

**CALENDAR YEAR 2020 ALARA REPORT**  
**RIO ALGOM MINING, LLC – AMBROSIA LAKE FACILITY**  
McKinley County, New Mexico

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**May 24, 2020**

## Table of Contents

Table of Contents .....	ii
Acronyms and Abbreviations.....	iii
1 Site Activities.....	1
1.1 First Quarter .....	1
1.2 Second Quarter .....	1
1.3 Third Quarter.....	1
1.4 Fourth Quarter.....	1
2 Occupational Radiation Protection Program .....	3
2.1 External Dosimetry Program .....	3
2.1.1 Deep Dose Equivalent.....	3
2.1.2 Shallow Dose Equivalent .....	3
2.1.3 Lens Dose Equivalent .....	3
2.2 Internal Dosimetry Program .....	4
2.2.1 Committed Dose Equivalent.....	4
2.2.2 Committed Effective Dose Equivalent .....	4
2.2.3 Bioassay Program .....	4
2.3 Total Effective Dose Equivalent .....	4
2.4 Radiation Work Permit Program .....	4
2.5 Contamination Control Program.....	5
2.6 Training Program .....	5
2.7 Audits and Inspections.....	5
3 Environmental Monitoring Program and Public Dose Evaluation .....	5
4 References .....	6

## Acronyms and Abbreviations

Term	Definition
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
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.
CDE	committed dose equivalent
CEDE	committed effective dose equivalent
CFR	Code of Federal Regulations
Ci	Curie
contractor	an individual or business who has signed a contract, field services agreement, or purchase order and is completing work for RAML at the facility
DAC	derived air concentration
DDE	deep dose equivalent
employee	an employee of RAML who is completing work for RAML at the facility
ERG	Environmental Restoration Group, Inc.
facility	RAML's Ambrosia Lake West Mill facility
g	gram
H3	H3 Environmental, LLC
INTERA	INTERA, Inc.
L	liter
LDE	lens dose equivalent (eye dose equivalent to the lens of the eye)
license	NRC license SUA-1473 for RAML's Ambrosia Lake West Mill facility
licensed materials	radioactive and non-radioactive material that is regulated by NRC pursuant to the facility license
mrem	millirem
mrem y <sup>-1</sup>	millirem per year
ML#	Agencywide Documents Access and Management System accession number
N	north
NRC	United States Nuclear Regulatory Commission
OSL	optically stimulated luminescent dosimeter
POE	point of exposure
pCi L <sup>-1</sup>	picocuries per liter
RAML	Rio Algom Mining, LLC
rem	roentgen equivalent man
rem y <sup>-1</sup>	rem per year
Rn-222	radon-222
RPEM	radiation protection and environmental monitoring

RIO ALGOM MINING LLC – AMBROSIA LAKE, NM, Radioactive Materials License SUA-1473  
CALENDAR YEAR 2020 ALARA REPORT

Term	Definition
RWP	radiation work permit
SDE	shallow dose equivalent
SDP	Soil Decommissioning Plan
SOP	standard operating procedure
SUA-1473	NRC license SUA-1473 for RAML's Ambrosia Lake West Mill facility
TEDE	total effective dose equivalent
Th-230	thorium-230
uranium (U)	total uranium
visitor	any individual who is on-site at the facility who is not classified as a worker
worker	an employee or contractor who is completing work for RAML

## 1 Site Activities

This report summarizes calendar year 2020 activities, occupational radiation dose monitoring results, and public dose estimates at Rio Algom Mining, LLC's (RAML's) Ambrosia Lake West Mill facility (the facility). The facility is a former uranium mill currently being decommissioned. The facility is regulated by the U.S. Nuclear Regulatory Commission (NRC) via radioactive materials license SUA-1473 (NRC 2020a), and facility specific radiation protection programs are defined in the *Radiation Protection and Environmental Monitoring Program Manual* (RPEM) (RAML 2021a). Within the RPEM, RAML commits to maintain exposure to all licensed materials at levels that are as low as is reasonably achievable (ALARA), and to prepare this annual report summarizing the results of the RPEM program for the previous calendar year.

Much of the licensed material subject to decommissioning has been consolidated in engineered repositories that were closed following NRC-approved plans. Licensed activities at the facility in 2020 consisted of 1) routine environmental monitoring and 2) soil investigations pursuant to the NRC-approved *Soil Decommissioning Plan* (SDP) (Komex 2006), are summarized for each quarter below:

### 1.1 First Quarter

Activities involving licensed material in the first quarter consisted of:

- Routine environmental monitoring including: 1) groundwater sampling in and around the licensed area; and 2) passive track etch monitoring for radon-222 (Rn-222) in ambient air at the seven locations shown on Figure 1-1; and
- Soils characterization work within the windblown tailings affected area designated in the NRC-approved SDP (Komex 2006) performed in accordance with site standard operating procedures.

### 1.2 Second Quarter

Activities involving licensed material in the second quarter consisted of:

- Routine environmental monitoring as described in first quarter; and
- Soils characterization work within the windblown tailings affected area designated in the NRC-approved SDP (Komex 2006) performed in accordance with a radiation work permit (RWP). This work involved limited breathing zone monitoring for verification purposes.

### 1.3 Third Quarter

Activities involving licensed material in the third quarter consisted of:

- Routine environmental monitoring as described in first quarter;
- Soils characterization work within the windblown tailings affected area designated in the NRC-approved SDP (Komex 2006) performed in accordance with site standard operating procedures.
- GHD performed site maintenance.

### 1.4 Fourth Quarter

Activities involving licensed material in the fourth quarter consisted of:

- Routine environmental monitoring as described in first quarter; and

- October 2020 transfer of oversized byproduct material investigation-derived waste from a rental roll-off container to a RAML-owned container. This work was conducted under an RWP and involved limited breathing zone monitoring for verification purposes.

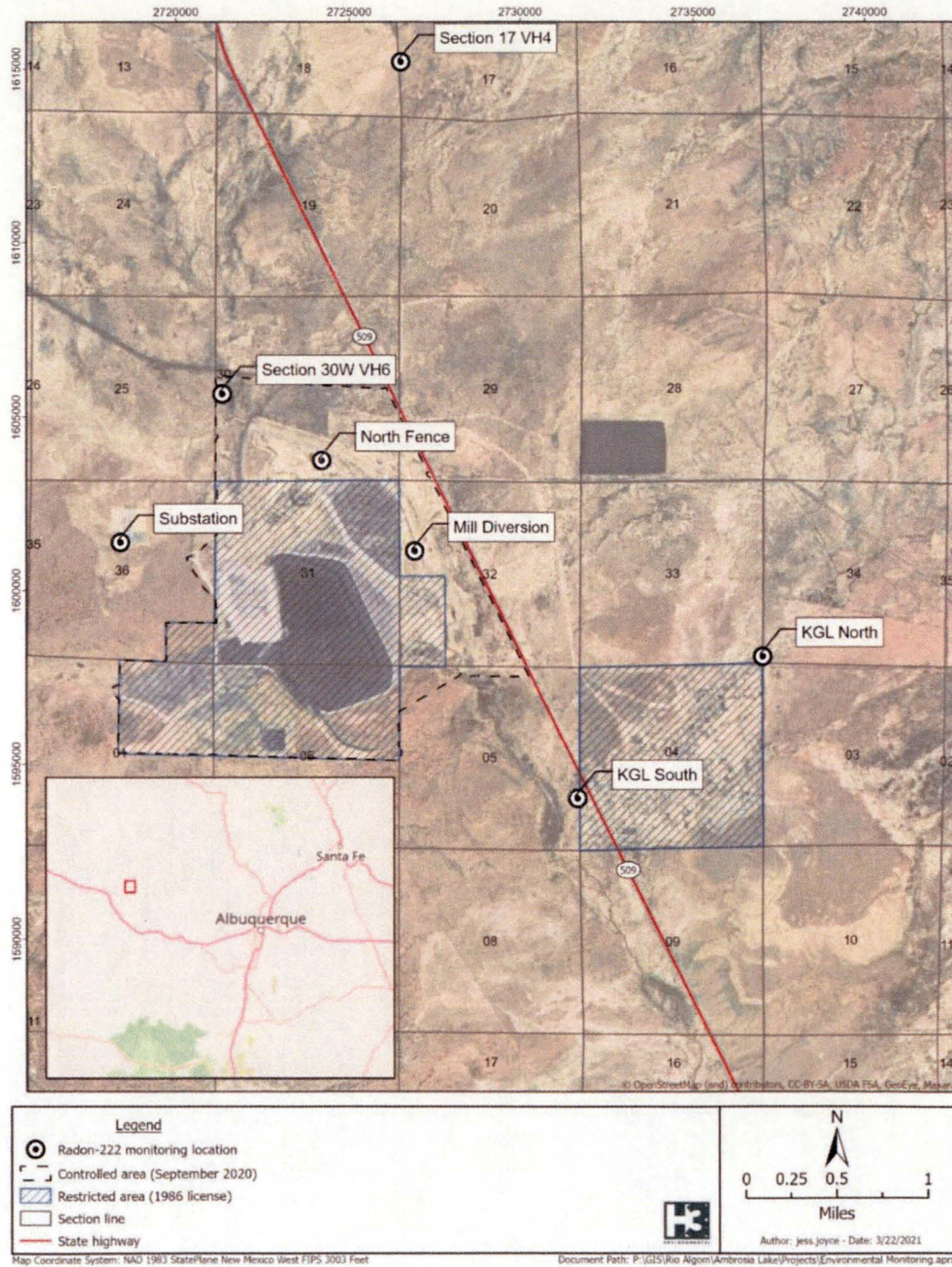


Figure 1-1. Radon-222 monitoring locations for the Ambrosia Lake West mill facility

## 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 and associated standard operating procedures (SOPs). RAML’s dose calculations are performed in a manner consistent with NRC guidance described 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

Optically stimulated luminescent dosimeters (OSLs) are used to monitor occupational exposure to ionizing radiation from external sources at the facility. In 2020, 32 facility workers were assigned dosimeters that were required to be worn while onsite. OSLs allow determination of deep dose equivalent (DDE), eye lens dose equivalent (LDE), and shallow dose equivalent (SDE). OSLs (including controls) are stored in a background location (the facility trailer) while personnel are not onsite. As a result, the measured external dose is from potential exposure to licensed material. Landauer’s Luxel® OSLs were used to monitor external dose parameters for the monitoring period. Landauer reports that this dosimeter has a sensitivity of 1 mrem. All reported external doses are well below regulatory limits. Since 2000, the external doses at the facility have been low (typically less than ten percent of regulatory limits). The data for the external doses in 2020 are tabulated in Table 2-1. Since doses are less than ten percent of the applicable limits in 10 CFR 20.1201, workers are not required to be monitored per 10 CFR 20.1502. Likewise, a determination of prior occupational dose in 10 CFR 20.2104 is not applicable. RAML chooses to monitor workers to demonstrate occupational doses are ALARA.

#### 2.1.1 Deep Dose Equivalent

In 2020, two individuals had DDEs exceeding the 1 mrem sensitivity of the Luxel® OSL. The highest dose was 1 mrem. The 2020 DDE results are ALARA and well below the regulatory standard of 5 rem y<sup>-1</sup>.

#### 2.1.2 Shallow Dose Equivalent

In 2020, zero individuals had SDEs exceeding the 1 mrem sensitivity of the Luxel® OSL.

#### 2.1.3 Lens Dose Equivalent

In 2020, zero individuals had LDEs exceeding the 1 mrem sensitivity of the Luxel® OSL.

Table 2-1. 2020 Summary of External Dosimetry

Entity	Number of Individuals Monitored	Number of Individual Doses ≥ 1 mrem	Highest Annual DDE (mrem)
RAML	3	0	0
H3	4	0	0
ERG	4	0	0
INTERA	10	1	1
GHD	1	1	1
TOTAL	22	2	1

DDE – deep dose equivalent  
 ERG – Environmental Restoration Group, Inc.  
 GHD – GHD Group

H3 - H3 Environmental, LLC  
 INTERA – INTERA, Inc.  
 RAML - Rio Algom Mining, LLC

## 2.2 Internal Dosimetry Program

Internal doses from ionizing radiation were not evaluated because the largest sources of internal exposure have been mitigated, and previous monitoring has demonstrated that internal doses from ionizing radiation are much lower than ten percent of the applicable regulatory limit of a committed effective dose equivalent (CEDE) of 5 rem y<sup>-1</sup>. For this reason, RAML did not conduct breathing zone monitoring for routine activities at the facility in 2020.

### 2.2.1 Committed Dose Equivalent

No estimate of committed dose equivalent (CDE) to the highest exposed organ was made because no routine occupational long-lived air samples were collected. As such, no internal dose was calculated or assigned to workers.

### 2.2.2 Committed Effective Dose Equivalent

No estimate of CEDE was made because no routine occupational long-lived air samples were collected. As such, no internal dose was calculated or assigned to workers.

### 2.2.3 Bioassay Program

Routine bioassay was discontinued in 2017 because all sources of soluble uranium at the facility have been mitigated. Future bioassay monitoring will be driven by the requirements of RWPs issued for a specific task. In 2020, there were no RWPs that required bioassay sampling.

## 2.3 Total Effective Dose Equivalent

The total effective dose equivalent (TEDE) is the sum of the internal dose component (CEDE) and the external dose component (DDE). All TEDE estimates for 2020 based on personnel monitoring data are ALARA and less than ten percent of any applicable limit.

## 2.4 Radiation Work Permit Program

Two RWPs were issued in 2020. Results of breathing zone sampling are presented in Table 2-2.

The first RWP was issued June 17, 2020 in support of dust-generating soils characterization work within the windblown tailings affected area. Breathing zone sampling was conducted on three days during the work to confirm dust control was adequate. The air concentration for each day was less than 10% of the derived air concentration for Class W thorium-230.

The second RWP was issued October 7, 2020 to transfer oversized byproduct material investigation-derived waste from a rental roll-off container to a RAML-owned container. Breathing zone sampling was conducted during the work and results were less than 50% of the derived air concentration for Class W thorium-230. This activity was conducted in approximately 3 hours after which the RWP was closed. Controls to limit airborne radionuclides were not implemented since the activity ended prior to evaluating the sample.

Table 2-2. 2020 Summary of Breathing Zone Sampling

Monitoring Date	% DAC <sup>a</sup>
6/17/2020	8.2%
7/7/2020	9.3%
7/9/2020	5.7%
10/7/2020	49.8%

<sup>a</sup> RAML's SOP defines a conservative estimate for breathing zone sampling using the 10 CFR 20 Appendix B Table 1 DAC for thorium-230, class W.



## 2.5 Contamination Control Program

Control of potential contamination from licensed material at the facility includes personnel and equipment scan surveys in accordance with the RPEM and RAML SOPs. No elevated surface activity from self-scanning was reported in 2020. On one occasion, an individual recorded a count rate exceeding the instrument background but did not contact the radiation safety officer. While this represents a deviation from RAML's SOP, the recorded count rate was well within release limits for surface contamination. Use of the personnel self-scanning form and equipment will be emphasized in future radiation safety awareness training. All equipment scanned for unrestricted release in 2020 was successfully decontaminated to meet criteria in license condition 25 of SUA-1473.

## 2.6 Training Program

Annual radiation safety awareness training, as outlined in Section 3.1 of the RPEM, was completed for a total of 54 workers including employees and contractors.

## 2.7 Audits and Inspections

An in-depth review of the RPEM program including content and implementation of applicable requirements and guidance was conducted in Q4 2020. No deviations from the RPEM or SUA-1473 were identified.

Periodic inspections of the facility were conducted January 8, 2020, June 3, 2020, September 23, 2020, and October 14, 2020 by the radiation safety officer to verify that radiation protection practices were being followed and that the site fences and gates were secure and properly posted.

NRC performed a virtual facility inspection including interviews and document review September 29 – October 1, 2020 and identified no violations (NRC 2020b).

# 3 Environmental Monitoring Program and Public Dose Evaluation

In addition to the occupational exposures discussed above, RAML annually evaluates radiation doses resulting from its operations to members of the public. These are prepared per the requirements of 10 CFR 20.1301-1302, 40 CFR 190.10, the RPEM and RAML SOPs.

RAML submitted semiannual effluent reports to the NRC covering January-June 2020 (RAML 2020b) and July-December 2020 (RAML 2021b). Data contained within these reports were used to evaluate doses to members of the public. The calculated radiation doses to members of the public includes only the Rn-222 inhalation pathway.

Monitoring locations are shown on Figure 1-1. The Substation location is considered background. Radiation dose was calculated to three hypothetical members of the public, as follows:

- “Nearest resident” using data from location Section 17 VH4 for point of exposure (POE) concentration. The decay product equilibrium fraction of 0.5 represents indoor exposure.
- “Delivery driver” using data from location Section 30 West VH6 for POE concentration. The occupancy factor of 0.0072 represents 15 minutes per day, 252 days per year and decay product equilibrium fraction of 0.7 represents outdoor exposure.
- “Occasional visitor” using an average of all site monitoring data except the Substation for POE concentration. The occupancy factor of 0.0128 represents 8 hours per day, 14 days per year and decay product equilibrium fraction of 0.7 represents outdoor exposure.

The 2020 results for dose to member of the public are shown in Table 3.1. The potential dose calculations for members of the public for 2020 were well below the 10 CFR 20.1301 dose limit of 100 mrem y<sup>-1</sup>. Rn-222 and its progeny are excluded from dose limits in 40 CFR 190.10.

Table 3-1. 2020 dose estimate (Rn-222 only) for hypothetical public receptors near the Ambrosia Lake facility

Receptor Scenario	Average Net Rn-222 Concentration (pCi L <sup>-1</sup> )	Occupancy Factor	Equilibrium Fraction	Dose Conversion Factor <sup>b</sup> (mrem per pCi L <sup>-1</sup> )	TEDE (mrem)
Nearest resident	0 <sup>a</sup>	1	0.5	500	0
Delivery driver	2.6	0.0072	0.7	500	6.6
Occasional visitor	1.6	0.0128	0.7	500	7.2

<sup>a</sup> Net radon concentration for this receptor location was negative and is reported as zero dose.

<sup>b</sup> Dose conversion factor for Rn-222 is derived using the effluent concentration limit for Rn-222 with all decay products from 10 CFR 20, Appendix B, Table 2.

pCi L<sup>-1</sup> – picocuries per liter  
 Rn-222 – Radon-222  
 TEDE – total effective dose equivalent

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