Rio Algom Mining LLC

6 May 2024

Thomas Lancaster
United States Nuclear Regulatory Commission (NRC)
Mail Stop T5-A10
Washington, DC 20555-0001

Subject: **2023 ALARA Report**
Rio Algom Mining LLC – Ambrosia Lake West Mill
License SUA-1473, Docket No. 40-8905

Dear Mr. Lancaster,

Rio Algom Mining LLC (RAML) respectfully submits the *Calendar Year 2023 ALARA Report* (Attachment 1) for your records. The submittal of this report is not required by license condition but was verbally committed to by RAML during the NRC inspection conducted in September 2018.

If you have any questions or need additional information, please call me at (541) 250-0519.

Sincerely,

Rio Algom Mining LLC

Elizabeth Ruedig
Superintendent New Mexico & Utah Sites

cc: Document Control
Attachment: Calendar Year 2023 ALARA Report

CALENDAR YEAR 2023 ALARA REPORT

RIO ALGOM MINING LLC – AMBROSIA LAKE WEST MILL

McKinley County, New Mexico

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Acronyms and Definitions

Term	Definition
ALARA	as low as is reasonably achievable
ALW	Ambrosia Lake West
byproduct material	tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material" within this definition.
BZ	breathing zone
CDE	committed dose equivalent
CEDE	committed effective dose equivalent
CFR	Code of Federal Regulations
Ci	curies
DAC	derived air concentration
DDE	deep dose equivalent
LDE	lens dose equivalent
license	NRC license SUA-1473 for RAML's ALW mill
licensed material	radioactive and non-radioactive material that is regulated pursuant to the license
mrem	millirem
mrem y^{-1}	millirem per year
N	north
NRC	US Nuclear Regulatory Commission
OSL	optically stimulated luminescent dosimeter
pCi L^{-1}	picocuries per liter
POE	point of exposure
RAML	Rio Algom Mining LLC
RPEM	radiation protection and environmental monitoring
RWP	radiation work permit
SDE	shallow dose equivalent
SOP	standard operating procedure
SUA-1473	NRC license SUA-1473 for RAML's ALW mill
TEDE	total effective dose equivalent
visitor	any individual who is onsite at the facility who is not classified as a worker
worker	an employee or contractor who is completing work for RAML onsite at the facility for 5 or more days per year

1 Activities

This report summarizes calendar year 2023 activities, occupational radiation dose monitoring results, and public dose evaluations at Rio Algom Mining LLC's (RAML's) Ambrosia Lake West (ALW) former uranium mill, which is currently being decommissioned.

The ALW mill is regulated by the US Nuclear Regulatory Commission (NRC) via radioactive materials license SUA-1473 (NRC 2023a), which requires that RAML implement a radiation protection and environmental monitoring (RPEM) program as described in RAML's *Radiation Protection and Environmental Monitoring Program Manual* (RAML 2022a). Among other items, the RPEM program manual requires RAML to maintain worker and public exposure to licensed material at levels that are as low as is reasonably achievable (ALARA), perform an annual audit of the RPEM program content and implementation, and prepare this annual report summarizing the RPEM program activities and data for each calendar year.

Much of the licensed material at the ALW mill has been consolidated in engineered repositories that were closed following NRC-approved plans. Activities involving licensed material at the ALW mill in 2023 are summarized for each quarter in the following subsections.

1.1 First Quarter

Activities involving licensed material in January-March 2023 consisted of:

- Routine environmental monitoring required by SUA-1473 consisting of 1) groundwater sampling in and around the ALW mill; and 2) passive track etch monitoring for radon-222 in ambient air at the seven locations shown on Figure 1; and
- The following tasks described in radiation work permits (RWPs), see Table 2: 1) replacement of groundwater monitoring well 5-04ALL as reported to NRC in February 2023 (RAML 2023e); and 2) operation of a geotechnical soil laboratory that processed soil samples collected for the *Geotechnical Characterization for Disposal Cell 4 Candidate Locations* work plan (RAML 2022b).

1.2 Second Quarter

Activities involving licensed material in April-June 2023 consisted of:

- Routine environmental monitoring as described in first quarter;
- Maintenance activities for the groundwater monitoring network as described in the *Groundwater Stability Monitoring Report First Half of 2023* (RAML 2023b, p. 6); and
- Continued operation of a geotechnical laboratory as described in first quarter.

1.3 Third Quarter

Activities involving licensed material in July-September 2023 consisted of:

- Routine environmental monitoring as described in first quarter; and
- The following tasks performed in accordance with a workplan (Stantec 2023) and described in RWPs, see Table 2: 1) advancement of direct push borings consistent with RAML standard operating procedures (SOPs); 2) excavation and backfill of test pits; and 3) continued operation of a geotechnical laboratory as described in first quarter.

1.4 Fourth Quarter

Activities involving licensed material in October-December 2023 consisted of:

- Routine environmental monitoring as described in first quarter;
- Soil characterization work performed in accordance with RAML SOPs; and

- Continued operation of a geotechnical laboratory as described in first quarter.

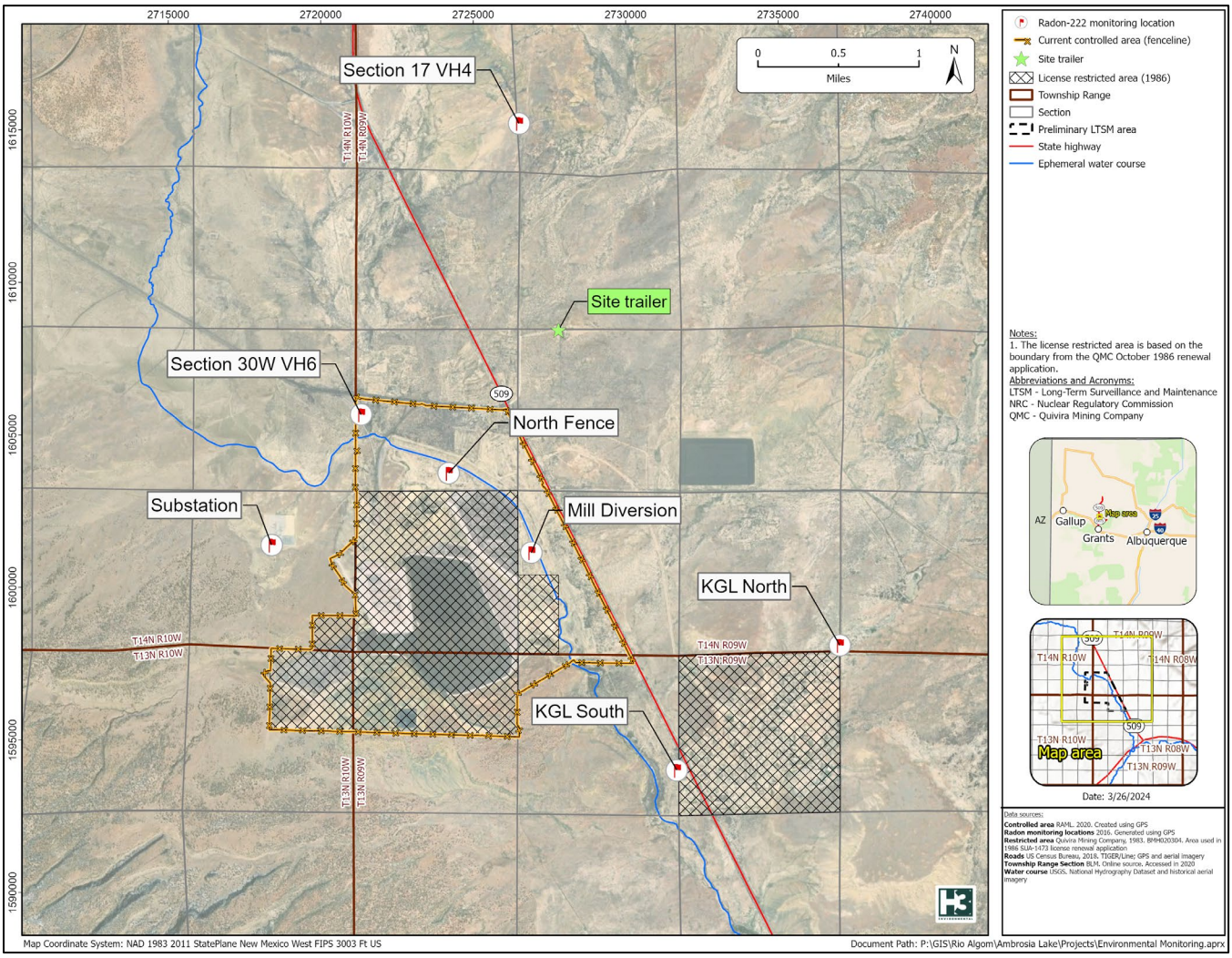

Figure 1. Radon-222 track etch monitoring locations and site trailer at the Ambrosia Lake West mill

2 Occupational Radiation Protection Program

External doses from ionizing radiation were monitored for personnel working with and around licensed materials. The monitoring methods are identified in the RPEM program manual and associated SOPs. RAML's dose calculations are performed consistent with NRC guidance in NRC Regulatory Guide 8.34 *Monitoring Criteria and Methods to Calculate Occupational Radiation Doses* (NRC 1992). All applicable regulatory limits for occupational radiation doses are contained in Title 10 *Code of Federal Regulations* (CFR) Part 20 (10 CFR 20.1201).

2.1 External Dosimetry Program

Landauer's Luxel® optically stimulated luminescent dosimeters (OSLs) are used to monitor occupational dose from external sources of ionizing radiation at the ALW mill. OSLs allow determination of deep dose equivalent (DDE), eye lens dose equivalent (LDE), and shallow dose equivalent (SDE). OSLs (including control dosimeters) are exchanged quarterly and stored in a background location (the site trailer, see Figure 1) when personnel are not onsite. Landauer

reports background-corrected external dose quarterly to a sensitivity of 1 millirem (mrem). RAML conservatively assumes that all reported dose is the result of exposure to licensed material.

In 2023, 70 workers were assigned OSLs to be worn while onsite. Results are tabulated in Table 1 and indicate that external doses are consistently less than ten percent of regulatory limits. Since 2019, between 22 and 73 individuals have been monitored each year at the ALW mill. Maximum recorded external DDE, LDE, and SDE doses have been consistently low and non-varying (6 mrem y^{-1}, 9 mrem y^{-1}, and 8 mrem y^{-1}, respectively) over the past five years. Therefore monitoring is not required per 10 CFR 20.1502; a determination of prior occupational dose in 10 CFR 20.2104 is also not applicable. However, RAML has opted to continue monitoring worker external doses as an ALARA practice.

2.1.1 Deep Dose Equivalent

In 2023, nine individuals had a DDE exceeding the 1 mrem sensitivity of OSL. The highest DDE was 2 mrem y^{-1}. The 2023 DDE results are below RAML's administrative action level of 500 mrem y^{-1} and are less than 1% of the regulatory occupational standard of 5,000 mrem y^{-1}.

2.1.2 Lens Dose Equivalent

In 2023, five individuals had an LDE exceeding the 1 mrem sensitivity of the OSL, with a maximum LDE of 1 mrem y^{-1}.

2.1.3 Shallow Dose Equivalent

In 2023, three individuals had an SDE exceeding the 1 mrem sensitivity of the OSL, with a maximum LDE of 1 mrem y^{-1}

Table 1. Ambrosia Lake West mill external dosimetry (2023)

Individuals Monitored	Individuals with Dose [a] ≥ 1 mrem y^{-1}			Max Annual Dose [a] (mrem)		
	DDE	LDE	SDE	DDE	LDE	SDE
70	9	5	3	2	1	1

[a] External dosimetry results are corrected for background doses measured by control dosimeters located at the site trailer.
DDE – deep dose equivalent
LDE – lens dose equivalent
mrem - millirem
SDE – shallow dose equivalent

2.2 Internal Dosimetry Program

RAML did not estimate internal doses from ionizing radiation in 2023 because previous monitoring has demonstrated that potential internal doses resulting from the types of activities conducted at the ALW mill in 2023 are below the monitoring thresholds in 10 CFR 20.1502(b) (i.e., potential intakes less than ten percent of the applicable annual limit on intake in 10 CFR 20 Appendix B Table 1). Radio-particulate sampling of worker breathing zones (BZs) was performed in 2023 as required by specific RWPs (see section 2.4); results are presented in Table 2.

Routine bioassay was discontinued in 2017. Future bioassay monitoring will be driven by the requirements of RWPs issued for a specific task. In 2023, there were no RWPs that required bioassay sampling and as such, no internal dose was estimated or assigned to workers.

2.3 Total Effective Dose Equivalent

The total effective dose equivalent (TEDE) is the sum of the internal dose component [(committed effective dose equivalent (CEDE)] and the external dose component (DDE). Since RAML did not estimate internal doses (CEDE) in 2023, TEDE estimates are equivalent to the DDEs reported in Table 1. Worker TEDEs in 2023 were less than 10% of any applicable limit.

2.4 Radiation Work Permit Program

Consistent with RAML's RPEM program manual, RAML uses RWPs to control dose to workers from ionizing radiation for non-routine work activities. RAML describes most non-routine work in work plans. These plans are reviewed by the radiation safety officer or the radiation safety officer's designee to evaluate the radiation hazard for each proposed job task and if an RWP is required to control the proposed work. In 2023, RWPs were issued for the activities described in Table 2. All RWPs included confirmatory BZ sampling; a summary of confirmatory BZ sampling is included on Figure 2.

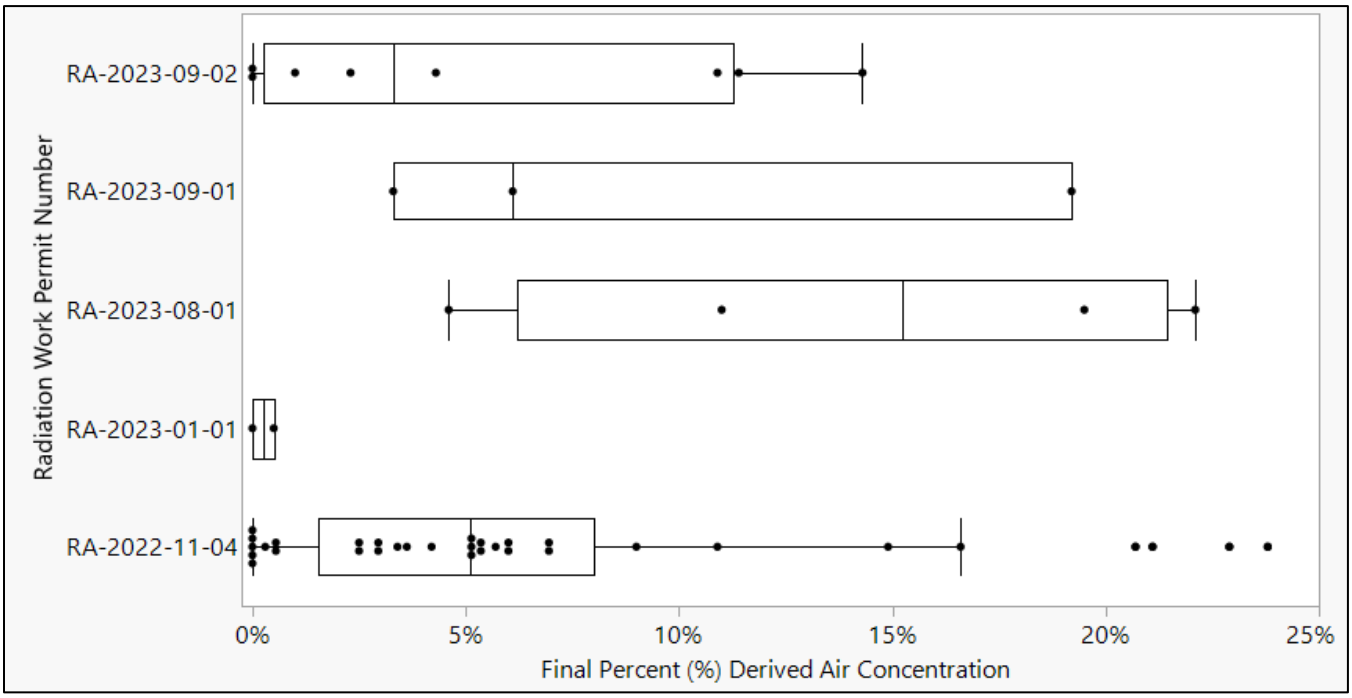

Figure 2. Box plot of breathing zone sample results as percent of the most restrictive derived air concentration

Note: The most conservative DAC from 10 CFR 20 Appendix B, Table 1 applicable to ALW mill operations is 3E-12 microcuries per milliliter for thorium-230, class W. BZ samples exceeding 0.3 DAC on an initial count were recounted to correct for decay of short-lived decay products of radon-222; the final count for each sample is included in the above figure.

Table 2. Ambrosia Lake West mill radiation work permits (2023)

RWP Number	Scope / Description	Open Date	Close Date	Working Days	BZ Samples Collected	Measured %DAC [c] Max (Average)	Hypothetical Intake %ALI [d]
RA-2022-11-04 [a]	On-site geotechnical testing of soil samples collected as part of the Cell 4 program at the Geotechnical Lab located adjacent to the site trailer and shop.	Nov 11 2022	Jul 31 2023	141	33	23.8% (6.7%)	3.8%
RA-2023-01-01 [b]	Replacement of groundwater monitoring well 05-04ALL including drilling and well completion.	Jan 10 2023	Jan 11 2023	2	2	0.05% (0.03%)	0.002%
RA-2023-08-01	Advancement of direct push borings with continuous sample collection to investigate geotechnical properties of soil affected by byproduct material.	Aug 22 2023	Aug 28 2023	4	4	22.1% (14.3%)	0.23%
RA-2023-09-01	Excavation and backfill of trenches with the purpose of investigating geotechnical properties of soil affected by byproduct material.	Sep 5 2023	Sep 8 2023	3	3	19.2% (9.5%)	0.11%
RA-2023-09-02	On-site geotechnical testing of soil samples collected from the byproduct material investigation at the Geotechnical Lab located adjacent to the site trailer and shop.	Sep 11 2023	Open	40[e]	8[f]	14.3% (5.5%)	0.88%

[a] Work supported the *Geotechnical Characterization for Disposal Cell 4 Candidate Locations* work plan which RAML provided to NRC in May 2022 (RAML 2022b).

[b] Work supported the *Monitoring Well 5-04 ALL Abandonment and Replacement* project for which RAML provided a report to NRC in February 2023 (RAML 2023e).

[c] The most conservative DAC from 10 CFR 20 Appendix B, Table 1 applicable to ALW mill operations is 3E-12 microcuries per milliliter for thorium-230, class W. BZ samples exceeding 0.3 DAC on an initial count were recounted to correct for decay of short-lived decay products of radon-222; the maximum of the final counts for each RWP is reported. Results with negative activity (sample count rate less than background count rate) were recorded as 0% DAC.

[d] Hypothetical intakes from inhalation conservatively assume one worker worked 8 hour days for the entire project duration at the average recorded %DAC, Hypothetical %ALI was calculated as: $\frac{\#\ working\ days \times Average\ DAC}{250\ working\ days}$. The most conservative ALI from 10 CFR 20 Appendix B Table 1 applicable to site operations is 6E-3 microcuries for thorium-230, class W inhalation.

[e] Working days in 2023 only; estimated by assuming five working days were represented by each of eight collected BZ samples.

[f] No sample was collected for the week of September 18th 2023.

ALI – annual limit on intake
ALW – Ambrosia Lake West
BZ – breathing zone
DAC – derived air concentration
mrem – millirem
NRC – United States Nuclear Regulatory Commission
RAML – Rio Algom Mining LLC
RWP – radiation work permit

2.5 Contamination Control Program

Control of potential contamination from licensed material at the ALW mill consisted of facility, equipment, and personnel surveys. Surveys for total and removable alpha/beta contamination were completed on equipment prior to unrestricted release per RAML SOPs. Equipment was released as consistent with release limits specified in SUA-1473 condition 10D or moved to onsite storage if above release limits.

Personnel contamination surveys were completed in accordance with SOPs with an ALARA action level of "above background". In two instances, personnel with surveys that were slightly above background were released with RSO consultation. All other personnel surveys that were above background were remedied by hand washing (12 instances) and by washing the bottoms of shoes (1 instance). In all cases, personnel surveys were below site release limits specified in the RPEM program manual.

2.6 Audits and Inspections

An internal audit of the RPEM program was conducted during the preparation of this report. No deviations from the RPEM program manual or SUA-1473 were identified, and proper radiation practices were being implemented at the ALW mill. Periodic inspections of the facility were conducted monthly, and the ALW mill was found to be secure and properly posted unless otherwise noted in Table 3.

NRC performed a scheduled inspection consisting of a site visit, interviews, and document review September 26-28, 2023 (NRC 2023b) and identified a violation of minor significance regarding failure (in the second half of 2022) to sample two wells in the timeframe required by condition 34 of SUA-1473. This violation was addressed by RAML prior to NRC's inspection via a root cause analysis and implementation of corrective actions and was documented in the *Groundwater Stability Monitoring Report Second Half of 2022* (RAML 2023c) and in a "Memo to File" (RAML 2023d).

Table 3. Ambrosia Lake West mill radiation safety officer inspections (2023)

Inspection Date	Actions
Jan 3 2023	None
Feb 20 2023	None
Mar 7 2023	RSO found that signage for a Conex located at the site trailer required replacement.
Apr 27 2023	None
May 31 2023	RSO found that the inventory label at a Conex located at the laydown yard required replacement.
Jun 22 2023	None
Jul 25 2023	None
Aug 29 2023	None
Sep 19 2023	RSO added signage to a trailer located adjacent to the site trailer.
Oct 26 2023	None
Nov 28 2023	None
Dec 28 2023	None

RSO – radiation safety officer

2.7 Training Program

Annual radiation safety awareness training was carried out per Section 3.1 of the RPEM program manual for a total of 75 workers, including contractors and employees.

3 Public Dose Evaluation

In addition to the occupational exposures discussed above, RAML annually evaluates radiation doses to the public from its operations. These are prepared per the requirements of 10 CFR 20.1301-1302, the RPEM program manual, and RAML SOPs.

RAML submitted semiannual effluent reports to the NRC of quarterly radon monitoring results from January-June 2023 (RAML 2023f) and July-December 2023 (RAML 2024). Data contained within these reports were used to demonstrate compliance with dose limits to members of the public from licensed sources. The calculated radiation doses to members of the public includes only the radon-222 inhalation pathway. Monitoring for and calculation of doses resulting from other pathways, such as external dose, vegetation, and airborne radioactive particulates, was discontinued in 2017 following NRC concurrence (NRC 2017).

Monitoring locations are shown on Figure 1. The Substation location is considered background. Table 4 provides annual average radon-222 concentrations measured at each location.

Table 4. Measured radon-222 concentrations near the Ambrosia Lake West mill (2023)

Location	Average Annual Gross Radon-222 Concentration ($pCi\ L^{-1}$)	*Duplicate* Average Annual Gross Radon-222 Concentration ($pCi\ L^{-1}$)
Substation	0.5	-
Mill diversion	1.8	-
Section 30W VH6	3.0	3.0
North Fence	2.1	2.2
Section 17 VH4	0.4	-
KGL-north	1.5	1.4
KGL-south	1.4	-

"-" – no duplicate result for this location

$pCi\ L^{-1}$ – picocuries per liter

Radiation dose was calculated to three hypothetical members of the public consistent with a RAML SOP as follows:

- "Nearest resident[1]" using data from location Section 17 VH4 at the RAML property boundary for the point of exposure (POE) concentration. The dose estimate uses a decay product equilibrium fraction of 0.5 representing an indoor exposure.
- "Delivery driver" using data from location Section 30W VH6 for the POE concentration. The dose estimate uses an occupancy factor of 0.0072 representing a 15 minute per day, 252 day per year exposure and a decay product equilibrium fraction of 0.7 representing an outdoor exposure.
- "Occasional visitor" using an average of all radon-222 monitoring data except the Substation (background) for the POE concentration. The dose estimate uses an occupancy factor of 0.0128 representing an 8 hour per day, 14 day per year exposure and a decay product equilibrium fraction of 0.7 representing an outdoor exposure.

[1] The nearest resident is the individual member of the public likely to receive the highest dose from the licensed operation and is identified in RAML's annual land use survey report as the Berryhill Ranch (RAML 2023a).

The 2023 results for dose to hypothetical members of the public are shown in Table 4. The potential dose calculations for members of the public for 2023 were less than 10% of the 10 CFR 20.1301 dose limit[2] of 100 mrem y^{-1}.

Table 5. Public dose estimate for hypothetical public receptors near the Ambrosia Lake West mill (2023)

Receptor Scenario	Average Net Radon-222 Concentration (pCi L^{-1})	Occupancy Factor	Equilibrium Fraction	Dose Conversion Factor [b] (mrem per pCi L^{-1})	TEDE (mrem)
Nearest resident	0 [a]	1	0.5	500	0
Delivery driver	2.5	0.0072	0.7	500	6
Occasional visitor	1.4	0.0128	0.7	500	6

[a] Net radon concentration for this receptor location was negative and is reported as zero dose.
[b] Dose conversion factor for radon-222 is derived using the effluent concentration limit for radon-222 with all decay products from 10 CFR 20, Appendix B, Table 2.

mrem – millirem
pCi L^{-1} – picocuries per liter
TEDE – total effective dose equivalent

4 References

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[2] The ALW mill transitioned to "possession only" status in 2003 (NRC 2003); possession only status does not meet the definition of "uranium fuel cycle" in 40 CFR 190.02. Therefore, the public dose limits in 40 CFR 190.10 do not apply to the ALW mill.

and ML22146A411 (work plan): Rio Algom Mining LLC). https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML22146A410.

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