From: Michael Raddatz
To: Betty Garrett
Date: 07/25/2006 3:33:30 PM
Subject: Fwd: RE: My questions - RAL- Ambrosia Lake-Doc. 40-8905

Betty please docket this also. Public Avail normal release

Mike,

Attached are the responses to your questions.
Let me know if you need me to send a hard copy.

Peter

-----Original Message-----
From: Michael Raddatz [mailto:MGR@nrc.gov]
Sent: Monday, July 24, 2006 6:06 AM
To: Luthiger, Peter
Subject: My questions

When you will you can get back to me on my questions?

Mail Envelope Properties (44C67204.551 : 15 : 35214)

Subject:	Fwd: RE: My questions
Creation Date	07/25/2006 3:33:24 PM
From:	Michael Raddatz
Created By:	MGR@nrc.gov

Recipients
nrc.gov
OWGWPO02.HQGWDO01
BSG (Betty Garrett)

Post Office	**Route**
OWGWPO02.HQGWDO01	nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	1892	07/25/2006 3:33:24 PM
cover letter - RAM response to 7-17-06 email questions.doc	56320	07/25/2006 3:32:53 PM
RAM Response to NRC 7-17-06 Questions.doc	240640	07/25/2006 3:32:53 PM

Options

Expiration Date:	None
Priority:	Standard
ReplyRequested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard

Junk Mail Handling Evaluation Results
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Message is from an internal sender

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Rio Algom Mining LLC

July 26, 2006

Via email

ADDRESSEE ONLY
Mr. Michael Raddatz
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Re: **Response to NRC Questions on Soil Plan**

Dear Mr. Raddatz,

The following responses are provided by Rio Algom Mining LLC (RAM) to questions raised by the Nuclear Regulatory Commission (NRC) within a July 17, 2006 email correspondence regarding RAMs Soil Decommissioning Plan.

Please contact me if you have any questions or are in need of additional information.

Regards,

Peter Luthiger
Manager, Radiation Safety
and Environmental Affairs

Attachment

xc: T. Fletcher (RAM)
R. Jones (Tronox)
B. Lewis (WP)
File

Mail Envelope Properties (44C67204.551 : 15 : 35214)

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Block List is not enabled

RIO ALGOM MINING LLC
LICENSE SUA-1473, DOCKET 40-8905

RESPONSE TO NRC QUESTIONS ON CONSOLIDATED SOIL DECOMMISSIONING PLAN

The following responses are provided by Rio Algom Mining LLC (RAM) to questions raised by the Nuclear Regulatory Commission (NRC) within a July 17, 2006 email correspondence received from Mr. Mike Raddatz of NRC.

NRC Question #1

The engineered earth and rock cover for Ponds 1 and 2 (now considered as Tailings Impoundments) were completed in 1999. The Plan states that Pond 3 is considered part of the main disposal cell (Impoundment 1) and is covered by those requirements. RAM stated that they intend to do radon flux measurements of Pond 3 following placement of all contaminated soils requiring disposal. The flux testing will determine the need for an engineered cover for Pond 3. If the measured radon flux on Pond 3 is below regulatory standards of 20 pCi/m2 s, then no engineering cover will be proposed, and RAM will proceed with pond closure. If the radon flux exceeds regulatory standards, then RAM will construct a cover system to comply with 10 CFR Appendix A, Criterion 6. The sampling plan consists of collecting soil samples from 50 locations.

1) Please Justify the no engineering cover it appears to conflict with Criterion 6

RAM response

Criterion 6 requires the disposal area to:

1)Be effective for 1000 years to the extent reasonable and
2)Limit radon releases below the 20 pCi/m2-s standard.

RAM's plan intends to achieve both requirements.

First, RAM has previously received approval from NRC for placement of an erosion protection layer over Pond 3 (Amendment #51). This erosion protection plan was developed and reviewed pursuant to NUREG-1623 with a finding that "the erosion protection design appears to be adequate to provide reasonable assurance of protection for 1000 years, as required in Criterion 6 of 10 CFR Part 40, Appendix A." (NRC approval letter, Amendment #51). Based on this, RAM achieves the first requirement.

The second requirement of limiting the radon flux will be achieved as described in the plan. The primary waste material that has been placed on Pond 3 has been surface soils contaminated with windblown tailings (typically low concentration following excavation, placement, spreading, compaction). Any additional residual radioactive materials currently being disposed of on Pond 3 are consistent with past materials. Spot testing that was performed several years ago indicated that the flux level was below the 20 pCi/m2-s standard. The flux limit is based on the average over the entire pond

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area. Based on these preliminary results, combined with the knowledge that all subsequent wastes placed into Pond 3 will likely contain minimal residual radioactive material, RAM anticipates that the flux limit will be met, which would achieve the *second requirement in Crtierion 6.*

In the scenario described above, even though RAM would have demonstrated that the radon flux criteria was met, RAM will place a one (1) foot of cover over the waste materials so as to facilitate efficient placement of the erosion protection layer. The erosion protection plan previously approved by NRC contemplated this one foot layer in the design. Placement of this cover, which would not be necessary if the flux from Pond 3 is below the standard, will guarantee that the flux limit of 20 pCi/m2-s will be achieved. Following placement of this cover layer, the rock will be placed to ensure the 1000 year protection is achieved.

Of course, the alternative scenario would be if flux testing following placement of all remaining wastes onto Pond 3 indicates that the 20 pCi/m2-s standard is exceeded. RAM would then be required to submit a cover design (engineered barrier) for NRC approval that would demonstrate the flux standard is met. Following placement of this engineered barrier, the erosion protection would be placed.

Based on this, RAM believes that the current proposed path forward provides assurance that compliance with Criterion 6 will be achieved.

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NRC Question #2

Review of the analytical results above, the radium-226 concentrations appear to conform to the Criterion 6 concentrations for radium-226. The results for Pond 10 are indicative of the same condition that was observed within the other evaporation ponds where concentrations of other radionuclides remain elevated at depth. As a result of these factors, combined with the fact that NRC required Rio Algom to develop and submit a new soil decommissioning plan for the site pursuant to the revised Criterion 6, Alternate Release Criteria (ARC) approved for Pond 10 as a practical solution that is protective of human health and the environment. Other proposed ARC areas are described within the Soil Plan.

2) Locations G1-C3 and I2-A5 appear not to conform to Criterion 6

RAM Response

RAM intends to reclaim Pond 10 in the same manner as Ponds 4-9 through the application of Alternate Release Criteria. Tables 2-11 and 2-12 within the Consolidated Soil Plan present the analytical results for Pond 10. Within Table 2-11, the samples G1-C3 and I2-A5 for the 0" to 6" sample indicate a radium-226 concentration of 13.6 and 15.7 pCi/g, respectively. In a July 21, 2005 letter, NRC requested RAM to reanalyze at least 15 soil samples from Pond 10. Eighteen (18) archived soil samples from the 1994 sample event were re-analyzed with the results presented within Table 2-12. The re-analyses for samples G1-C3 and I2-A5 for the 0" to 6" sample indicate a radium-226 concentration of 17.2 and 14.6 pCi/g, respectively. The 2005 re-analysis appears to correlate with the original 1994 sample analysis.

Pond 10 area was situated on a rock ledge and reclamation efforts continued until bedrock was reached that prevent further excavation as all soil in the area that was used for pond construction was removed. The sample data presented in Tables 2-11 and 2-12 reflect this rocky surface as the 0"-6" layer. Since excavation resulted in contacting the underlying rock surface, RAM intends to bring in clean cover material in order to facilitate revegetation of the area. To achieve final topography objectives for the area, approximately 3 feet of clean fill material would be required in the Pond 10 area.

By adding this additional 3 feet of cover over the area, the samples originally represented by the 0"–6" layer are in actuality samples representative of the 36" to 42" layer, and the 15 pCi/g plus background criteria applies to the area. As such, concentrations at G1-C3 and I2-A5 would fall within the Criterion 6 requirements. Notwithstanding this, RAM intends to reclaim Pond 10 in the same manner as Ponds 4-9 through the application of Alternate Release Criteria (ARC). Section 5.2 of the Consolidated Soil Plan provides discussion on the ARC approach.

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NRC Question #3

A dose assessment will be completed for Pond 10 to demonstrate that the contribution to the Total Effective Dose Equivalent (TEDE) at the site is small. The Pond 10 dose assessment will account for site-specific information regarding the source term; critical group, scenario, and pathways identification and selection; the conceptual model; and calculations and input parameters. The Pond 10 dose assessment will be completed solely with respect to dose received due to pathways related to residual radioactive material in subsurface soil.
Ponds 11 - 21 (a.k.a., "Section 4 Ponds")

3) What about Th and U ? Criterion 6(6) requires a sum of ratios analysis.

RAM Response

RAM intends to reclaim Pond 10 in the same manner as Ponds 4-9 through the application of Alternate Release Criteria (ARC). By doing so, the soil release criteria in Criterion 6, including the Unity Rule is not applicable. Section 5.2 of the Consolidated Soil Plan provides discussion and justification for use of the ARC approach.

Since Pond 9 was located directly adjacent to Pond 10 on the same rock ridge, RAM anticipates that a similar excavation effort will be required for Pond 9 in that excavation will continue until bedrock prevents further excavation. Based on this, RAM believes that following excavation of Pond 9, the area will exhibit similar residual radioactive material concentrations to those observed during the Pond 10 excavation work. As such, RAM proposes to utilize the same modeling assessment for the Pond 9 and Pond 10 area as exposure potential will be consistent for the area.

Attachment 1 is the dose assessment for Pond 9 and 10. Based on the RESRAD dose assessment, which indicated an annual exposure of less than 1 millirem per year, the proposed closure process for Pond 9 and 10 will result in minimal exposure to the critical group. Based on the dose assessment, RAM will place well in excess of the cover needed to reduce the exposure to below the benchmark dose, thereby adding additional assurance that exposure potential is maintained as low as reasonably achievable. RAM requests that this be incorporated into the Consolidated Soil Plan as Appendix E.

Clarification

RAM would like to clarify that Section 5.2.4 of the Consolidated Soil Plan (page 59) refers to the Section 4 Ponds. RAM will not seek ARC for the Section 4 Ponds as RAM intends to remediate this area to comply with Criterion 6 for soil clean-up.

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ATTACHMENT 1

Proposed

Appendix E

for

Consolidated Soil Decommissioning Plan

APPENDIX E

DOSE ASSESSMENT FOR PONDS 9 AND 10

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INTRODUCTION

Several lined and unlined evaporation ponds at the site were used to evaporate the liquid mill effluents that contained natural uranium, thorium 230, and radium 226. The concentrations of these radionuclides in evaporation ponds exceed the likely soil concentration limits that would be established for the site.

The Reclamation Plan does not include complete excavation of the evaporation ponds. A dose assessment, described below, has been completed demonstrating that the contribution to total effective dose equivalent (TEDE) at the site is small. The dose assessment is centered on the rancher scenario used to establish the benchmark dose.

Exposure pathway modeling was used to calculate the dose to the rancher from the planned final condition of Evaporation Ponds 9 and 10. Exposure pathway modeling is an analysis of various exposure pathways of a given exposure scenario used to convert dose into concentration of radioactive material in the source media.

The exposure pathway modeling completed here was a deterministic analysis of the peak annual dose to the average member of the critical group for a rancher exposure scenario. The dose assessment accounted for site-specific information regarding the source term; critical group, scenario, and pathways identification and selection; the conceptual model; and calculations and input parameters.

SCOPE OF DOSE ASSESSMENT

The dose assessment was developed in particular for the case of license termination. The dose assessment was developed without consideration of any institutional controls and such that there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is as low as is reasonably achievable.

The dose assessment was completed solely with respect to dose received due to pathways related to residual radioactive material in subsurface soil at an evaporation pond. There were several pathways not included in the dose assessment. Some pathways were not included because they are not applicable; e.g. drinking water. Other pathways were not included because they cannot be considered directly by the conceptual model applied; e.g. exposure rate from the disposal cell. These and other pathway exceptions are discussed in a following section of this Appendix.

SOURCE TERM

CONFIGURATION

The radionuclides that have the potential to contribute the dose against which the dose limit criteria are compared are identified as the radionuclides of concern (RoC). The RoCs are specifically evaluated for the development of site-specific dose assessment. The RoCs were chosen based on historical information and findings of site investigations[1]. The RoCs were determined to be natural uranium, thorium-230, and radium-226.

The source term is assumed to be covered contaminated zone of cylindrical shape. The contaminated zone is modeled as a 1-meter thick zone of uppermost bedrock. The contaminated zone is known underlain by continuation of the uppermost bedrock; this continuation of the uppermost bedrock is modeled as an uncontaminated saturated zone independent of thickness.

RESIDUAL RADIOACTIVITY

The RoCs are assumed homogenously distributed within the contaminated zone at concentrations equivalent to the maximum concentrations provided in Table 2-12.

CHEMICAL FORM

In an effort to quantify the mobility of the RoCs in soil at the site, a distribution coefficient (K_d) was respectively selected for each of the soil units in the model. Description of the selection and application of the K_ds is provided in Appendix B, Attachment 1.

CRITICAL GROUP, SCENARIO, AND PATHWAYS IDENTIFICATION AND SELECTION

SCENARIO IDENTIFICATION

The exposure scenario applied here may be described as representing a local rancher. The rancher scenario accounts for exposure involving residual radioactivity that is initially in the subsurface soil at the locations of the lined and unlined evaporation ponds. A rancher periodically is present on the site and retrieves some of his diet from

[1] Rio Algom Mining Corporation, site characterization data.

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the site. The scenario assumes no disturbance of the disposal cell or the subsurface soils (this qualification is discussed later).

CRITICAL GROUP DETERMINATION

The average member of the critical group is the rancher. This individual is assumed to be an adult with common habits and characteristics. This individual is reasonably expected to receive the greatest exposure to residual radioactivity for the applicable exposure scenario.

EXPOSURE PATHWAYS

The starting point for exposure of the critical group to the RoCs is the contaminated soil zone. The RoCs are assumed potentially released from the soil by erosion, plant uptake, direct ingestion, infiltration, and leaching. The RoCs may also be transported to or by groundwater to eventually be released from soil. The scenario also considers exposure to direct gamma radiation emitted by the RoCs.

The primary exposure pathways include:

- External exposure from soil;
- Inhalation of suspended soil;
- Ingestion of soil;
- Ingestion of plant products grown in contaminated soil; and
- Ingestion of animal products grown onsite using feed and surface water from potentially contaminated sources.

Three exposure pathways not included in the dose assessment are groundwater usage, intrusion of the subsurface soils, and radon; each is discussed below.

Groundwater Usage

Groundwater usage includes use of groundwater for irrigation, livestock water supply, and drinking water. Groundwater usage was not considered a pathway applicable to the exposure scenario.

Limited yield of groundwater wells is typical throughout this part of New Mexico and has resulted in the reliance on surface water as their source(s).

Localized areas of groundwater at the Site have been created by recharge from existing surface sources or man-made subsurface reservoirs such as utility trenches and

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foundation backfill areas. Once these features are removed during reclamation, these groundwater sources will disappear.

In the context of the previous description, there exists a reasonable assurance that there is no direct groundwater usage pathway, especially drinking water, resulting in exposure to RoCs at the Site.

Subsurface Soil Intrusion

Deliberate intrusion into the subsurface soil was not considered during development of the dose assessment.

Radon

The radon pathway was not considered because it is specifically excluded from the scope of the technical criteria.[2]

CONCEPTUAL MODEL

The conceptual model used to evaluate the previously described exposure scenario and pathways was the RESRAD[3] computer code version 6.21. RESRAD was developed, in part, to calculate site-specific concentrations for RESidual RADioactive material in soil corresponding to a radiation dose limit to a chronically exposed on-site resident. The RESRAD code considers multiple environmental transport and exposure pathways. A description of the code models, as applied here, is provided below.[4]

RESRAD models external exposure from volume sources when the individual is outside, using volume dose rate factors. Correction factors are used to account for soil density, areal extent of contamination, and thickness of contamination. When the individual is indoors, exposure from external radiation is modeled in a similar manner except that additional attenuation is included to account for the building. Exposure through ingestion of contaminated animal and plant products is modeled simply through the use of transfer factors.

The generic source-term conceptual model in RESRAD assumes a time-varying release rate of radionuclides into the water and air pathways. Radionuclides in the contaminant

[2] 10 CFR 40, Appendix A, Criterion 6 (6)

[3] Yu, C., et. al. "Users Manual for RESRAD Version 6", Argonne, IL: Argonne National Laboratory. ANL/EAD-4. July 2001.

[4] NUREG-1727, Appendix C, Section 5.3.2.1.2

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zone are assumed uniformly distributed. No transport is assumed to occur within the source zone, but account is made for radioactive transformation. The radioactive material is not assumed contained. The subject scenario does not include a cover of clean soil over the contaminated area. Release of radionuclides by water is assumed to be a function of a constant infiltration rate, time-varying contaminant zone thickness, constant moisture content, and equilibrium adsorption. The contaminant zone is assumed to decrease over time from a constant erosion rate. Particulates are assumed instantaneously and uniformly released into the air as a function of the concentration of particulates in the air, based on a constant mass loading rate.

The RESRAD conceptual groundwater model includes two horizontal homogenous strata for the unsaturated zone. Transport in the unsaturated zone is assumed to result from steady-state, constant vertical flow, with equilibrium adsorption, and decay, but no dispersion. RESRAD, for the subject case, models radionuclides in the saturated zone by a nondispersion approach. In the nondispersion approach, transport in the saturated zone is assumed to occur in a single homogenous stratum, under steady-state, unidirectional flow, with constant velocity, equilibrium adsorption, and radioactive transformation. The nondispersion model is the RESRAD default based on the size of the contaminated area.

The generic conceptual model of the surface water pathway in RESRAD assumes that radionuclides are uniformly distributed in a finite volume of water within a watershed. Radionuclides are assumed to enter the watershed at the same time and concentration as in the groundwater. Accordingly, no additional attenuation is considered as radionuclides are transported to the watershed. Radionuclides are assumed diluted as a function of the size of the contaminated area in relation to the size of the watershed. The model assumes that all radionuclides reaching the surface water are derived from the groundwater pathway. Thus transport of radionuclides overland from runoff is not considered. As well, additional dilution from overland runoff is not considered.

The generic conceptual model of the air pathway in RESRAD uses a constant mass loading factor and area factor to model radionuclide transport. The area factor, which is used to estimate the amount of dilution, relates the concentration of radionuclides from a finite area source to the concentration of radionuclides from an infinite area source. It is calculated as a function of particle diameter, wind speed, and the side length of a square area source. The model assumes a fixed particle density, constant annual rainfall rate, and constant atmospheric stability. No radioactive decay is considered.

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CALCULATIONS AND INPUT PARAMETERS

Inputs are provided for parameters of the source term configuration and exposure pathways described previously. Site-specific values were used for parameters when available. Otherwise the parameter value was assigned a default value or a value based on professional judgment.

For the source term, the inputs include site-specific values or estimates of contaminated area, thickness, density, porosity, hydraulic conductivity, hydraulic gradient, and distribution coefficient.

Particulars of the input parameters include: the rancher spends 45% of the time indoors on site, 20% of the time outdoors on site, and 35% of the time away from the site.[5] Food production is assumed to occur in the contaminated area: 5% of the resident's vegetable, grain, and fruit diet assumed produced from the contaminated area; 5% of the resident's meat diet is assumed produced from the contaminated area.[8] Neither milk nor aquatic food is included in the rancher's diet.[8] Dust levels represent ambient suspension of soil particles in air.

Vegetables, fruits, and grains are not irrigated with water from the contaminated area. Some contaminated water is used for watering livestock on site. The rancher's drinking water is assumed from an uncontaminated potable water system or uncontaminated surface water.

The walls, foundation, and floor of the resident's house reduce external exposure by 21%. Indoor dust level in air is assumed to be 56% of the outdoor dust level.

The parameters, associated inputs, and rationale for value, are included in Table E-1.

Appendix B, Attachment 1 provides description of the rationale for the value of each parameter.

SENSITIVITY ANALYSIS

A sensitivity analysis was not performed for this dose assessment.

COMPLIANCE WITH REGULATORY CRITERIA

This dose assessment was performed to compare the residual radioactivity in subsurface soils of Evaporation Ponds 9 and 10 to the radium benchmark dose limit of 18 mrem per

[5] SECY 98 084, Attachment 3, Table 1.

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year. The result of the dose assessment for Evaporation Ponds 9 and 10 was less than one mrem per year. This value is substantially smaller than the radium benchmark dose, therefore stabilization in place of Evaporation Ponds 9 and 10 is an approvable alternative to application of soil concentration limits.

Table E-1. Model Selected Values for Evaporation Ponds 9 & 10		
Parameter	**Input**	**Background Information**
Source		
Nuclide concentration for U-238 (pCi/g)	6	A maximum from site characterization information; Table 2-12, Location H4-C1.
Transport Distribution coefficients for U-238		
Contaminated zone (cm**3/g)	90	Site-specific estimate.
Unsaturated zone 1 (cm**3/g)	--	Site-specific estimate.
Saturated zone (cm**3/g)	90	Site-specific estimate.
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default
Nuclide concentration for U-235 (pCi/g)	0.3	A maximum determined from site characterization information.
Transport Distribution coefficients for U-235		
Contaminated zone (cm**3/g)	90	Site-specific estimate.
Unsaturated zone 1 (cm**3/g)	--	Site-specific estimate.
Saturated zone (cm**3/g)	90	Site-specific estimate.
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default
Nuclide concentration for Pa-231 (pCi/g)	--	Estimated from *nuclide concentration for U-235.*
Transport Distribution coefficients for daughter Pa-231		
Contaminated zone (cm**3/g)	380	Assigned by RESRAD guidance.[2]
Unsaturated zone 1 (cm**3/g)	--	Assigned by RESRAD guidance.[2]
Saturated zone (cm**3/g)	380	Assigned by RESRAD guidance.[2]
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default

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Table E-1. Model Selected Values for Evaporation Ponds 9 & 10		
Parameter	**Input**	**Background Information**
Nuclide concentration for Ac-227 (pCi/g)	--	Estimated from *nuclide concentration for U-235.*
Transport Distribution coefficients for daughter Ac-227		
Contaminated zone (cm**3/g)	825	Assigned by RESRAD guidance.[2]
Unsaturated zone 1 (cm**3/g)	--	Assigned by RESRAD guidance.[2]
Saturated zone (cm**3/g)	825	Assigned by RESRAD guidance.[2]
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default
Nuclide concentration for U-234 (pCi/g)	6	A maximum determined from site characterization information.
Transport Distribution coefficients for U-234		
Contaminated zone (cm**3/g)	90	Site-specific estimate.
Unsaturated zone 1 (cm**3/g)	--	Site-specific estimate.
Saturated zone (cm**3/g)	90	Site-specific estimate.
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default
Nuclide concentration for Th-230 (pCi/g)	5030	A maximum from site characterization information; Table 2-12, Location I2-A5.
Transport Distribution coefficients for Th-230		
Contaminated zone (cm**3/g)	90	Site-specific estimate.
Unsaturated zone 1 (cm**3/g)	--	Site-specific estimate.
Saturated zone (cm**3/g)	90	Site-specific estimate.
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default

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Table E-1. Model Selected Values for Evaporation Ponds 9 & 10		
Parameter	**Input**	**Background Information**
Nuclide concentration for Ra-226 (pCi/g)	18	A maximum from site characterization information; Table 2-12, Location F2-A2.
Transport Distribution coefficients for Ra-226		
Contaminated zone (cm**3/g)	90	Site-specific estimate.
Unsaturated zone 1 (cm**3/g)	--	Site-specific estimate.
Saturated zone (cm**3/g)	90	Site-specific estimate.
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default
Nuclide concentration for Pb-210 (pCi/g)	18	Estimated from *nuclide concentration for Ra-226.*
Transport Distribution coefficients for Pb-210		
Contaminated zone (cm**3/g)	90	Site-specific estimate.
Unsaturated zone 1 (cm**3/g)	--	Site-specific estimate.
Saturated zone (cm**3/g)	90	Site-specific estimate.
Time since material placement (yr)	0	RESRAD default
Groundwater concentration (pCi/L)	--	Not available; reflects availability of distribution coeff.[1]
Solubility Limit (mol/L)	0	RESRAD default
Leach Rate (/yr)	0	RESRAD default
Calculation Parameters		
Basic radiation dose limit (mrem/yr)	25	RESRAD default
Times for Calculations (years)	0	RESRAD default
Times for Calculations (years)	3	RESRAD default
Times for Calculations (years)	10	RESRAD default
Times for Calculations (years)	30	RESRAD default
Times for Calculations (years)	100	RESRAD default
Times for Calculations (years)	300	RESRAD default
Times for Calculations (years)	1000	RESRAD default
Contaminated Zone Parameters		
Area of contaminated zone (m**2)	183000	Site-specific value: Pond 9 = 32 ac, Pond 10 = 13 ac.
Thickness of contaminated zone (m)	1	Estimate from site characterization data.

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Table E-1. Model Selected Values for Evaporation Ponds 9 & 10		
Parameter	**Input**	**Background Information**
Length parallel to aquifer flow (m)	483	Diameter of circle of contaminated zone
Cover and Contaminated Zone Hydrological Data		
Cover depth (m)	1	Planned actual conditions: equivalent to three feet alluvium cover.
Density of cover material (g/cm**3)	1.5	Site-specific estimate.
Cover erosion rate (m/yr)	1 E-05	Estimate from NRC evaluation.[3].
Density of contaminated zone (g/cm**3)	2.4	Site-specific estimate.
Contaminated zone erosion rate (m/yr)	1 E-05	Estimate from NRC evaluation.[3]
Contaminated zone total porosity	0.08	Site-specific estimate.
Contaminated zone field capacity	0.04	Site-specific estimate.
Contaminated zone hydraulic conductivity (m/yr)	67	Site-specific estimate.
Contaminated zone b parameter	1	Estimate for sand from RESRAD guidance.[2]
Humidity in air (g/cm**3)	--	Not available; reflects absence of radon pathway.[1]
Evapotranspiration coefficient	0.9	Estimate from NRC evaluation.[3]
Wind Speed (m/sec)	3.9	Site-specific estimate.
Precipitation (m/yr)	0.266	Site-specific estimate.
Irrigation (m/yr)	0	Assumed site condition.
Irrigation mode	overhead	Site specific observation (local practice).
Runoff coefficient	0.4	Estimate from RESRAD guidance.[2]
Watershed area for nearby stream or pond (m**2)	1.56 E+08	Site-specific estimate.
Accuracy for water/soil computations	0.001	RESRAD default
Saturated Zone Hydrological Data		
Density of saturated zone (g/cm**3)	2.4	Site-specific estimate.
Saturated zone total porosity	0.08	Site-specific estimate.
Saturated zone effective porosity	0.04	Site-specific estimate.
Saturated zone field capacity	0.04	Site-specific estimate.
Saturated zone hydraulic conductivity (m/yr)	67	Site-specific estimate.
Saturated zone hydraulic gradient	0.04	Site-specific estimate.
Saturated zone b parameter	1	Estimate sand from RESRAD guidance.[2]
Water table drop rate (m/yr)	1	Assume recharge from mine water stops after reclamation.
Well pump intake depth (m below water table)	0.00001	Lowest value allowed by RESRAD[1]; reflects absence of a well

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Table E-1. Model Selected Values for Evaporation Ponds 9 & 10		
Parameter	**Input**	**Background Information**
Model for Water Transport Parameters		
Nondispersion (ND) or Mass-Balance (MB)	ND	RESRAD default based on size of contaminated area.[1]
Well pumping rate (m**3/yr)	0	Reflects absence of a well (no groundwater usage).
Uncontaminated Unsaturated Zone Parameters		
Unsaturated Zones	0	Site-specific condition.
Unsaturated Zone 1, Thickness (m)	--	Not applicable.
Unsaturated Zone 1, Density (g/cm**3)	--	Not applicable.
Unsaturated Zone 1, Total Porosity	--	Not applicable.
Unsaturated Zone 1, Effective Porosity	--	Not applicable.
Unsaturated Zone 1, Field Capacity	--	Not applicable.
Unsaturated Zone 1, Hydraulic Conductivity (m/yr)	--	Not applicable.
Unsaturated Zone 1, b Parameter	1	Estimate for sand from RESRAD guidance.[2]
Occupancy, Inhalation, and External Gamma Data		
Inhalation rate (m**3/yr)	8400	Recommendation from RESRAD guidance.[2]
Mass loading for inhalation (g/m**3)	0.0001	RESRAD default.
Exposure duration	1	Reflects applicable regulatory evaluation period.
Indoor dust filtration factor	0.56	Estimate from RESRAD guidance.[2]
External gamma shielding factor	0.21	Suggestion from RESRAD guidance.[2]
Indoor time fraction	0.45	Estimate from NRC evaluation.[3]
Outdoor time fraction	0.20	Estimate from NRC evaluation.[3]
Shape of the contaminated zone	circular	Assumed shape of *area of contaminated zone.*
Ingestion Pathway, Dietary Data		
Fruits, vegetables and grain consumption (kg/yr)	178	Suggestion from RESRAD guidance.[2]
Leafy vegetable consumption (kg/yr)	25	Estimate from RESRAD guidance.[2]
Milk consumption (L/yr)	--	Not available; reflects absence of pathway.[1]
Meat and poultry consumption (kg/yr)	63	RESRAD default.
Fish consumption (kg/yr)	--	Not available; reflects absence of aquatic

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Table E-1. Model Selected Values for Evaporation Ponds 9 & 10		
Parameter	**Input**	**Background Information**
		pathway.[1]
Other seafood consumption	--	Not available; reflects absence of aquatic pathway.[1]
Soil ingestion (g/yr)	36.5	RESRAD default.
Drinking water intake (L/yr)	--	Not available; reflects absence of drinking water pathway.[1]
Contaminated fraction Drinking water	--	Not available; reflects absence of drinking water pathway.[1]
Contaminated fraction Household water	--	Not available; reflects absence of radon pathway.[1]
Contaminated fraction Livestock water	1	Assume all from onsite surface water.
Contaminated fraction Irrigation water	0	Reflects absence of irrigation.
Contaminated fraction Aquatic food	--	Not available; reflects absence of aquatic pathway.[1]
Contaminated fraction Plant food	0.05	Estimate from NRC evaluation.[3]
Contaminated fraction Meat	0.05	Estimate from NRC evaluation.[3]
Contaminated fraction Milk	--	Not available; reflects absence of milk pathway.[1]
Ingestion Pathway, Nondietary Data		
Livestock fodder intake for meat (kg/day)	68	RESRAD default
Livestock fodder intake for milk (kg/day)	--	Not available; reflects absence of milk pathway.[1]
Livestock water intake for meat (L/day)	50	RESRAD default
Livestock water intake for milk (L/day)	--	Not available; reflects absence of milk pathway.[1]
Livestock soil intake (kg/day)	0.5	RESRAD default
Mass loading for foliar deposition (g/m**3)	1 E-04	RESRAD default
Depth of soil mixing layer (m)	0.15	RESRAD default
Depth of roots (m)	0.3	Estimate from NRC evaluation.[3]
Groundwater Fractional Usage Drinking water	--	Not available; reflects absence of drinking water pathway.[1]
Groundwater fractional Usage Household water	--	Not available; reflects absence of radon pathway.[1]
Groundwater Fractional Usage Livestock water	0	Reflects the absence of groundwater usage

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Table E-1. Model Selected Values for Evaporation Ponds 9 & 10		
Parameter	**Input**	**Background Information**
Groundwater Fractional Usage Irrigation water	0	Reflects the absence of groundwater usage; e.g. *well pumping rate* equal zero.
Plant Factors		
Wet weight crop yield for Non-Leafy (kg/m**2)	0.7	RESRAD default
(continued, 7 of 7)		
Wet weight crop yield for Leafy (kg/m**2)	1.5	RESRAD default
Wet weight crop yield for Fodder (kg/m**2)	1.1	RESRAD default
Length of growing season for Non-Leafy (years)	0.17	RESRAD default
Length of growing season for Leafy (years)	0.25	RESRAD default
Length of growing season for Fodder (years)	0.08	RESRAD default
Translocation factor for Non-Leafy	0.1	RESRAD default
Translocation factor for Leafy	1	RESRAD default
Translocation factor for Fodder	1	RESRAD default
Weathering removal constant for vegetation	20	RESRAD default
Wet foliar interception fraction for Non-Leafy	0.25	RESRAD default
Wet foliar interception fraction for leafy	0.25	RESRAD default
Wet foliar interception fraction for fodder	0.25	RESRAD default
Dry foliar interception fraction for Non-Leafy	0.25	RESRAD default
Dry foliar interception fraction for Leafy	0.25	RESRAD default
Dry foliar interception fraction for Fodder	0.25	RESRAD default

[1] Yu, C., et. al. "Users Manual for RESRAD Version 6", Argonne, IL: Argonne National Laboratory. ANL/EAD-4. July 2001.

[2] U.S. Nuclear Regulatory Commission. Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes. Washington, D.C.: U.S. Nuclear Regulatory Commission. NUREG/CR-6697. December 2000.

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[3] U.S. Nuclear Regulatory Commission, Commission Paper SECY 98 084, "Status of Efforts to Finalize Regulations for Radiological Criteria for License Termination: Uranium Recovery Facilities", April 15, 1998.