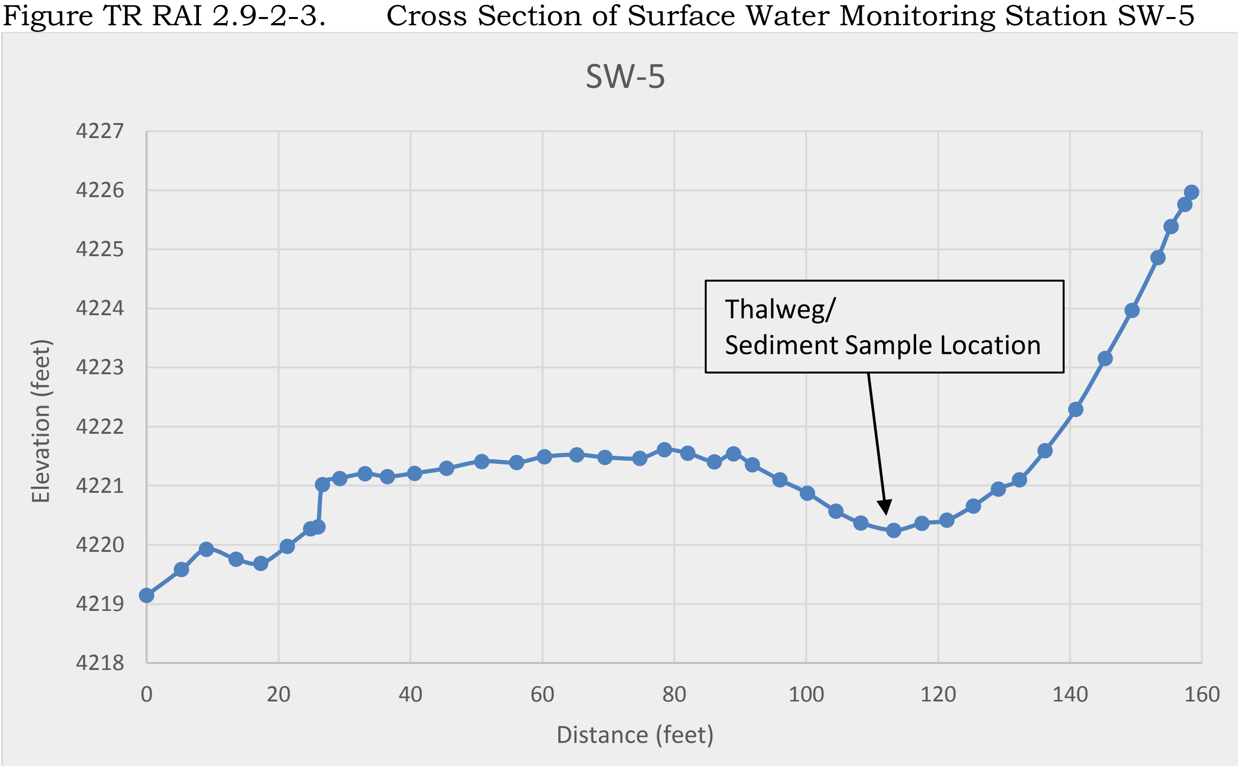


Figure TR RAI 2.9-2-3. Cross Section of Surface Water Monitoring Station SW-5



RAI 2.9-3

Description of the Deficiency

The air monitoring stations selected for the pre-operational monitoring period were: (1) site OCH, located upwind and to the east, as a control location; (2) site D-Road, located at the nearest residence, on the southeast side of the proposed Kendrick Expansion Area; (3) sites Berger Hill, Burch, and Deadman, located near the northern boundary. According to section 7.3.5.5 of the TR for the Kendrick Expansion Area, the location of the nearest residence that would receive the highest predicted annual dose is the Wesley residence. However, no air sampling results were provided for the Wesley residence, which is located approximately 1.56 kilometers (0.97 miles) to the north of the Ross central processing plant and 0.4 kilometer (0.25 miles) from the northern site boundary.

The staff notes that there is no overlap between the Ross and proposed Kendrick Area Expansion air monitoring programs, although several air monitoring stations for Ross are physically located in the proposed Kendrick Area Expansion.

Basis for Request

NUREG-1569 Acceptance Criterion 2.9.3 (1) states "Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980). Air monitoring stations are located in a manner consistent with the principal wind directions reviewed in Section 2.5 of the standard review plan."

Regulatory Guide 4.14 recommends pre-operational air particulate and radon sampling at three locations at or near the site boundaries, one control location remote from the site, and one location at or close to the nearest residence with the highest predictable airborne radionuclide concentration from milling operations.

Request for Additional Information

Please explain why an air particulate sampling station was not located near the Wesley residence during the preoperational monitoring period.

Please describe the air monitoring network that would integrate air monitoring stations during operations at the proposed Kendrick Area Expansion with the approved air monitoring stations for operations at the Ross portion of the site.

TR RAI 2.9-3 Response

As discussed in Ross TR Section 2.9.2.4, Strata originally selected five air particulate sampling stations for the Ross Project preoperational air monitoring program. Monitoring was initiated at these stations in January of 2010. Based on wind data collected from the Ross Meteorological Station through the first half of 2010, Strata determined that a sixth air particulate station was needed at the Wesley residence to comply with recommendations in RG 4.14 which suggests that air monitoring should be conducted at the nearest residence which would represent the "maximally exposed offsite individual". Therefore, in November 2010 an air particulate sampling station was

located at the Wesley residence. The location is depicted on Ross TR Figure 2.9-24 as the "Wesley" location. The designation of the location was later changed to "North". Four consecutive quarters of data was collected at the Wesley/North air monitoring station from the 4th quarter of 2010 through the 3rd quarter of 2011. This data was not available for inclusion with the Ross license application but is included in Table TR RAI 2.9-3-1 as part of this response.

The North air particulate station was moved when operational air monitoring was established in early 2015 at the request of the surface owner due to the noise of the continuously-operating pump. The proposed location of the new site was approximately 250 feet southwest of the original location. Strata conducted a SERP review of the proposed change and the SERP approved the change in SERP 15-17. The SERP review is detailed in the Semi-Annual Environmental and Effluent Report for the period of July 1st to December 31st, 2015 (ML16076A276). The North air particulate station is currently part of the Ross Project's operational air monitoring program.

Since preoperational data has been collected from the North site (near the Wesley residence) and it is currently part of the Ross operational program, Strata determined that no additional data was needed as part of the KEA baseline air monitoring program.

As discussed in the response to TR RAI 7.3-1, an updated MILDOS-AREA model was conducted based on revised source term estimates for the KEA. The updated MILDOS model confirmed that the Wesley residence would be the location of the maximally exposed member of the public during operation of the Ross and KEA projects.

As stated, no overlap exists between the currently approved Ross and proposed KEA operational air monitoring networks. Therefore, Strata proposes an integrated monitoring network that would be used for both the Ross and KEA if the KEA license amendment is approved. The proposed operational air monitoring network is depicted on Figure TR RAI 2.9-3-1 and would consist of the following sites:

- North Site
  - Downwind of the project area in the prevailing wind direction (South, Southwest) and near the residence calculated to be the maximally exposed offsite individual.

- South Site
  - At the project boundary and downwind of the project area in the secondary wind direction (North, Northwest). The East Site which was used for preoperational monitoring for Ross would be a better location as it is near a residence; however, access is difficult to the East Site especially during snow or precipitation events. Therefore, for personnel safety considerations, the South Site was chosen.

- Burch Site
  - Near the northern project boundary, near four residences, and downwind of the project area in the prevailing wind direction.

- D Road Site
  - Near the southern project boundary and downwind of the project area in the secondary wind direction.

- OCH Site
  - The designated “control” or background location. Upwind and remote from the project area and consistent with the control location used during the KEA preoperational monitoring program.

Strata believes these locations will provide an adequate air monitoring network for the operational air monitoring program as the locations meet the recommendations of RG 4.14, i.e., a minimum of three locations at or near the site boundary, one control location remote from the site, and one location at or close to the nearest residence with the highest predicted airborne radionuclide concentration from milling operations.

Pending acceptance of this response from NRC staff, Strata would submit revisions to Section 5.7.7 of the KEA TR. Upon issuance of the license amendment for the KEA, Strata would modify the operational monitoring program to include the integrated air monitoring network.

Table TR RAI 2.9-3-1 North Site Preoperational Air Particulate Monitoring and Radionuclide Analysis

Parameter	**4th Quarter 2010**	**1st Quarter 2011**	**2nd Quarter 2011**	**3rd Quarter 2011**
Lead-210 (µCi/mL	1.58E-14	1.29E-14	5.81E-15	1.24E-14
Radium-226 (µCi/mL)	<DL	<DL	<DL	<DL
Thorium-230 (µCi/mL)	<DL	<DL	<DL	<DL
Uranium (µCi/mL)	<DL	<DL	<DL	<DL

Note: <DL - Sample results less than NRC DL per Regulatory Guide 4.14 (Uranium=1.0E-16 µCi/mL, Th-230=1.0E-16 µCi/mL, Ra-226=1.0E-15 µCi/mL, Pb-210=2.0E-15 µCi/mL)

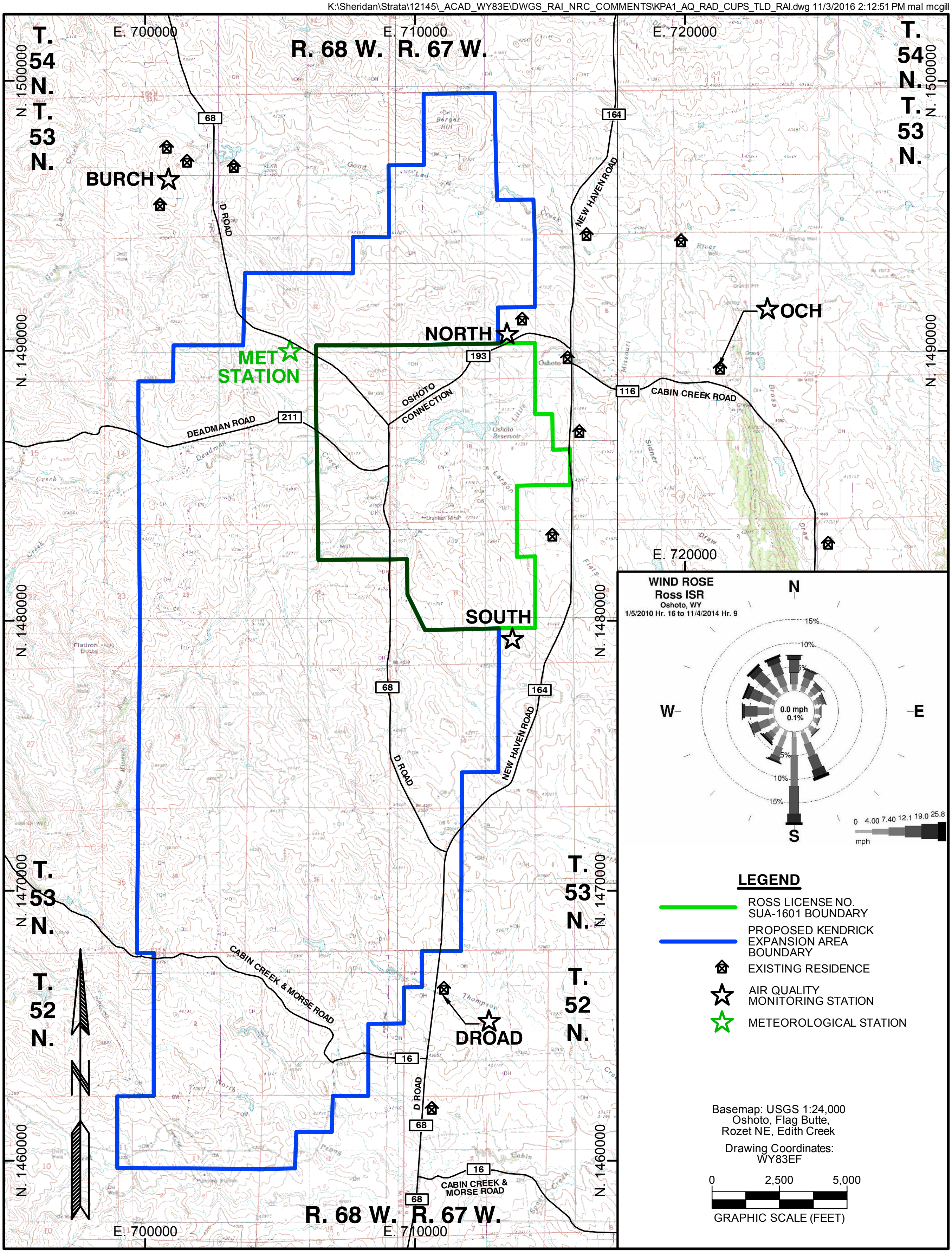


Figure TR RAI 2.9-3-1. KEA and Ross Operational Air Monitoring Network.

RAI 2.9-4

Description of the Deficiency

Strata stated that the operational environmental soil sampling program within the proposed Kendrick Expansion Area will be the same as that approved for the Ross ISR Project. Therefore, it is expected that during operations, soil samples will be collected at air monitoring stations to a depth of 15 cm, the same depth specified in Strata's Environmental Management Program. Also, soil samples will be analyzed for total uranium, radium-226, lead-210, and gross alpha, which is consistent with the Environmental Management Program for the Ross ISR Project.

Strata collected and analyzed soil samples to a depth of 5 centimeters where air sampling stations are located, and used a soil sample depth of 15 centimeters for the remaining 34 locations.

Basis for Request

NUREG-1569 Acceptance Criterion 2.9.3 (1) states "Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980)."

NUREG-1569, Acceptance Criterion 2.9.3(2), states: "Soil sampling is conducted at both a 5-cm [2-inch] depth as described in Regulatory Guide 4.14, Section 1.1.4 (NRC, 1980) and 15 cm [6 in] for background decommissioning data."

RG 4.14 provides guidance on the preoperational and operational aspects of effluent and environmental monitoring at uranium mills. RG 4.14 recommends a 5 centimeter depth for surface soil samples, and subsurface soil samples should be analyzed for Ra-226, natural uranium, Th-230 and Pb-210. The Strata Environmental Management Program stipulates that soil and sediment samples will be analyzed for gross alpha.

Request for Additional Information

Please provide justification for not collecting and analyzing surface soils at 5-cm and 15-cm depths at each location or indicate where this can be found in the TR.

Please clarify why one set of subsurface samples was not analyzed for natural uranium, Th-230 and Pb-210.

Please clarify why soil and sediment samples did not include gross alpha analyses, which is included in the Strata Environmental Management Program, but not mentioned for the proposed Kendrick Expansion Area program.

TR RAI 2.9-4 Response

Due to the proximity of the projects, and the fact that no major radiological anomalies were identified in the soil sampling for the Ross ISR Project, Strata conducted a reduced soil sampling program for the KEA. The plan included surface soil samples along the

ore trends at 0-15 cm in order to meet the reclamation standards in 10 CFR Part 40, Appendix A, Criterion 6(6), but did not include surface soil samples at all locations at 0-5 cm interval as recommended in RG 4.14. Experience at the Ross ISR Project with respect to the baseline soil sampling indicated that surface soil concentrations in the 0-5 cm range were generally very similar to those in the 0-15 cm range. This is evident in the soil sampling results from the Ross ISR Project presented in Table 2.9-11 of the Ross TR, and also when reviewing the results of the soil samples analyzed at the air particulate stations in the KEA area which are presented in Table 2.9-11 of the KEA TR. Based on the similarities in concentrations, NRC staff should have reasonable assurance that baseline radiological soil concentrations have been adequately characterized within the KEA area. If necessary, Strata would propose to collect additional surface soil samples at 0-5 cm interval at a select number of the 36 ore trend locations. Sampling results would be submitted to NRC for review and verification prior to operations in the KEA.

RG 4.14 recommends that at least one subsurface soil sample be analyzed for natural uranium, Th-230, and Pb-210. As noted, none of the subsurface samples collected in the KEA were analyzed for these parameters. Therefore, Strata proposes to collect and analyze one additional subsurface sample for natural uranium, Th-230, and Pb-210 at one of the locations previously sampled. The results would be submitted to NRC for review and verification prior to operations in the KEA.

None of the KEA baseline radiological soil samples were analyzed for gross alpha which Strata recognizes is not consistent with the current Environmental Management Program (EMP) for the Ross ISR Project. This is because the EMP for the Ross ISR Project was established approximately one year after the soil samples for the KEA amendment were collected. Strata followed guidance in RG 4.14 when selecting soil sampling parameters for the KEA which does not recommend measurement of gross alpha. All of the KEA baseline radiological sediment samples were analyzed for gross alpha as reported in KEA TR Table 2.9-6. No revisions to the license amendment application are proposed in response to this RAI.

RAI 2.9-5

Description of the Deficiency

Strata used portable survey instruments mounted on an all-terrain vehicle to conduct a baseline gamma radiation survey of the proposed Kendrick Expansion Area. Radiation detector readings were correlated to radionuclide concentrations in soil to derive gamma exposure rates, as described in Addendum 2.9-A, "Baseline Gamma Survey Report; Radiological Baseline Characterization Program; Kendrick Expansion Area," (December 2014). Strata also compared gamma exposure rate measurements obtained from the gamma scanning system with exposure rate measurements obtained from optically stimulated luminescent (OSL) dosimeters installed as part of the long-term direct radiation study for the proposed Kendrick Expansion Area.

The Baseline Gamma Survey Report describes methods to correlate radiation detector response to radionuclide concentrations in soil and gamma exposure rates. The report states that coefficient of determination (R^2) values greater than 0.75 are sufficient for this application, and concludes that RadEye-radiation detector correlations produced the best results using regression analyses. According to NUREG-1475, Revision 1 "Understanding Statistics," irreproducible results are suggested when a correlation coefficient (r) is smaller than 0.95, which is equivalent to a coefficient of determination of 0.9. Information provided on the correlation of natural uranium soil concentrations and exposure rates is insufficient, based on the data and analyses presented in the report.

Basis for Request

NUREG-1569 Acceptance Criterion 2.9.3 (1) states "Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980)."

Regulatory Guide 4.14 recommends that gamma radiation measurements should be made with passive integrating device (such as a thermoluminscent dosimeter), pressurized ion chamber, or properly calibrated portable survey instruments. The TR describing the proposed method for correlating portable survey instrument response to soil concentrations should provide the requested information. The TR that described the method for correlating instrument response to soil concentrations did not contain sufficient information on the statistical analyses to support the correlations of natural uranium soil concentrations with exposure rates, based on the data and analyses presented in the report.

Request for Additional Information

Please provide additional information about the radiation detection system employed for the direct gamma field survey at the Kendrick Expansion Area, including the minimum detectable activities based on actual scan speeds of the vehicle during data acquisition.

Please provide additional information on the statistical methods that were used to correlate instrument response to soil concentrations, for each radionuclide analyzed, across the Kendrick Expansion Area.

TR RAI 2.9-5 Response

It is assumed that the first part of this RAI is specifically requesting information on the minimum detectable concentration (MDC) of Ra-226 in soil while scanning (scan MDC) with the gamma survey system detailed in the Baseline Gamma Survey Report (KEA TR Addendum 2.9-A). The concept of a scan MDC is described in the Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) (NRC 2000). The objective of this parameter is to provide an *a priori* estimate of the sensitivity of the planned "measurement process" in advance of the survey to help ensure that the instruments and survey method will be capable of detecting radiological contamination at levels prescribed by cleanup criteria (NRC 1998a and 2000; Abelquist 2014).

The survey in question was a baseline survey and thus, identification of contamination from ISR operations was not a survey objective and a scan MDC was not calculated prior to the survey. The baseline gamma survey design, instruments and methods employed were based on well-established precedents regarding the use of modern gamma survey technologies/methods that have been accepted by the NRC for baseline characterizations in recent license applications at other uranium ISR sites. In response to this RAI, a scan MDC for the gamma scanning system/method used to collect baseline gamma radiation data across the KEA has been retrospectively calculated as described below.

The applicable soil cleanup criterion with respect to detection of soil contamination with a gamma survey system at any uranium ISR site is a soil Ra-226 concentration of 5 pCi/g above pre-existing baseline levels in surface soils [per 10 CFR Part 40, Appendix A, Criterion 6(6)]. Certain aspects of the method described in MARSSIM for calculating scan MDCs are technically not applicable to modern Global Positioning Systems (GPS)-based gamma survey methods and technologies (Alecksen and Whicker 2016). However, a new "probabilistic method" for calculating scan MDCs specifically for GPS-based gamma surveys has recently been developed and published in the peer-reviewed journal of Health Physics (Alecksen and Whicker 2016). This publication includes reference to an associated online calculator that uses the probabilistic method to generate scan MDC values for various radionuclides and scanning parameters. Based on site/method-specific assumptions and online calculation with the probabilistic method, the Ra-226 scan MDC for the gamma survey system/method used at the KEA is estimated to be 2.4 pCi/g as shown on Figure TR RAI 2.9-5-1. The assumed average background count rate of 13,000 counts per minute (cpm) is based on actual scan data and knowledge of Ludlum 44-10 detector response in similar environmental gamma fields. A contaminated source area of 8 m diameter (≈ 50 m^2 area) is conservative (erring in favor of higher scan MDC estimates) relative to the 100 m^2 areal basis for 10 CFR 40 soil cleanup criteria. A scan speed of 1.5 meters per second is about 3.4 mph, which is a reasonable estimate of the average scan speed for this survey based on study of typical gamma scan tracks across the KEA. This analysis indicates that the gamma survey system/method used is capable of detecting Ra-226 contamination at levels well below the applicable 5 pCi/g soil cleanup criterion specified in 10 CFR Part 40.

With respect to the second part of this RAI, the statistical methods for correlations between gamma radiation and radionuclide concentrations in surface soils involve least squares regression analyses generated with standard Excel spreadsheet curve fitting algorithms (including both linear and nonlinear regression models). For each set of

paired gamma/radionuclide data, the type of regression model available in Excel that resulted in the highest coefficient of determination (R^2) value was assumed to represent the best statistical model (fitted curve) for the data. The R^2 value gives a measure of the amount of variation in the relationship explained by the regression. Even if this metric has a relatively low value (e.g. < 0.75), the predictive capability of the regression may still be statistically significant (i.e. gamma readings can still be a statistically significant predictor of the radionuclide in question).

For example, regression data for select relationships presented in Figure 13 of the KEA TR Addendum 2.9-A are shown Table TR RAI 2.9-5-1, including P-values which provide a measure of statistical significance for the regression model coefficients. P-values lower than 0.05 indicate that the coefficients for the regression (slope) or intercept are statistically significant at the 95% level of confidence. In cases where the R^2 value is relatively high (e.g., > 0.75) and the P-value is considered significant (< 0.05 by convention), the regression model is statistically significant and the amount of prediction error is expected to be relatively low. This is the ideal circumstance. In cases where the R^2 is relatively low (e.g., < 0.75) but the P-value is still significant (< 0.05), the independent variable (gamma reading) is still a significant predictor of the dependent variable (soil radionuclide concentration), but the amount of prediction error is likely to be greater. This uncertainty is acknowledged and described in KEA TR Addendum 2.9-A, TR Addendum 2.9-A, Section 2.3.4 (particularly with respect to radionuclides other than Ra-226).

While NUREG-1475 suggests that R^2 values below 0.9 may generate irreproducible results, it also indicates that an R^2 value as low as 0.5 can be very significant depending on the application. The amount of prediction uncertainty that is tolerable for a given statistical application is subjective, and usually depends on the study objectives and/or anticipated consequences of decision errors. In this case, an R^2 value of 0.75 or higher was considered a reasonable bound on limiting the amount of prediction error in gamma-based estimates of soil radionuclide concentrations. While this value is subjective and somewhat arbitrary, it is considered a reasonable qualitative criterion for this application (characterizing the spatial distribution of baseline soil radionuclide concentrations across the site).

The description of deficiency for this RAI specifically mentions that information on the correlation between exposure rate and natural uranium is insufficient. While this regression (a nonlinear power function) has a relatively moderate R^2 value (0.78), p-values on the slope and intercept for a linear regression on log-transformed data show that the relationship is highly significant statistically, and there is a single statistical outlier in the relationship that strongly influences this R^2 value (Figure TR RAI 2.9-5-2). The uncertainty associated with the R^2 value becomes more important during decommissioning phases of the project. For remedial applications, upper prediction limits on such regressions are used to determine gamma guideline levels that account for prediction error to ensure that remediation based on gamma measurements will meet the cleanup levels with a specified probability of compliance.

To provide empirical evidence regarding uncertainty in correlation-related data presented in KEA TR Addendum 2.9-A, the nature and magnitude of prediction errors in gamma-based estimates of soil Ra-226 concentrations (in this case for interpolated krig values) was evaluated by subtracting actual measured baseline concentrations at

corresponding locations (n = 59) across the site (Figure TR RAI 2.9-5-3). These data indicate a slight high bias on average in predicted krig values (+0.14 pCi/g). Aside from one clear outlier, individual prediction errors (numerical differences) are approximately normally distributed, with 90% of predicted values falling within ± 1.4 pCi/g or less of measured values, and 80% falling within ± 1.2 pCi/g or less. This magnitude of prediction error represents an analytical quantity that is difficult to measure with good precision in soil samples [counting error alone as reported by laboratories can exceed ± 0.5 pCi/g (e.g. Whicker et al. 2006), and total propagated sampling and measurement uncertainty can be significantly higher].

Finally, as pointed out in KEA TR Addendum 2.9-A, direct sampling and analysis of radionuclides in soil is inherently limited in terms of characterizing the degree of spatial variability present, especially when such large areas are involved. A grid based soil sampling design can mischaracterize sizeable areas with elevated levels of soil radionuclides (Whicker et al. 2008). The spatial uncertainty associated with soil sampling characterization techniques alone is much higher than the uncertainty in gamma-based estimates of soil radionuclide concentrations at any given location. The value of gamma surveys and correlation techniques is the sheer volume of spatial and quantitative data that is collected. For all of the above reasons, the gamma-based estimates of soil radionuclide concentrations across the KEA are considered generally reliable, and the data are believed to be of high value despite R^2 values on some correlations that fall below 0.9. No revisions to the license amendment application are proposed in response to this RAI.

Table TR RAI 2.9-5-1. Statistical Data for Select Correlation Parameters

Paired Data	No. Data Points	Regression Fit	R^2 Value	P-values	
				Regression	Intercept
Gamma/Ra-226	23	Exponential	0.78	<0.0001	<0.0001
Gamma/Ra-226	14	Linear	0.93	<0.0001	<0.0001
Gamma/U-nat	14	Power	0.78	<0.0001	<0.0001
Gamma/Pb-210	14	Linear	0.40	0.015	0.122
Gamma/Th-232	14	Linear	0.16	0.158	0.229

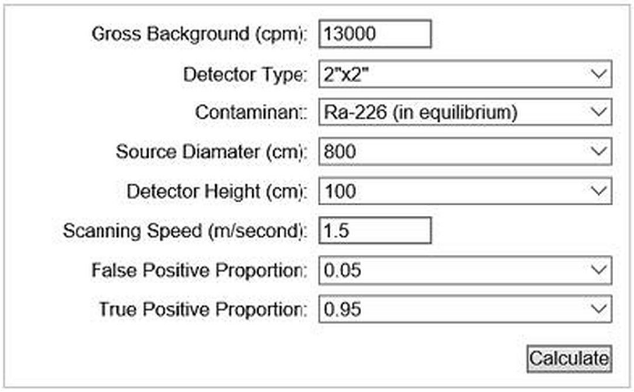


Figure TR RAI 2.9-5-1. Calculated Scan MDC for Ra-226 in Surface Soils

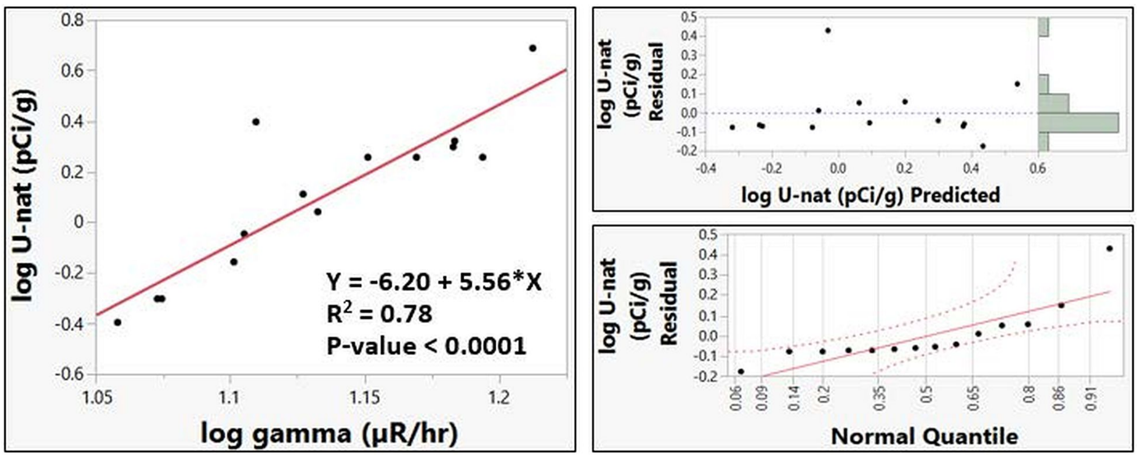


Figure TR RAI 2.9-5-2. Regression Statistics for Log-Transformed Gamma Exposure Rate and U-nat Correlation Data

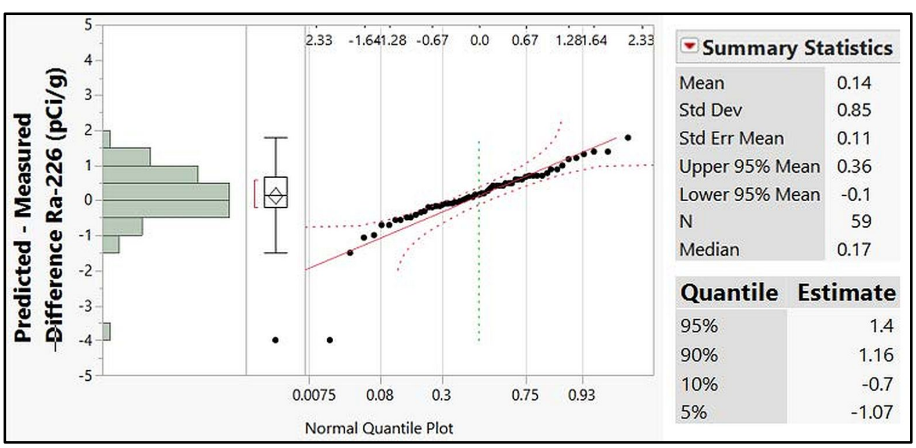


Figure TR RAI 2.9-5-3. Statistical Evaluation of Prediction Error Between Gamma-Based Estimates of Soil Ra-226 Concentrations and Direct Sampling Results in Corresponding Locations

Section 3.1

RAI 3.1-1

Description of Deficiency

Several non-Strata wells (e.g., Mellott Ranch WS#3 and ENL Sophia 1A) are located in a proposed wellfield and screened in the ore aquifer. In Section 5.7.8.2 of the Kendrick application, Strata discusses monitoring at nearby wells but did not propose any limitation or special consideration of operating a wellfield (module) in which a private well is located.

Basis for Request

Acceptance criterion 3.1.3(5)(f) states that "[t]he description of the in situ leaching process includes … [a]n analysis of the effects that the in situ leach operations are likely to have on surrounding water users".

Request for Additional Information

Please provide a discussion on management of private wells located within the Kendrick area that could affect or be affected by the proposed operations.

TR RAI 3.1-1 Response

Potential management measures for EOR, stock, and domestic wells potentially impacted by Strata's operations are presented in KEA ER Section 5.4.2.1.2. Strata will work with each operator or landowner on a case-by-case basis to mitigate potential impacts if Strata's operations prevent the full use of a well. In addition and as discussed in KEA ER Section 5.4.2.1.2, mitigation measures will include the following:

1) Modifying stock or domestic wells suspected of experiencing drawdown with a sounding tube or similar device to allow periodic water level measurement.
2) Lowering the pump in an affected stock or domestic well.
3) Providing an alternate water source of equal or better quality and quantity subject to Wyoming State water law should Strata's activities prevent full use of a well.

As discussed in Section 4.12 of KEA TR Addendum 2.7-I, the wells most likely to be impacted are the EOR water supply wells located within the KEA and the current license area. Appendix A of KEA TR Addendum 2.7-I summarizes the flow rates and historical operations for all the wells within the KEA groundwater model domain. Not all of the wells are actively being used, and some wells are used intermittently. As discussed in KEA ER Section 5.4.2.1.2, some of the EOR water supply wells may not be needed in the future. Prior to operations in the vicinity of EOR water supply wells with the potential to be impacted by ISR operations, Strata will work with the operator to plug and abandon the wells and provide an alternate water source, as necessary. For example, Strata has entered into an agreement with the oil production company operating within the current license area to abandon the existing industrial water supply wells when Strata's ISR operations may interfere with the wells. As part of the agreement, Strata will provide an alternate source of water to replace the existing industrial water supply

wells. Strata anticipates that this agreement will serve as a template for any future agreements that may be necessary to avoid interference in the KEA.

Further, Strata acknowledges that the mitigation measures discussed in the KEA ER are not binding; however, SUA-1601 LC 10.19 requires Strata to demonstrate in the wellfield data package for wellfields south of the Little Missouri River that proposed operations are outside of the area of influence of the industrial wells. LC 10.19 further stipulates that any industrial wells located in a wellfield or a portion of a wellfield must be properly abandoned. In addition, LC 10.19 requires Strata to conduct monthly sampling of water from any industrial wells operating within the license area during ISR operations as part of the effluent monitoring program. Considering the commitments in place as prescribed by LC 10.19 as well as other commitments in LC 10.7 (maintaining an inward hydraulic gradient), LC 10.13 (defining heterogeneities that may affect groundwater flow) and LC 11.5 (excursion monitoring), managing the potential for interference between private wells and uranium recovery operations is clearly addressed in SUA-1601.

No revisions to the license amendment application are proposed in response to this RAI.

Section 5.7.7

RAI 5.7.7.1

Description of the Deficiency

The operational environmental monitoring program for the proposed Kendrick Expansion Area is planned to be conducted in accordance with recommendations contained in Regulatory Guides 4.14 (NRC 1980), 4.15 (NRC 2007) and 8.37 (NRC 1993).

In Section 5.7.7.1 of the TR for the Kendrick Expansion Area, Strata stated that field sample collection and/or measurement techniques will be conducted in accordance with accepted scientific protocols. The example field survey and sampling methods Strata noted are those described in NUREG/CR-5849, "Manual for Conducting. Radiological Surveys in Support of License Termination: Draft Report for Comment, "and/or NUREG-1575, "Multi-Agency Radiological Survey and Site Investigation Manual," as applicable.

The methods described in NUREG/CR-5849 have been updated by methods described in NUREG-1575. Their underlying methods in the two documents differ significantly and are not compatible. The NRC endorses the use of the MARSSIM approach for the design and execution of certain types of radiological surveys (Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria; NUREG-1757, Volume 2, Revision 1; 2006).

Basis for Request

NUREG-1569 Acceptance Criterion 5.7.7.3(4) states that the airborne effluent and environmental monitoring program is acceptable if the proposed sampling methods are consistent with guidance in Regulatory Guide 4.14 Section 3 (NRC, 1980).

Section 3 of Regulatory Guide 4.14 states that provisions should be made to ensure that representative samples are obtained by use of proper sampling equipment, proper location of sampling points, and proper sampling procedures.

MARSSIM provides guidance on how to plan and carry out a study to demonstrate that a site meets appropriate release criteria. It describes a methodology for planning, conducting, evaluating, and documenting environmental radiation surveys conducted to demonstrate compliance with cleanup criteria.

NUREG/CR-5849 is a draft report published in 1992 that has been superseded by NUREG- 1575 and its supplements. It is incorrect for applicants to use both guidance documents in their program because of significant differences in technical approaches between the two NUREG reports. The staff notes that NRC and other regulatory agencies have endorsed the use of NUREG-1575 for environmental measurements for more than a decade.

Request for Additional Information

Please provide additional information on the selection of field sample collection and/or measurement techniques in the operational environmental monitoring program using updated guidance, such as MARSSIM.

TR RAI 5.7.7.1 Response

The operational Environmental Monitoring Program (EMP) for the Ross ISR Project (which would incorporate the KEA upon amendment application approval) is based on the specifications found in NRC RG 4.14. NUREG-1569 Review Procedure 2.9.1 indicates that the reviewer should evaluate the baseline monitoring program against guidance provided in RG 4.14 as well as NUREG-5849 or NUREG–1575 (MARSSIM). This ISR-specific guidance suggests that acceptable analytical methods for environmental monitoring programs are not limited to those discussed in MARSSIM, and that NUREG-5849 may also contain suitable methods for some aspects, including elements of *operational* monitoring programs (i.e., if an analytical method is used for baseline monitoring, it should also be used for operational monitoring for consistency and minimization of analytical uncertainty). MARSSIM does not provide guidance for the *design* (i.e., locations, frequencies, etc.) of operational environmental monitoring programs, nor does NUREG-5849.

As noted by NRC in the basis for this RAI, MARSSIM pertains only to decommissioning surveys. The objectives are limited to post-operational identification of contamination on building surfaces and land areas, and after remediation, final status surveys to verify that dose-based release criteria [derived concentrations guideline levels (DCGLs)] have been met. Conversely, guidance on the design of operational environmental monitoring programs at uranium recovery facilities appears to be limited to RG 4.14 specifications. Under this guidance, acceptable analytical methods for most parameters are subject only to specifications on data quality (e.g., data uncertainty and detection limits). MARSSIM discusses operational monitoring data only in a context of helping to inform the design of final status surveys after remediation of building surfaces and land areas.

Appendix M of MARSSIM provides a list of publications that may be relevant to methods for environmental monitoring of groundwater, surface water, and air (generalized DOE and EPA guidance). No NRC references are given in MARSSIM with respect to sampling designs for operational environmental monitoring programs at uranium recovery facilities (RG 4.14 appears to be unique in this respect). RG 4.15 describes quality assurance for individual environmental and effluent monitoring measurements, and RG 8.37 provides guidance on ALARA concepts for effluent monitoring. The EMP for the Ross ISR Project is consistent with each of these guidance documents.

Appendix H of MARSSIM provides generic descriptions of available analytical methods for performing radiological field measurements and laboratory analysis of samples. It does not; however, advocate for the use of any particular type(s) for performing MARSSIM surveys. Instead, the Data Quality Objectives (DQO) process is used to select those that will meet the DQOs for the survey. Technologies and methods change over time, and some have advanced considerably since the publication of MARSSIM. For example, modern GPS-based gamma surveys with electronic data collection and retrospective GIS-based spatial analysis techniques, versus the manual survey approach described in MARSSIM of a human surveyor listening to audible count rate output from the detector and making real-time field decisions regarding the presence of contamination (Alecksen and Whicker 2016). The MARSSIM approach was designed to be flexible as every site is different and survey objectives and circumstances can vary.

A list of general elements of the EMP for the Ross ISR Project, the basis for respective monitoring designs, analytes, and analytical methods, and notes on consistency with MARSSIM guidance (where applicable) has been compiled in Table TR RAI 5.7.7.1-1. The analytical methods (as opposed to survey design) described in NUREG-5849 are identical to those found in MARSSIM (see Table 5-1 in NUREG-5849 and Table 6.1 in MARSSIM). Concepts described in the latter guidance suggest that older methods should not automatically be dismissed as unacceptable (e.g., they may produce data that meet the DQOs in a more cost-effective manner).

Because the *design* of the operational EMP for the Ross ISR Project (and the KEA) is not based on either MARSSIM or NUREG-5849 guidance, and since relevant analytical methods being used for the EMP at the Ross ISR (for both field and laboratory measurements) are consistent with those described in MARSSIM, references to NUREG-5849 in Section 5.7.7.1 of the KEA TR are unnecessary.

In summary, the operational EMP for the Ross ISR Project is consistent with RG 4.14 specifications, including sampling locations, field measurements, sampling techniques, and laboratory analysis methods. In some cases, analytical methods are also consistent with those described in MARSSIM for decommissioning surveys, though MARSSIM concepts on survey objectives/design are not applicable to the EMP. References to NUREG-5849 in Section 5.7.7.1 of the KEA TR, which include acceptable methods for environmental monitoring under NUREG-1569 guidance, are unnecessary and would be eliminated from the KEA TR pending acceptance of this response by NRC staff.

Table TR RAI 5.7.7.1-1 Summary of Radiological EMP parameters, Design, Analytes/Methods, and Consistency with MARSSIM Guidance

EMP Parameter	**Basis of Monitoring Program Design (locations/frequency)**	**Basis of Radioanalytes and Analytical Method(s)**	**Consistency with MARSSIM Guidance**
Air Particulates and Radon	RG 4.14	RG 4.14 (radioanalytes, LLD requirements)	• Particulates: N/A • Rn-222: N/A for objectives/design; Section 6.9 of MARSSIM for method
Direct Radiation	RG 4.14	RG 4.14 (TLD method, sensitivity)	• Section 6.5.1.4 of MARSSIM for method • N/A for objectives/design
Soil and Sediment	RG 4.14	RG 4.14 (radioanalytes, LLD requirements); Standard analytical lab methods	• Most lab methods listed in Appendix H of MARSSIM • N/A for objectives and design
Groundwater	RG 4.14; SUA-1601 License Conditions	WDEQ/LQD Guideline No. 4 (ref. to approved EPA methods); NRC RG 4.14 (analytes, LLD requirements)	N/A
Surface Water	RG 4.14; SUA-1601 License Conditions	Same EPA analytical methods as for groundwater; RG 4.14 (radioanalytes, LLD requirements)	N/A
Discharge Water	WDEQ-WQD issued WYPDES permits	WDEQ-WQD issued WYPDES permits; Approved EPA methods	N/A
Drinking Water Resources	EPA Safe Drinking Water Act; 40 CFR §141.2	National Primary Drinking Water Regulations (40 CFR §141.2); Approved EPA methods	N/A

Section 5.7.8

RAI 5.7.8-1

Description of Deficiency

In the Ross license application as originally approved, Strata proposed an extensive list of baseline parameters. Subsequently, Strata requested that the list be reduced. Staff approved that request through Amendment 2 to License SUA-1601, the basis for which is documented in the accompanying SER. However, the list in the Kendrick amendment differs from the approved list.

Basis for Request

SRP Review Procedure 5.7.8.2(1) states that the reviewer should "[v]erify that procedures for establishing baseline water quality include acceptable sample collection methods, a set of sampled parameters that is appropriate for the site and in situ leach extraction method, and collection of sample sets that are sufficient to represent any natural spatial and temporal variations in water quality."

Request for Additional Information

Please revise Table 5.7-2 "Wellfield Background Aqueous Sampling Parameter List" to be consistent with the approved list of parameters for this project or provide an analysis for the change in the list of parameters.

TR RAI 5.7.8-1 Response

KEA TR Table 5.7-2 has been updated to be consistent with the approved list of parameters as amended by License Amendment 2 of SUA-1601. The revised table is included with this response. Table 5.7-2 of the KEA TR would be replaced following acceptance of this response by NRC staff.

Table 5.7-2. Wellfield Background Aqueous Sampling Parameter List

Parameter	Units
Field	
Field conductivity	µmhos/cm
Field pH	s.u.
Depth to water	feet
Temperature	Deg C
General	
Alkalinity (as $CaCO_3$)	mg/L
Ammonia	mg/L
Fluoride	mg/L
Silica, dissolved	mg/L
Laboratory conductivity	µmhos/cm
Laboratory pH	s.u.
Nitrate/nitrite	mg/L
Total dissolved solids	mg/L
Major Ions	
Calcium	mg/L
Magnesium	mg/L
Potassium	mg/L
Sodium	mg/L
Bicarbonate	mg/L
Carbonate	mg/L
Chloride	mg/L
Sulfate	mg/L
Metals	
Aluminum, dissolved	mg/L
Arsenic, dissolved	mg/L
Barium, dissolved	mg/L
Boron, dissolved	mg/L
Cadmium, dissolved	mg/L
Chromium, dissolved	mg/L
Copper, dissolved	mg/L
Iron, dissolved	mg/L
Lead, dissolved	mg/L
Manganese, dissolved	mg/L
Mercury, dissolved	mg/L
Molybdenum, dissolved	mg/L
Nickel, dissolved	mg/L
Selenium, dissolved	mg/L
Silica, dissolved	mg/L
Silver, dissolved	mg/L
Uranium, dissolved	mg/L
Vanadium, dissolved	mg/L
Zinc, dissolved	mg/L
Radiological	
Ra-226, dissolved	pCi/L
Ra-228, dissolved	pCi/L
Gross alpha	pCi/L
Gross beta	pCi/L

RAI 5.7.8-2

Description of Deficiency

In Section 5.7.8.2 and on Figure 5.7-1 of the Kendrick TR, Strata discusses "potential" surface water sampling locations based on an evaluation in the wellfield data package for a specific mine unit. The potential locations include 3 monitoring stations, 6 grab stations and 13 reservoirs. In Section 2.7 of the Kendrick TR, Table 2.7-11 lists 19 reservoirs of which 18 are located within the proposed Kendrick area and the preoperational sampling conducted at four surface water sampling locations (Table 2.7-14), four grab stations and 18 reservoirs. The information provided in the application is insufficient in detail for staff to evaluate whether or not it meets the above review procedures, acceptance criterion or guidance or that the justification for departure from the guidance was adequate.

Basis for Request

Review procedure 5.7.8.2(6) states the reviewer should "[e]valuate whether a surface-water monitoring program is necessary at the site and, if so, whether the monitoring program will be effective to detect migration of contaminants into surface-water bodies." Acceptance criterion 5.7.8.3(5) states, in part, that "[p]rocedures for monitoring surface-water quality during operations should be discussed in the application: this discussion must include a monitoring schedule, monitor locations, and a list of sampled constituents. Strata may be exempted from monitoring during operations if the site characterization demonstrates that no significant flow of ground water to surface water occurs near the site (e.g., if surface-water bodies are perched and ephemeral)." Guidance in Regulatory Guide 4.14 states "[s]amples of surface water should be collected quarterly from each onsite water impoundment (such as a pond or lake) and any offsite water impoundment that may be subject to seepage from tailings, drainage from potentially contaminated areas, or drainage from a tailings impoundment failure.

Samples should be collected at least monthly from streams, rivers, any other surface waters or drainage systems crossing the site boundary, and any offsite surface waters that may be subject to drainage from potentially contaminated areas or from a tailings impoundment failure.

Any stream beds that are dry part of the year should be sampled when water is flowing. Samples should be collected at the site boundary or at a location immediately downstream of the area of potential influence."

Request for Additional Information

Please clarify and/or provide justification for the following:

a) *The closest location on the Little Missouri River upstream of the Kendrick area is reservoir TSRES03. Is TSRES03 representative of the upstream quality?*

TR RAI 5.7.8-2(a) Response

Reservoir TSRES03 would not be representative of the water quality upstream of the site during operation since proposed wellfields are located directly upstream and uphill of the reservoir. In order to satisfy the requirement for an upstream sample location on the Little Missouri River, Strata proposes to add an additional grab station location just outside the KEA boundary on the Little Missouri River. The new grab station location (GS7) is shown on Figure TR RAI 5.7.8-1-1 along with the other operational surface water monitoring sites as previously depicted on KEA TR Figure 5.7.8-1. KEA TR Figure 5.7.8-1 will be replaced following acceptance of this response by NRC staff.

In a Category 1 public meeting held on October 4, 2016 (ML16265A542) to discuss NRC RAIs, NRC staff noted that there is a discrepancy between KEA TR Figure 2.7-8 and KEA ER Figure 6.1-1 with respect to the location of monitoring site GS2. The location of GS2 in KEA TR Figure 2.7-8, which was sampled during preoperational baseline, was located within the proposed KEA. Due to its location downstream of proposed wellfields the site was moved upstream and just outside the KEA boundary for operational surface water monitoring as shown on KEA ER Figure 6.1-1. The updated location meets the recommendations of RG 4.14.

During the public meeting NRC staff also requested the GPS coordinates of the potential operational surface water monitoring sites. These coordinates are provided in Table TR RAI 5.7.8-2-1.

Table TR RAI 5.7.8-2-1 Locations of Potential Operational Surface Water Monitoring Sites

Potential Surface Water Monitoring Site ID	**Surface Water Monitoring Site Type**	**Coordinates (WGS84)**	
		Latitude	**Longitude**
SW-1	Surface Water Station	44.58760	-104.94265
SW-2	Surface Water Station	44.56992	-104.96157
SW-3	Surface Water Station	44.57545	-104.96854
GS1	Grab Sample	44.60411	-104.94566
GS2	Grab Sample	44.57617	-105.00121
GS3	Grab Sample	44.53246	-105.00980
GS4	Grab Sample	44.52382	-105.00792
GS5	Grab Sample	44.50729	-104.96533
GS6	Grab Sample	44.60712	-104.96953
GS7	Grab Sample	44.55337	-105.00019
P732S	Reservoir	44.60244	-104.94406
TSRES01	Reservoir	44.57736	-104.97475
P19820S	Reservoir	44.56019	-104.98922
CSRES13	Reservoir	44.55378	-104.95205
CSRES06	Reservoir	44.55269	-104.95217
P4869S	Reservoir	44.55260	-104.98745
P514S	Reservoir	44.54652	-104.98428
TSRES05	Reservoir	44.54505	-104.97805
SCHRES03	Reservoir	44.54145	-104.98972
P8531R	Reservoir	44.52378	-104.95861
SCHRES01	Reservoir	44.51772	-104.98109
SCHRES04	Reservoir	44.51395	-104.99355
P4010S	Reservoir	44.51161	-104.98314

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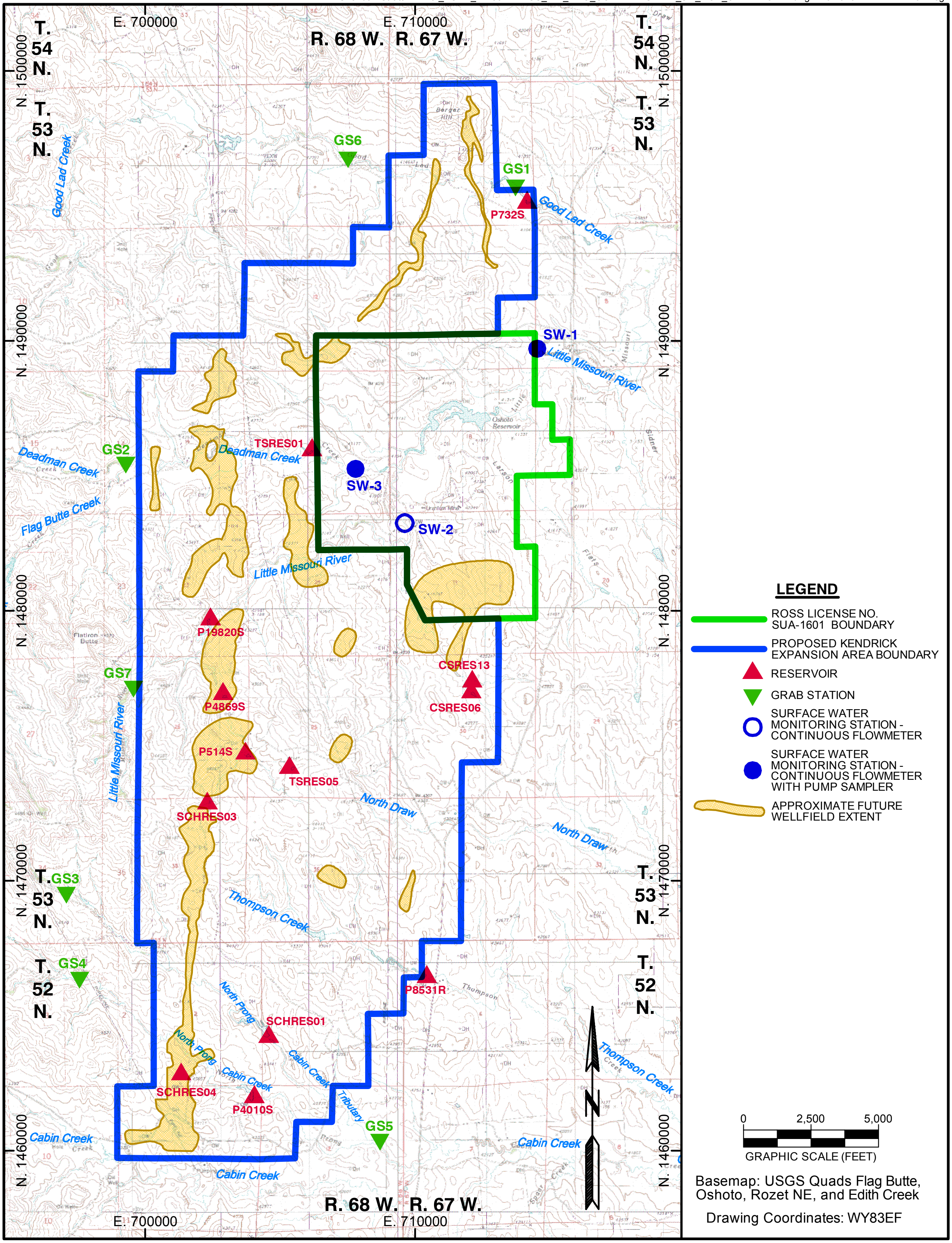

Figure TR RAI 5.7.8-2-1. Potential Operational Surface Water Monitoring Network.

RAI 5.7.8-2

<u>*Description of Deficiency*</u>

In Section 5.7.8.2 and on Figure 5.7-1 of the Kendrick TR, Strata discusses "potential" surface water sampling locations based on an evaluation in the wellfield data package for a specific mine unit. The potential locations include 3 monitoring stations, 6 grab stations and 13 reservoirs. In Section 2.7 of the Kendrick TR, Table 2.7-11 lists 19 reservoirs of which 18 are located within the proposed Kendrick area and the preoperational sampling conducted at four surface water sampling locations (Table 2.7-14), four grab stations and 18 reservoirs. The information provided in the application is insufficient in detail for staff to evaluate whether or not it meets the above review procedures, acceptance criterion or guidance or that the justification for departure from the guidance was adequate.

<u>*Basis for Request*</u>

Review procedure 5.7.8.2(6) states the reviewer should "[e]valuate whether a surface-water monitoring program is necessary at the site and, if so, whether the monitoring program will be effective to detect migration of contaminants into surface-water bodies." Acceptance criterion 5.7.8.3(5) states, in part, that "[p]rocedures for monitoring surface-water quality during operations should be discussed in the application: this discussion must include a monitoring schedule, monitor locations, and a list of sampled constituents. Strata may be exempted from monitoring during operations if the site characterization demonstrates that no significant flow of ground water to surface water occurs near the site (e.g., if surface-water bodies are perched and ephemeral)." Guidance in Regulatory Guide 4.14 states "[s]amples of surface water should be collected quarterly from each onsite water impoundment (such as a pond or lake) and any offsite water impoundment that may be subject to seepage from tailings, drainage from potentially contaminated areas, or drainage from a tailings impoundment failure.

Samples should be collected at least monthly from streams, rivers, any other surface waters or drainage systems crossing the site boundary, and any offsite surface waters that may be subject to drainage from potentially contaminated areas or from a tailings impoundment failure.

Any stream beds that are dry part of the year should be sampled when water is flowing. Samples should be collected at the site boundary or at a location immediately downstream of the area of potential influence."

<u>*Request for Additional Information*</u>

Please clarify and/or provide justification for the following:

b) *Based on the proposed mine units, please provide a listing of which specific surface sampling locations will be sampled for the proposed mine unit as currently envisioned.*

TR RAI 5.7.8-2(b) Response

Table TR RAI 5.7.8-2-2 lists the surface water sampling sites which would potentially be monitored during operation of each Mine Unit. The table does not show the cumulative monitoring that would occur as mine unit development progresses, but rather which sites could be monitored for operations under each individual mine unit. As stated in Section 5.7.8.2 of the KEA TR, the surface water sampling locations would be confirmed by the Safety and Environmental Review Panel (SERP) during evaluation of the wellfield package for each mine unit.

Table TR RAI 5.7.8-2-2 Potential Operational Surface Water Monitoring Sites by Mine Unit

Proposed Mine Unit ID	**Potential Operational Surface Water Sites**
A	SW-1, GS1, GS6, P732S
B	SW-1, GS1, GS6, P732S
C	SW-3, GS2, TSRES01
D	SW-2, SW-3, GS7, TSRES01
E	SW-2, GS7, P19820S, P4869S
F	SW-2, TSRES05, P514S, P4869S, P19820S
G	GS3, GS4, P4010S, SCHRES01, P8531R, SCHRES03
H	GS4, GS5, P4010S, SCHRES04
3 Ext[1] (KEA Portion)	SW-2, CSRES06, CSRES13

1 Mine Unit 3 Ext is an extension into KEA Sections 19 and 30 of T53N, R67W of Ross Mine Unit 3.

RAI 5.7.8-2

Description of Deficiency

In Section 5.7.8.2 and on Figure 5.7-1 of the Kendrick TR, Strata discusses "potential" surface water sampling locations based on an evaluation in the wellfield data package for a specific mine unit. The potential locations include 3 monitoring stations, 6 grab stations and 13 reservoirs. In Section 2.7 of the Kendrick TR, Table 2.7-11 lists 19 reservoirs of which 18 are located within the proposed Kendrick area and the preoperational sampling conducted at four surface water sampling locations (Table 2.7-14), four grab stations and 18 reservoirs. The information provided in the application is insufficient in detail for staff to evaluate whether or not it meets the above review procedures, acceptance criterion or guidance or that the justification for departure from the guidance was adequate.

Basis for Request

Review procedure 5.7.8.2(6) states the reviewer should "[e]valuate whether a surface-water monitoring program is necessary at the site and, if so, whether the monitoring program will be effective to detect migration of contaminants into surface-water bodies." Acceptance criterion 5.7.8.3(5) states, in part, that "[p]rocedures for monitoring surface-water quality during operations should be discussed in the application: this discussion must include a monitoring schedule, monitor locations, and a list of sampled constituents. Strata may be exempted from monitoring during operations if the site characterization demonstrates that no significant flow of ground water to surface water occurs near the site (e.g., if surface-water bodies are perched and ephemeral)." Guidance in Regulatory Guide 4.14 states "[s]amples of surface water should be collected quarterly from each onsite water impoundment (such as a pond or lake) and any offsite water impoundment that may be subject to seepage from tailings, drainage from potentially contaminated areas, or drainage from a tailings impoundment failure.

Samples should be collected at least monthly from streams, rivers, any other surface waters or drainage systems crossing the site boundary, and any offsite surface waters that may be subject to drainage from potentially contaminated areas or from a tailings impoundment failure.

Any stream beds that are dry part of the year should be sampled when water is flowing. Samples should be collected at the site boundary or at a location immediately downstream of the area of potential influence."

Request for Additional Information

Please clarify and/or provide justification for the following:

c) *Please clarify why not all reservoirs within the Kendrick area are included in the operational monitoring program.*

TR RAI 5.7.8-2(c) Response

Strata selected the reservoirs which would be included in the operational surface water monitoring program based on guidance presented in Table 2 of RG 4.14. Table 2 of

RG 4.14 states that the operational monitoring program should include impoundments which could be subject to drainage, or influenced by seepage from potentially contaminated areas. Based on these recommendations, all reservoirs upstream of potential wellfield areas or facilities were excluded from the operational monitoring network. In instances where multiple reservoirs were located in the same drainage downstream of potential wellfield areas or facilities, Strata selected reservoirs which would provide the best chance of obtaining a viable sample (i.e. larger reservoirs with less chance of being dry during sampling and reservoirs which are the most accessible during inclement weather conditions).

Section 6.3

RAI 6.3-1

Description of the Deficiency

Strata currently disposes of its municipal waste at the Campbell County Landfill, and disposes of solid byproduct material at the Pathfinder Mines Corporation site in Shirley Basin, Wyoming.

Strata committed to adhering to the procedures for removing and disposing of structures and equipment of the proposed Kendrick Expansion Area as described in Section 6.3 of the TR for the Ross ISR Project.

A proposed modification to this commitment is to add a disposal option that would allow non- contaminated and decontaminated material to be disposed in a permitted on-site disposal facility. Section 1.10 of the Kendrick Technical Report states that solid waste will include construction debris and decontaminated material and equipment. A portion of solid waste is planned for disposal at lined retention ponds, following pond decommissioning. Strata's 2015 annual surety estimate for SUA-1601 assumes that 100 percent of concrete with no potential for contamination (e.g., building footings) and 80 percent of concrete with potential for contamination (e.g., CPP and CPP Truck Bay buildings) would be disposed on site (Strata 2016). The planned location of the future non-site landfill is within the lined retention ponds, following pond decommissioning.

Materials disposed in the on-site facility would consist of construction debris, piping, and equipment that meet surface contamination limits referenced in Section 5.7.6.3.2 of the approved Ross TR. The surface contamination limits are those contained in NRC document FC 83-23," Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source and Special Nuclear Material (1987)." This guidance applies to solid material with surface contamination, but it is not applicable to solid material with volumetric contamination, such as concrete. Also, the total inventory of residual radioactivity buried in the disposal cell would need to be accounted for, as part of demonstrating compliance with license termination criteria contained in 10 CFR Part 40, Appendix A, Criterion 6(6).

Basis for Request

Review Procedure 6.3.2 states that staff should review provisions made for the removal and disposal of byproduct material to an existing uranium mill or licensed disposal sites to ensure that requirements of 10 CFR 40, Appendix A, Criterion 2, are met. Criterion 2 states that, to avoid proliferation of small waste disposal sites and thereby reduce perpetual surveillance obligations, byproduct material from in situ extraction operations, such as residues from solution evaporation or contaminated control processes, and wastes from small remote above ground extraction operations must be disposed of at existing large mill tailings disposal sites; unless, considering the nature of the wastes, such as their volume and specific activity, and the costs and environmental impacts of transporting the wastes to a large disposal site, such offsite disposal is demonstrated to be impracticable or the advantages of onsite burial clearly outweigh the benefits of reducing the perpetual surveillance obligations. In addition, Strata needs to account for the onsite

disposed material as part of demonstrating compliance with license termination criteria contained in 10 CFR Part 40, Appendix A, Criterion 6(6).

If a licensee plans to bury solid material onsite with surficial or volumetric residual radioactivity that meets FC 83-23 limits, an evaluation of the proposed disposal method and materials is required. 10 CFR 20.2001 identifies the mechanisms by which a licensee may lawfully dispose of its licensed radioactive waste. One of the mechanisms is an alternative disposal authorization in accordance with 10 CFR 20.2002, which allows disposal within a licensee's site of low-activity wastes that contain residual radioactivity. NRC guidance on evaluating onsite disposal requests under 20.2002 in contained in NUREG-1757, Volume 1, Section 15.12.

Request for Additional Information

Please provide additional information on Strata's proposed disposal of material and equipment in an onsite disposal facility located in the current Ross license area. Requests to dispose of material that contains, or is suspected of containing, residual radioactivity in an onsite location needs to be approved by the NRC using procedures established for compliance with 10 CFR 20.2002, "Method for obtaining approval of proposed disposal procedures."

TR RAI 6.3-1 Response

The KEA TR in Sections 1.10 and 6.3 discuss the potential disposal of non-11.e(2) solid waste in an on-site disposal facility that would be properly permitted by the WDEQ-SHWD. Strata believes that this approach would adequately protect the public health and environment while saving space in the local landfills. However, the characteristics of the "clean" concrete are not known at this time and should be based on the actual measurement of residual radioactive material present in the concrete at the time of decommissioning. Therefore, Strata believes that the proposal to dispose of this material on-site and the required analysis should be deferred until preparation of the Decommissioning Plan required under LC 10.3. Accordingly, Strata withdraws the proposal to dispose of clean concrete on site. The Ross surety will be revised to reflect this change in the next annual update, which is scheduled for submittal to WDEQ-LQD and NRC by November 17, 2016. Pending approval of this RAI response package, KEA TR pages 1-9 and 6-7 would be replaced to reflect the change in the disposal method for non-11e.(2) solid waste material.

Section 6.4

RAI 6.4-1

Description of the Deficiency

Section 6.4 of the TR for the Kendrick Expansion Area states Strata does not propose to revise the existing RESRAD model used in the Ross ISR Project to calculate site-specific soil cleanup criteria for the Kendrick Expansion Area. The rationale for not performing new RESRAD calculations is the similarity of the environment and land use characteristics between the Ross ISR Project and Kendrick Expansion Area sites. Section 6.4 does not provide additional justification for not performing a site-specific analysis of the Kendrick Expansion Area.

Based on the limited information provided, the staff can't verify that input parameters for a RESRAD model of the Kendrick Expansion Area are similar to those used for the Ross ISR Project, or that RESRAD results would be similar for soil cleanup criteria in the Kendrick Expansion Area.

Also, Section 6.4.1 of the TR for the Ross ISR site provides an analysis for a natural uranium cleanup standard of 479 pCi/gm, based on a RESRAD model using site-specific parameters and the Radium Benchmark Dose Approach method described in NUREG-1569 Appendix E. The licensee is required, however, to develop soil cleanup criteria that accounts for Th-230, if elevated levels are indicated in soil samples collected during decommissioning. This commitment was not mentioned in the TR.

Basis for Request

NUREG-1569 Acceptance Criterion 6.4.3(1) states that cleanup criteria for radium in soils are met as provided in 10 CFR Part 40, Appendix A, Criterion 6(6). This criterion states that the design requirements for longevity and control of radon releases apply to any portion of a licensed and/or disposal site unless such portion contains a concentration of radium in land, averaged over areas of 100 m2, which as a result of byproduct material, does not exceed the background level by more than:

i. 5 picocuries per gram (pCi/g) of radium-226, or, in the case of thorium byproduct material, radium-228, averaged over the first 15 cm [5.9 in.] below the surface; and

ii. 15 pCi/g of radium-226, or, in the case of thorium byproduct material, radium- 228, averaged over 15-cm [5.9-in.] thick layers more than 15 cm [5.9 in.] below the surface."

NUREG-1569 Acceptance Criterion 6.4.3(3) states that acceptable cleanup criteria for uranium in soil, such as those in Appendix E of the SRP, are proposed by the applicant. This is the radium benchmark dose approach of 10 CFR Part 40, Appendix A, Criterion 6(6).

NUREG-1569 Acceptance Criterion 6.4.3(4) states that, for areas that already meet the radium cleanup criteria but that still have elevated thorium levels, Strata proposes an acceptable cleanup criterion for thorium-230. One acceptable criterion is a concentration that, combined with the residual concentration of radium-226, would result in the radium

concentration (residual and from thorium decay) that would be present in 1,000 years meeting the radium cleanup standard.

NUREG-1569 Appendix E Acceptance Criterion E2.1.3 item (2) states that "code/calculation input data are appropriate for the site and represent current or long-term conditions, whichever is more applicable to the time of maximum dose. When code default values are used, they are justified as appropriate (representative) for the site."

Request for Additional Information

Please develop soil cleanup criteria using a site-specific analysis for the Kendrick Expansion Area (e.g., soil type, wind speed, precipitation, etc.) which will be developed using RESRAD to derive site-specific soil cleanup criteria. As part of this analysis, differences in site-specific parameters between the Kendrick Expansion Area and Ross ISR Project sites should be summarized. Also, the analysis should address Th-230 in soil samples collected during decommissioning in the Kendrick Expansion Area.

TR RAI 6.4-1 Response

As proposed in a Category 1 public meeting held on October 4, 2016 (ML16265A542) to discuss NRC RAIs, Strata will treat the Ross and KEA areas as a single licensed area in terms of soil decommissioning criteria. Accordingly, and in response to this RAI, a new Radium Benchmark Dose (RBD) assessment was performed using site-specific RESRAD modeling parameters representative of conditions for both sites, and soil cleanup levels for natural uranium (U-nat) and thorium-230 (Th-230), known as derived concentration guideline levels (DCGLs), have been derived to apply across both areas. The discussion of the applicable regulatory framework for soil cleanup criteria provided in Section 6.4 of the Ross TR is incorporated by reference. A summary of the RBD assessment, including RESRAD model input parameter selections, RBD results, and respective derivation of soil cleanup criteria for U-nat and Th-230 is provided in the following sections of this response.

RESRAD Modeling Parameters

A resident rancher is an appropriate receptor modeling scenario for the Ross ISR Project, including the original Ross ISR site and the adjacent KEA, based on historical/current land uses, climate, water resources, etc. as detailed in the TR for each area. A resident rancher receptor scenario was thus used for site-specific modeling of an overall RBD for both the Ross and the KEA licensed areas with RESRAD (Version 7.2). Respective occupancy factors of 50% indoors and 25% outdoors were assigned based on RESRAD User's Manual guidance. It is assumed that a rancher would spend a similar amount of time outdoors as a resident farmer. Although NUREG-1569 suggests an outdoor occupancy of 50% for this scenario (25% indoors), this is believed to be an error in the guidance that has never been corrected. The RESRAD user's manual recommends 25% outdoors and 50% indoors for a farmer scenario. It is unrealistic to assume that a farmer or rancher would spend 12 hours per day, 365 days per year working outdoors, and NUREG-1569 indicates that use of overly conservative (or unrealistic) RBD model parameter assumptions is unacceptable.

Based on NUREG-1569 guidance, realistic receptor scenarios and modeling parameters are required for RBD modeling, and the size (area) of the modeled contamination zone should be based on the extent of known or expected areas of impacts across the site (NRC 2003; NRC 1998b). For conventional uranium mills, the contaminated area usually represents an area large enough to realistically accommodate a rancher or farmer receptor scenario, even in semi-arid climates in western States like Wyoming (e.g. on the order of several hundred acres). In the case of uranium ISR facilities, the potential extent of impacted soils is expected to be very small in comparison. The RBD modeling for Ross assumed a contaminated zone of 10,000 m^2 (about 2.5 acres) situated near a water body (e.g., Oshoto Reservoir). A contaminated zone area of this size is not an unreasonable assumption for an ISR site, and was therefore used for this RBD modeling. It was assumed that livestock will graze across a much larger area, most of which is outside of the contaminated area.

The concentrations of Ra-226 and Pb-210 in surface soils (0-15 cm) within the contaminated zone were each set at 5 pCi/g per 10 CFR 40, Appendix A specifications (no cover was assumed for the surface soil RBD modeling). For subsurface soils (15-30 cm), respective concentrations were set at 15 pCi/g each, with 15 cm of clean cover soil. Various modeling parameters that are related to soil properties were fundamentally based on combined soil texture data for Ross and the KEA (obtained from respective TRs), with fine sandy loam being the dominate soil type overall as shown on Figure TR RAI 6.4-1-1. Lacking direct data on the soil erosion rate, an estimate of this parameter was calculated in RESRAD-OFFSITE based on the Universal Soil Loss Equation (USLE) and estimates of related factors for site-specific conditions (Figure TR RAI 6.4-1-2). NUREG-1569 (Appendix E) indicates that the erosion rate should be less than the RESRAD default value and should be justified. The RESRAD-OFFSITE code was used to calculate this value based on the USLE with model parameter selections based on site-specific soil/vegetation data and table lookup values given in Appendix B of the RESRAD-OFFSITE User's Manual. Default USLE parameters (highlighted in yellow) were used where considered consistent with site-specific conditions.

The average annual wind speed and precipitation, based on 4 years of site-specific meteorological monitoring data, were 5.2 m/s and 0.391 m respectively (see KEA TR Section 2.5). There is no reason to believe that climatic conditions would vary significantly across the overall project area for both Ross and the KEA.

To avoid overly conservative parameter selections with respect to dietary parameters, it was assumed that the resident rancher diet consists of 1 percent of all aquatic food sources from the adjacent surface water body, and 10 percent of plant foods from a small garden situated within the contamination zone. While all meat was assumed to be sourced from within the overall project area, livestock cannot realistically be raised in this climate with forage exclusively grown within a 2.5-acre contaminated zone and thus, the fraction of potentially affected meat in the diet was lowered to 10 percent. Irrigation water for the garden and livestock was assumed to be sourced 100 percent from the adjacent reservoir or from groundwater wells, and all drinking water was assumed to come from a well within the contamination zone. Dose pathways involving milk and radon were deactivated per NUREG-1569 guidance.

A summary of site-specific RESRAD modeling parameters for the RBD assessment is provided in Table TR RAI 6.4-1-1. RESRAD default values were used for other modeling parameters.

Radium Benchmark Dose Modeling Results

As shown in Figure TR RAI 6.4-1-3, the maximum total dose from 5 pCi/g of Ra-226 and Pb-210 in surface soil (0-15 cm) for a resident rancher scenario within the combined Ross and KEA project areas occurs in year number one. This maximum total dose (27.9 mrem/yr), is defined as the RBD in accordance with 10 CFR 40, Appendix A, Criterion 6(6). The vast majority of the RBD is due to external gamma radiation from Ra-226 and its short lived decay products, with minor contributions (2 mrem/yr) from Pb-210 via plant and soil ingestion pathways. Inhalation and meat pathways are negligible (< 0.2 mrem/yr), and other pathways lack any contribution to dose within 1,000 years.

It is clear from these results that variability in soil type, geology, hydrology, or meteorology across the overall Ross/KEA project area will have negligible implications for the RBD since nearly all of the dose is due to external gamma radiation within the assumed contaminated zone. The same is true for results of RBD modeling for subsurface soil (Figure TR RAI 6.4-1-4) since the maximum dose (17.2 mrem/yr) occurs in year one (mostly due to external gamma radiation), and variability in parameters that affect soil erosion would make only a slight difference in the total dose in later years. Note that the dose from ingestion of plant foods (grain, vegetables and fruits) is higher for subsurface soil due to higher soil concentrations in the root zone and some plant uptake of Ra-226 (in addition to Pb-210). Dose from the inhalation and meat ingestion pathways remains negligible for the subsurface soil modeling scenario, and other pathways lack any contribution to dose over 1,000 years.

Derived Soil Cleanup Criteria for Thorium-230

Based on the RBD for surface soil (27.9 mrem/yr), a Th-230 soil concentration required to produce an equivalent maximum dose rate (a DCGL for Th-230) was modeled using the same receptor scenario, exposure pathways, and parameter assumptions. To accomplish this, a hypothetical and mathematically convenient soil concentration of 100 pCi/g was modeled for use in a scaling equation (Equation 1) to determine the DCGL for Th-230 at the RBD. Equation 1 is provided as follows:

$$\frac{\text{DCGL}}{\text{RBD}} = \frac{\text{Radionuclide Conc. of 100 pCi/g}}{\text{Max Dose from 100 pCi/g}} \qquad \text{(Equation 1)}$$

Where:
DCGL = Derived Concentration Guideline Level for radionuclide (pCi/g)
RBD = Radium Benchmark Dose (27.9 mrem/yr for surface soil, 17.2 pCi/g for subsurface soil)

For Th-230, the maximum dose from 100 pCi/g in surface soil (0-15 cm) is 16.6 mrem/yr (occurring at 210 years). Scaling this result against the surface soil RBD

with Equation 1 results in a DCGL for Th-230 in surface soil of 168 pCi/g. The dose is largely attributable to direct exposure to gamma radiation due to the ingrowth of Ra-226. The maximum dose occurs at year 210 then declines as the effect of erosion losses begins to exceed the effect of Ra-226 ingrowth. Contributions from ingestion pathways (soil and plant) and inhalation are relatively minor (a maximum combined dose of about 3 mrem/yr). Because the calculated DCGL for Th-230 concentrations in surface soil is higher than the numeric limit cited in NUREG-1569 (based on build-up of Ra-226 in excess of 5 pCi/g within 1,000 years), the latter limit for Th-230 (14 pCi/g) will be used as the cleanup level for Th-230 in surface soil.

For subsurface soil (15-30 cm with 15 cm of clean cover), the maximum dose from 100 pCi/g of Th-230 is 19.2 mrem/yr (occurring at 1,000 years). Scaling this result against the subsurface soil RBD with Equation 1 results in a DCGL for Th-230 in subsurface soil of 90 pCi/g. Again the dose is almost entirely attributable to direct exposure to gamma radiation due to the ingrowth of Ra-226. Contributions from ingestion pathways are again relatively minor (about 4 mrem/yr in year 1,000). Because the calculated DCGL for Th-230 concentrations in subsurface soil is higher than the numeric limit cited in NUREG-1569 (based on build-up of Ra-226 in excess of 15 pCi/g within 1,000 years), the latter limit for Th-230 (43 pCi/g) will be used as the cleanup level for Th-230 in subsurface soil.

Derived Soil Cleanup Criteria for Natural Uranium

Based on the RBD for surface soil (27.9 mrem/yr), a U-nat soil concentration required to produce an equivalent maximum dose rate (a DCGL for U-nat) was modeled using the same receptor scenario, exposure pathways, and parameter assumptions. A hypothetical soil concentration of 100 pCi/g was modeled for use in the scaling equation (Equation 1) to determine the DCGL for U-nat at the RBD. The isotopic composition of U-nat that was modeled based on the following natural radiological abundances: 48.9% each for U-238 and U-234, and 2.2% for U-235.

For U-nat, the maximum dose from 100 pCi/g in surface soil (0-15 cm) is 5.6 mrem/yr (in year one). Scaling this result against the surface soil RBD with Equation 1 results in a DCGL for U-nat in surface soil of 498 pCi/g. The dose due to U-nat at this DCGL in surface soil is mostly attributable to direct gamma radiation from decay products and U-238. Contributions from ingestion and inhalation pathways are small (on the order of 1 mrem/yr total).

For subsurface soil (15-30 cm with 15 cm of clean cover), the maximum dose from 100 pCi/g of residual U-nat is 0.59 mrem/yr (occurring in year one). Scaling this result against the subsurface soil RBD with Equation 1 results in a DCGL for U-nat in subsurface soil of 2,915 pCi/g. The dose is mostly attributable to direct gamma radiation, with the plant ingestion pathway contributing about half that of the external dose.

Appendix E of NUREG-1569 indicates that chemical toxicity should also be considered in deriving a soil uranium concentration limit if soluble forms of uranium are present. The solubility of potential residual uranium at the site has not been established. The Agency for Toxic Substances and Disease Registry has published a toxicological profile

for uranium (ATSDR 2013), which includes the following recommended Minimal Risk Levels (MRL) for uranium intakes based on chemical toxicity:

- Ingestion intake limit = 51.2 mg/yr (based on toxicity for a 70 kg adult)
- Air concentration limit for inhalation intakes (insoluble forms) = 8 μg/m^3
- Air concentration limit for inhalation intakes (soluble forms) = 0.4 μg/m^3

The calculated DCGLs for U-nat in surface soil and subsurface soil (498 and 2,915 pCi/g respectively), were used to generate estimates of corresponding intakes to compare against these ATSDR limits. Equations for calculation of relevant ingestion and inhalation intake metrics are as follows:

$$\text{Ingestion}\left({}^{mg}/_{yr}\right)=\left(SC\frac{pCi}{g}\right)\left(\frac{{}^{mg}/_{kg}}{0.677\,{}^{pCi}/_{g}}\right)\left(0.001\,{}^{kg}/_{g}\right)\left(SIR\;{}^{g}/_{yr}\right)$$

$$\text{Air Conc.}\left({}^{\mu g}/_{m^3}\right)=\left(SC\frac{pCi}{g}\right)\left(\frac{{}^{mg}/_{kg}}{0.677\,{}^{pCi}/_{g}}\right)\left(1000\,{}^{\mu g}/_{mg}\right)\left(0.001\,{}^{kg}/_{g}\right)\left(MLI\;{}^{g}/_{m^3}\right)$$

Where:

		Value used	Parameter Source
SC =	soil concentration	DCGL	Calculated
SIR =	soil ingestion rate	36.5 g/yr	(RESRAD default)
MLI =	mass loading for inhalation	0.0001 g/m^3	(RESRAD default)

These calculations assume that the concentration of U-nat in ingested or inhaled soil particles is equivalent to that residing in bulk soil. Resulting uranium intake pathway estimates are shown in Table TR RAI 6.4-1-2. These results indicate that chemical toxicity is a limiting consideration only with respect to the calculated DCGL for U-nat in subsurface soils. Although the 15-cm cover layer would not be expected to be completely eroded until 1,000 years have elapsed (presumably largely preventing inhalation or ingestion intakes during this period), the subsurface DCGL for U-nat was adjusted downwards to 951 pCi/g to match the MRL from ATSDR for U-nat ingestion based on toxicity considerations (this is the most limiting intake pathway). This approach is conservative and consistent with ALARA principles.

Summary of Soil Cleanup Criteria and Applicability

The preceding DCGLs for the Ross and KEA project areas, along with numeric standards and/or toxicity adjustments (where applicable), are summarized in Table TR RAI 6.4-1-3. The final soil cleanup criteria represent the maximum above-background concentrations in soil expected to meet NRC criteria for release of the site for unrestricted future use. These criteria do not include the additional ALARA requirement specified in Criterion 6(6). Appendix E of NUREG-1569 describes removing an additional 2 inches of soil as a potentially appropriate measure to fulfill this requirement.

Each individual soil cleanup criterion in Table TR RAI 6.4-1-3 assumes that no other residual radionuclides are present in excess of background levels. If this is not the case, the unity rule as defined in 10 CFR 40 (Appendix A) will be used to verify that the sum of fractions for U-nat, Th-230 and Ra-226 concentrations relative to their individual

cleanup criteria do not exceed unity (a value of 1). Any 100 m^2 area containing more than one of these radionuclides in excess of background levels must meet the sum of fractions or "unity rule", which for this site is defined as follows:

$$\frac{Conc._{U\text{-}nat}}{DCGL_{U\text{-}nat}} + \frac{Conc._{Th\text{-}230}}{DCGL_{Th\text{-}230}} + \frac{Conc._{Ra\text{-}226}}{DCGL_{Ra\text{-}226}} \leq 1 \qquad \text{(Equation 2)}$$

Where:
$DCGL_{Ra\text{-}226}$ = 5 pCi/g for surface soils, 15 pCi/g for subsurface soils
$DCGL_{Th\text{-}230}$ = 14 pCi/g for surface soils, 43 pCi/g for subsurface soils
$DCGL_{U\text{-}nat}$ = 498 pCi/g for surface soils, 951 pCi/g for subsurface soils

Table TR RAI 6.4-1-1. Site-Specific RESRAD Modeling Parameters for the Resident Rancher Receptor Scenario

Model Parameter	Parameter Value	Rationale/Comments	Source/Reference
Occupancy / Gamma			
Fraction onsite indoor occupancy	0.5	Assumes rancher occupancy similar to resident farmer	Table 2.3, RESRAD Version 6 User's Manual
Fraction onsite outdoor occupancy	0.25	Assumes rancher occupancy similar to resident farmer (about 42 hr/wk annually working outdoors onsite)	Table 2.3, RESRAD Version 6 User's Manual
Gamma penetration factor	0.6	Mid-point of range given in guidance	Appendix E, NUREG-1569
Contamination Zone			
Area (m^2)	10,000 (about 2.5 acres)	Reasonable estimate of maximum area of contaminated soil for ISR site	
Thickness (m)	0.15	Defined by regulatory cleanup criteria	10 CFR 40, Appendix A
Soils (General)			
Soil b Parameter	5.3	Value indicated in RESRAD guidance for silty loam soil (most of site is fine sandy loam – nearest match in guidance is silty loam)	Table E.2, RESRAD Version 6 User's Manual
Runoff Coefficient	0.4	Value indicated in RESRAD guidance for sandy loam soil (most of site is fine sandy loam – nearest match in guidance is sandy loam)	Table E.1, RESRAD Version 6 User's Manual
Total Porosity	0.43	Mean for fine sand	Table E.8, RESRAD Version 6 User's Manual
Soil Erosion Rate (m/yr)	1.5E-4	Calculated value based on the USLE as generated in RESRAD-OFFSITE using estimated soil/vegetation/climate parameters (e.g. for semi-arid rangeland and sandy loam soils)	Table values found in Appendix B of RESRAD-OFFSITE User's Manual
Unsaturated Zone			
Thickness (m)	70	Mid-point between shallowest livestock watering well within the Ross permit area (39 m), and the shallowest domestic or livestock well within the KEA (100 m).	Site-specific estimate based on groundwater use data provided in the Ross and KEA Technical Reports.
Density (g/cm3)	2.1	Site-specific geologic rock density data	Table 7.3-2 of TR for KEA
Porosity / Effective Porosity	0.34 / 0.27	Average values for sandstone reported in RESRAD User's Manual	Table E.8, RESRAD Version 6 User's Manual
Meteorological Data			
Average Wind Speed (m/s)	5.2 (11.7 mph)	Site-specific meteorological station data (2010 – 2014)	Section 2.5 of Technical Report for KEA
Annual Precipitation (m)	0.391 (15.4 inches)	Site-specific meteorological station data (2010 – 2014)	Section 2.5 of Technical Report for KEA
Evapotranspiration Coefficient	0.8	Mean of cited range for semi-arid uranium mill sites	Appendix H, NUREG-1620

Table TR RAI 6.4-1-2. Calculated Uranium Intake Estimates Based on DCGL Values in Comparison to Corresponding ATSDR Limits

Intake Toxicity Parameter	Recommended Limit (ATSDR)	U-nat DCGL (pCi/g)	
		498 (surface)	2,915 (subsurface)
Ingestion Intake (mg/yr)	51.2	26.8	157
Inhalation air conc. (µg/m³)	8[1] / 0.4[2]	0.29	0.43

[1] Limit for insoluble forms of U-nat
[2] Limit for soluble forms of U-nat

Table TR RAI 6.4-1-3 Summary of Soil Cleanup Criteria for the Ross and KEA Project Areas

Soil Decommissioning Criteria for Surface Soils (0-15 cm)[1]					
Radionuclide	**RBD (mrem/yr)**	**Calculated DCGL (pCi/g)**	**Toxicity Adjustment (pCi/g)**	**Numeric Standard (pCi/g)**	**Final Soil Cleanup Criterion (pCi/g)***
Ra-226	27.9	-	-	5	5
Th-230	27.9	168	-	14	14
U-nat	27.9	498	-	-	498

Soil Decommissioning Criteria for Subsurface Soils (> 15 cm)[1]					
Radionuclide	**RBD (mrem/yr)**	**Calculated DCGL (pCi/g)**	**Toxicity Adjustment (pCi/g)**	**Numeric Standard (pCi/g)**	**Final Soil Cleanup Criterion (pCi/g)***
Ra-226	17.2	-	-	15	15
Th-230	17.2	90	-	43	43
U-nat	17.2	2,915	951	-	-

[1] Above background (baseline) values, pending Application of Criterion 6(6) ALARA requirement.

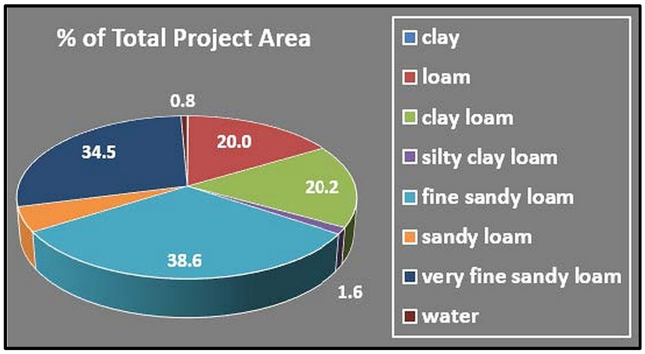

Figure TR RAI 6.4-1-1. Soil Type and Surface Water Coverage as a Percentage of the Total Project Area (Ross and KEA combined)

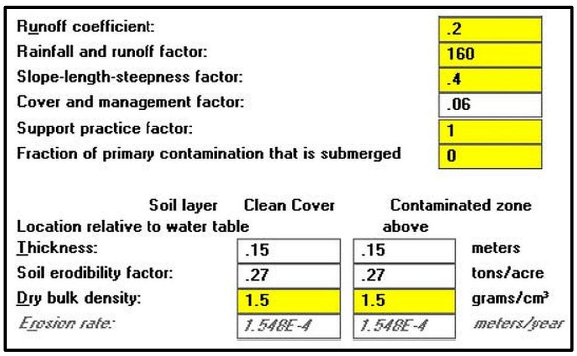

Figure TR RAI 6.4-1-2. USLE Modeling Parameters and Calculation in RESRAD-OFFSITE.

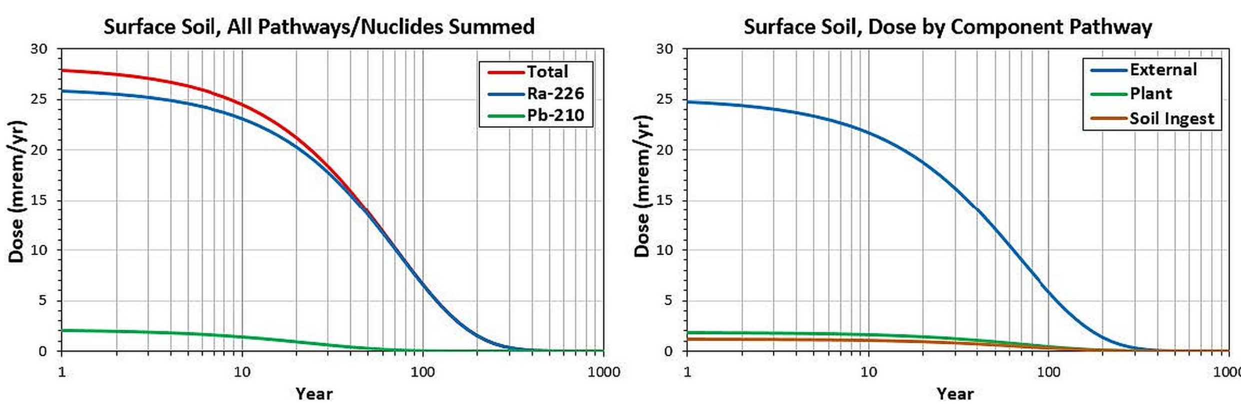

Figure TR RAI 6.4-1-3. RESRAD Dose Modeling Results for the Resident Rancher Receptor Scenario and 5 pCi/g of Ra-226 and Pb-210 in Surface Soil (0-15 cm)

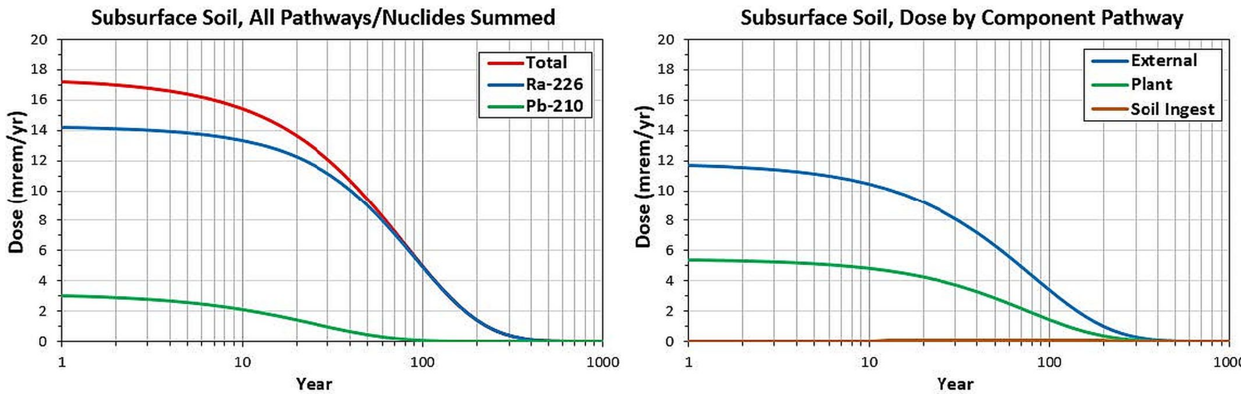

Figure TR RAI 6.4-1-4. RESRAD Dose Modeling Results for the Resident Rancher Receptor Scenario and 15 pCi/g of Ra-226 and Pb-210 in Subsurface Soil (15-30 cm, with 15 cm of clean cover soil)

Section 7.3

RAI 7.3-1

Description of Deficiency

With regard to modeling the public dose using MILDOS-AREA, the December 2010 version of the Ross ISR Project TR, Section 7.3.4.4, "Source Term Estimates," states that Strata used the source term methodology in NUREG-1569, Appendix D (ADAMS Accession Number ML110130335). Strata provided its input assumptions for calculating the source terms in Table 7.3-2, "MILDOS-AREA Input Parameters." Using this methodology, Strata reported wellfield leak rate source terms from production operations in Mine Unit 1 and 2 of 122 Ci/yr and 123 Ci/yr, respectively. Strata's estimate of the purge (bleed) source term was 70.2 Ci/year and the ion exchange resin transfer source term was 1.0 Ci/yr. Although Strata stated in Table 7.3-2 that the restoration wellfield flow rates would be lower than production flow rates, Strata stated that the source terms during mine unit restoration would be the same, except that the ion exchange resin transfer source term is zero. The source term values are summarized in Table 7.3-4 of the Ross ISR Project TR.

In Section 7.3.5.1, "Central Processing Plant Source Term," of the Kendrick Expansion Area TR (ADAMS Accession Number ML15096A157), Strata states that the method it used to estimate the radon source term was based on Regulatory Guide 3.59, rather than the NUREG-1569, Appendix D, methodology it originally used for the Ross ISR Project, as described above.

Strata derived a Regulatory Guide 3.59 source term of 2,552 Ci/year and stated:

To reflect the modern CPP design, it is assumed that 10% of this value is released from the center of the CPP as a radiological effluent, an assumption that was accepted in the NRC staff's SER for the Ross ISR Project.

On this basis, Strata asserted that the [Central Processing Plant] source term is 255.2 Ci/year. To the contrary, since Strata did not use the Regulatory Guide 3.59 methodology in the Ross ISR Project TR, but rather used the NUREG-1569, Appendix D methodology, the staff has neither previously evaluated nor has it approved a reduction of the Regulatory Guide 3.59 source term at Ross to 10% of the calculated value to estimate emissions from the Central Processing Plant.

Furthermore, in Section 7.3.5.3, "Operating Mine Units," of the Kendrick Expansion Area TR, Strata stated:

The methodology presented in NUREG-1569, Appendix D, is not a good fit for modern ISR mine units like those proposed for the KEA and those approved at the Ross ISR Project. This methodology includes source term contributions from large scale, open atmosphere ponds or reservoirs, a process that will not occur at the Ross ISR Project and proposed KEA due to use of deep well disposal methods.

This statement is incorrect. The methodology described in NUREG-1569, Appendix D is generally applicable to ISR facilities, whether or not there are ponds or reservoirs. Strata also stated:

Accordingly, the only release in the wellfield area itself is the result of well venting at a rate of 0.01 relative to the amount of radon in process fluids; and

NUREG-1569, Appendix D provides an estimate of a venting factor for mine units of 0.01, such that it is assumed that 1% of radon available in the process water may be emitted by venting at the mine units.

These statements are incorrect because the wellfield leak rate assumed in NUREG-1569, Appendix D is 1% <u>per day</u> of the total radon-222 activity in solution. The 1% per day value in NUREG-1569, Appendix D is not correctly interpreted to mean 1% of the radon-222 activity which passes through the CPP each year. Strata made the same mistake in Section 7.3.5.4, "Restoration of Mine Units," when estimating the source term from restoration of the Kendrick mine units.

Therefore, the source term methodology presented by Strata in Section 7.3.5.3 and 7.3.5.4 is incorrect. Since NRC staff has approved use of the methodology in NUREG-1569, Appendix D for the Ross ISR Project, the same method could be used for the Kendrick Expansion Area, or Strata could develop an alternative methodology for the entire licensed area with appropriate explanation and justification.

<u>Basis for Request</u>

NUREG-1569, Acceptance Criterion 7.3.1.2.3(5) states, "The parameters used to estimate the source term, environmental concentrations, and exposures are applicable to conditions at the site as reviewed in Section 2.0 of this standard review plan. Guidance on source term calculations is available in Regulatory Guide 3.59, Sections 1–3, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (NRC, 1987). Additionally, an example source term calculation specifically applicable to in situ leach facilities is described in Appendix D."

<u>Request for Additional Information</u>

Please correct the description of the source term methodology in Section 7.3.5 of the Kendrick Expansion Area TR and calculate revised source terms for each mine unit for both production and restoration.

<u>TR RAI 7.3-1 Response</u>

The source terms for the CPP and each mine unit have been updated to be consistent with methods contained in Section 7.3.4.4 of the Ross TR, and in NUREG-1569, Appendix D. Parameters in Table 7.3-2 of the KEA TR were used as appropriate as well as the parameters in Table TR RAI 7.3-1-1 below. Based on these methods and parameters, the source terms for the CPP and mine units were recalculated and are presented in Table TR RAI 7.3-1-2. Rn-222 releases from mud pits generated during wellfield construction were ignored since they are a very small fraction of the releases reported in Table TR RAI 7.3-1-2. While the releases from the CPP are lower than the releases calculated in the original KEA MILDOS model, the releases associated with the mine units are higher. Based on the higher source terms, the MILDOS model for the KEA was re-run using the "Total" source terms in Table TR RAI 7.3-1-2. The revised model used ten time steps to represent operations from year 5 through year 14 as shown

on the schedule presented on Figure 1.9-1 of the KEA TR. The source strength for each mine units was modified by a factor from 0 to 1 depending on if the mine unit was in operation, restoration, or not operating. For example, if in year 5 Mine Unit G was not operating, a factor of 0 was given to this source for this time step. Likewise, if Mine Unit A was operational in year 5, it was given a factor of 0.5 for this time step. If in year 7 Mine Unit A was operating part of the year and in restoration part of the year, a factor of 1 was used for this time step. A time step factor of 1 was always used for the CPP. In addition, releases from Ross mine units (as calculated in the original Ross MILDOS model) were included in year 5 through year 9 as these mine units were in various stages of operation and restoration during this time.

The revised KEA MILDOS model used the same receptors and meteorological data as were used in the original KEA MILDOS model, however, the coordinates and elevations for the receptors and source terms were re-evaluated and revised for this model run. Upon reviewing the inputs for the original KEA MILDOS model, Strata found that a coordinate transformation error had occurred which resulted in a relatively small and consistent displacement of the receptors and sources in relation to the CPP. The revised coordinates are provided in Tables TR RAI 7.3-1-3 and TR RAI 7.3-1-4 below.

Table TR RAI 7.3-1-5 shows the results of the revised KEA MILDOS model. The highest dose of 2.9 mrem per year occurs in year 9 at the "Wesley" receptor. Doses to the casual members of the public, specifically the courier and vendor described in Section 7.3.6 of the KEA TR would receive a dose of 0.02 and 0.05 mrem per year respectively, based on the maximum doses of 1.62 mrem per year at both locations modified by the occupancy factors in Table 7.3-6 of the KEA TR. Oilfield workers 3 and 4 would receive an annual dose of 0.05 and 0.08 mrem per year respectively, based on the maximum doses of 2.47 and 3.85 mrem per year modified by the occupancy factors in Table 7.3-7 of the KEA TR.

Table TR RAI 7.3-1-6 shows the dose by pathway at the Wesley location for operational year number 9. As shown in the table, the most significant pathway by far is inhalation.

While the magnitude of the dose at the maximally exposed member of the public has increased slightly (1.48 mrem/yr to 2.91 mrem/yr) from the original KEA MILDOS model, the general conclusions regarding the magnitude (between 2% and 3 % of the public dose limit) of the public dose and the comparison to dose limits discussed in Section 7.3 of the KEA TR is still applicable to the revised MILDOS model. Pending acceptance of the revised source terms and MILDOS model run, Strata will update Section 7.3 of the KEA TR to reflect the information presented in this RAI response.

In the RAI request for the KEA Environmental Report (ML16138A082) issued to Strata on May 27th, 2016, NRC requested input/output files for MILDOS runs for the KEA. These runs were provided as Appendix F to the RAI response package. Since the MILDOS inputs have been revised and the model re-run, Strata is providing an updated MILDOS output file (which includes inputs) for NRC review. The output file for the revised MILDOS run is provided in Appendix B to this response package.

Table TR RAI 7.3-1-1. Additional Parameters Used in Source Term Calculations and MILDOS Modeling

Model Parameter	Parameter Value	Units	Source/Reference
Mine Unit A Area	1.20×10^5	m^2	Previous KEA MILDOS
Mine Unit B Area	2.30×10^5	m^2	Previous KEA MILDOS
Mine Unit C Area	4.96×10^5	m^2	Previous KEA MILDOS
Mine Unit D Area	5.77×10^5	m^2	Previous KEA MILDOS
Mine Unit E Area	6.82×10^5	m^2	Previous KEA MILDOS
Mine Unit F Area	4.46×10^5	m^2	Previous KEA MILDOS
Mine Unit G Area	5.32×10^5	m^2	Previous KEA MILDOS
Mine Unit H Area	4.78×10^5	m^2	Previous KEA MILDOS
Average Production and Restoration Purge Rate	1.25	Percent	KEA TR
Mine Unit Venting Rate	0.01	d^{-1}	NUREG 1569, Appendix D
Fraction of Radon Source Carried by Production Water	0.8	NA	NUREG 1569, Appendix D
Decay Constant of Radon-222	0.181	d^{-1}	NUREG 1569, Appendix D
Volume of IX Column	14,160	L	Ross TR
Number of IX Column Unloadings Per Day	1.5	NA	Ross TR

Table TR RAI 7.3-1-2. Re-Calculated Source Terms for the KEA

Source	Release Mechanism	Release (Ci/Y)	Total (Ci/Y)
CPP	Average Radon-222 release from production purge water	42.2	48.4
	Average Radon-222 release from restoration purge water	5.5	
	Radon-222 Release from IX column unloading	0.7	
Mine Unit A	Wellfield Venting (Production)	92.1	184.2
	Wellfield Venting (Restoration)	92.1	
Mine Unit B	Wellfield Venting (Production)	178.4	356.8
	Wellfield Venting (Restoration)	178.4	
Mine Unit C	Wellfield Venting (Production)	386.6	773.3
	Wellfield Venting (Restoration)	386.6	
Mine Unit D	Wellfield Venting (Production)	450.4	900.9
	Wellfield Venting (Restoration)	450.4	
Mine Unit E	Wellfield Venting (Production)	532.7	1065.4
	Wellfield Venting (Restoration)	532.7	
Mine Unit F	Wellfield Venting (Production)	347.6	695.2
	Wellfield Venting (Restoration)	347.6	
Mine Unit G	Wellfield Venting (Production)	415.2	830.4
	Wellfield Venting (Restoration)	415.2	
Mine Unit H	Wellfield Venting (Production)	372.7	745.4
	Wellfield Venting (Restoration)	372.7	

Table TR RAI 7.3-1-3. Revised KEA MILDOS Model Receptor Locations

Resident Receptor	Distance E (km)	Distance N (km)	Elevation (m)
Wood	0.82	0.49	7.9
Strong	0.52	-0.68	6.4
Oshoto	0.69	1.32	-7.6
Wesley	0.18	1.76	3.4
SA Burch	-3.84	3.70	51.5
DA Burch	-3.61	3.55	29.0
A	0.56	7.23	-11.9
B	0.91	2.72	-14.0
C	1.98	2.64	-19.8
D	2.42	1.21	-1.2
E	-0.70	-5.79	33.5
F	-0.84	-7.15	36.3
G	-5.85	0.18	50.9
H	-6.78	1.99	134.7
I	-3.08	3.48	22.6
J	-3.91	3.05	52.7
Courier	0.04	0.00	-1.0
Vendor	0.02	-0.03	0.0
Oilfield Worker 3	-0.75	3.68	21.6
Oilfield Worker 4	-2.04	-3.62	102.4

Table TR RAI 7.3-1-4. Revised KEA MILDOS Model Source Term Locations

KEA Mine Unit	Distance E (km)	Distance N (km)	Elevation (m)
A	-0.35	3.39	13.3
B	-1.58	2.00	32.3
C	-3.33	0.27	42.3
D	-2.80	-0.92	33.2
E	-2.21	-2.16	54.4
F	-3.22	-3.26	86.8
G	-3.20	-4.84	71.4
H	-3.73	-7.19	55.7
Ross Mine Unit	**Distance E (km)**	**Distance N (km)**	**Elevation (m)**
1	-0.21	1.03	3.2
2	-1.24	0.76	14.0
3	-0.43	-1.28	22.3
4	-0.60	-0.26	11.1

Table TR RAI 7.3-1-5. Total Effective Dose Equivalent (TEDE) to an Adult Residential Receptor at all Locations in All Operating Phases (mrem/yr)

Receptor	Year							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Wood	0.75	0.86	0.96	1.17	1.26	1.29	1.20	1.08
Strong	0.49	0.58	0.65	0.89	1.04	1.13	1.04	0.89
Oshoto	0.97	1.08	1.20	1.35	1.44	1.44	1.37	1.27
Wesley	2.29	2.50	2.68	2.85	2.91	2.89	2.77	2.61
SA Burch	0.08	0.16	0.07	1.27	1.83	1.74	1.69	1.23
DA Burch	0.09	0.18	0.77	1.42	2.01	1.88	1.76	1.23
A	0.23	0.33	0.46	0.54	0.65	0.64	0.61	0.53
B	0.50	0.62	0.76	0.82	0.91	0.87	0.84	0.76
C	0.22	0.29	0.38	0.46	0.53	0.53	0.50	0.46
D	0.23	0.30	0.40	0.51	0.60	0.62	0.57	0.50
E	0.06	0.10	0.18	0.32	0.55	0.70	0.85	0.89
F	0.05	0.08	0.14	0.26	0.43	0.54	0.68	0.78
G	0.05	0.09	0.23	0.42	0.62	0.69	0.77	0.76
H	0.04	0.06	0.16	0.29	0.43	0.50	0.58	0.59
I	0.11	0.24	0.84	1.56	2.18	2.09	1.89	1.33
J	0.08	0.16	0.80	1.47	2.13	1.96	1.90	1.33

Table TR RAI 7.3-1-6. Wesley Receptor Dose by Pathway in Year 9 of Operations

Pathway	Dose (mrem/yr)	Contribution to Total Dose (%)
Inhalation	2.84	97.7
Ground	0.005	0.17
Cloud	0.06	2.1
Vegetation Ingestion	0.0007	0.02
Meat Ingestion	0.0001	0.01
Total	**2.906**	**100**

Section 7.5

RAI 7.5-1

Description of Deficiency

In Section 7.5 of the Kendrick TR, Strata states that the "above omissions are addressed in LC 12.11…[which the] [s]taff found … acceptable" [emphasis added]. Based on language in the application, the above omissions include "an accident scenario involving hydrochloric acid, sodium hydroxide, or chemicals associated with a reductant." However, the review of the information submitted to address LC 12.11 did not include an analysis of hydrochloric acid, sodium hydroxide or chemicals associated with a reductant.

Basis for Request

Staff's acceptance of the submittal for LC 12.11 focused on adherence to the transportation regulations and not necessarily the analysis of the handling and storage of the material. In fact, a review of Strata's Environmental Planning Procedures and Industrial Safety Program procedures during the pre-operational inspection only discussed limited quantities of hydrochloric acid and sodium hydroxide for laboratory usage only. Furthermore, license condition 10.10 requires NRC approval of a chemical or biological reductant.

Request for Additional Information

Please clarify the statement in Section 7.5 of the Kendrick TR, in which Strata states that the "above omissions are addressed in LC 12.11…[which the] [s]taff found … acceptable" [emphasis added]. Based on language in the application, the above omissions include "an accident scenario involving hydrochloric acid, sodium hydroxide, or chemicals associated with a reductant."

TR RAI 7.5-1 Response

NRC staff is correct in noting that the review conducted in reference to LC 12.11 did not include an analysis of emergency scenarios and responses for hydrochloric acid, sodium hydroxide, or reductant. The emergency and safety procedures that were developed by Strata to support pre-operational reviews and inspections for the Ross CPP were limited to the facility as constructed, i.e., a "satellite" ion exchange facility without elution, precipitation, or drying circuits. NRC staff noted this in the Authorization to Begin In-Situ Uranium Recovery Operations (ML15334A308). In the approval to operate, NRC staff noted the following:

> "Although licensed to construct the elution and precipitation circuits as well as the yellowcake dryer at the Ross ISR Project, as described in the license application, the licensee is not authorized by this letter to operate the elution, precipitation, and dryer systems using licensed material. If the licensee elects to construct these systems in the future, pursuant to License Condition 12.6, the NRC has to complete a preoperational inspection of the constructed systems as well as associated procedures, staff training, operational testing, and radiation safety protocols, prior to their use". (emphasis added)

Hydrochloric acid and sodium hydroxide are used in the precipitation circuit and were not addressed in the Strata Ross programs since they are not currently present on site. In accordance with the approval to operate, Strata will be required to submit all procedures related to elution, precipitation, and drying before NRC will allow these operations. Since development of the final design for these systems is not complete, Strata prefers to address accident scenarios and emergency procedures at the time these systems are constructed.

The possible future use of reductant would be addressed as required in LC 10.10. No revisions to the license amendment application are proposed in response to this RAI.

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APPENDIX A

Revised Geologic Cross Sections

(Provided via separate Adobe PDF document
due to file size limitations)

APPENDIX B

Input/Output File for the Revised KEA MILDOS Model
(CD only)