



Moab UMTRA Project
Environmental Air Monitoring Data Quarterly
Report for the Moab and Crescent Junction, Utah,
Sites Fourth Quarter (October – December 2022)

Revision 0

April 2023



U.S. Department
of Energy

Office of Environmental Management

**Moab UMTRA Project
Environmental Air Monitoring Data Quarterly Report for the Moab and Crescent
Junction, Utah, Sites Fourth Quarter 2022 (October - December 2022)**

Revision 0

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Revision History

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Acronyms and Abbreviations

DOE	Department of Energy
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MDC	minimum detectable concentration
MEI	maximally exposed individual
met	Meteorology
mrem	millirem
O	Order
OSL	optically stimulated luminescence
pCi	picocurie
pCi/L	picocurie per liter
RAC	Remedial Action Contractor
RRM	Residual Radioactive Material
SAP	Sampling Analysis Plan
TAC	Technical Assistance Contractor
TED	total effective dose
TLD	thermoluminescent dosimeter
UMTRA	Uranium Mill Tailings Remedial Action
VDV	Vista Data Vision
WL	Working level

1.0 Introduction

The purpose of this Report is to present the results of environmental air monitoring at the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project sites during the fourth calendar quarter of 2022 (October-December). The Project sites consist of the former uranium ore-processing mill located three miles north of Moab, Utah, and the disposal site located near Crescent Junction, Utah.

2.0 Regulatory Requirements

This Report demonstrates compliance with DOE Order (O) 458.1, Admin Chg. 4, “Radiation Protection of the Public and the Environment,” which states DOE radiological activities must be conducted in a manner that does not cause total effective dose (TED) to the public to exceed 100 millirems (mrem) in a year, or an equivalent dose to the lens of the eye exceeding 1,500 mrem in a year, or an equivalent dose to the skin or extremities of 5,000 mrem in a year. This limit excludes doses from background radiation, radon gas and its decay products in air, occupational doses, and medical exposures.

For the Project, the TED is the sum of the direct gamma radiation (minus background) and radioactive particulate material (radioparticulate) exposure. DOE O 458.1 also specifies releases of radioactive material to the atmosphere from DOE activities shall not exceed an annual average concentration of 3 picocuries per liter (pCi/L) of radon or its decay products, excluding background, at the site boundary.

Compliance with DOE O 458.1 is demonstrated by calculating the TED to the maximally exposed individual (MEI) or the representative person or group from the public likely to receive the highest radiation dose based on exposure pathways and parameters. The Project has established MEIs for each of the Moab and Crescent Junction Project sites.

3.0 Radiological Monitoring and Results

The Moab UMTRA Project monitors the following:

- radon, using radon measuring devices.
- direct gamma radiation, using optically stimulated luminescence (OSL) dosimeters.
- radioparticulates, using environmental air sampling equipment.

Off-site monitoring locations, including the Maximally Exposed Individual (MEI), for the Moab site are shown on Figure 1. On-site Moab locations are shown on Figure 2. All monitoring locations for the Crescent Junction sites are shown on Figure 3.

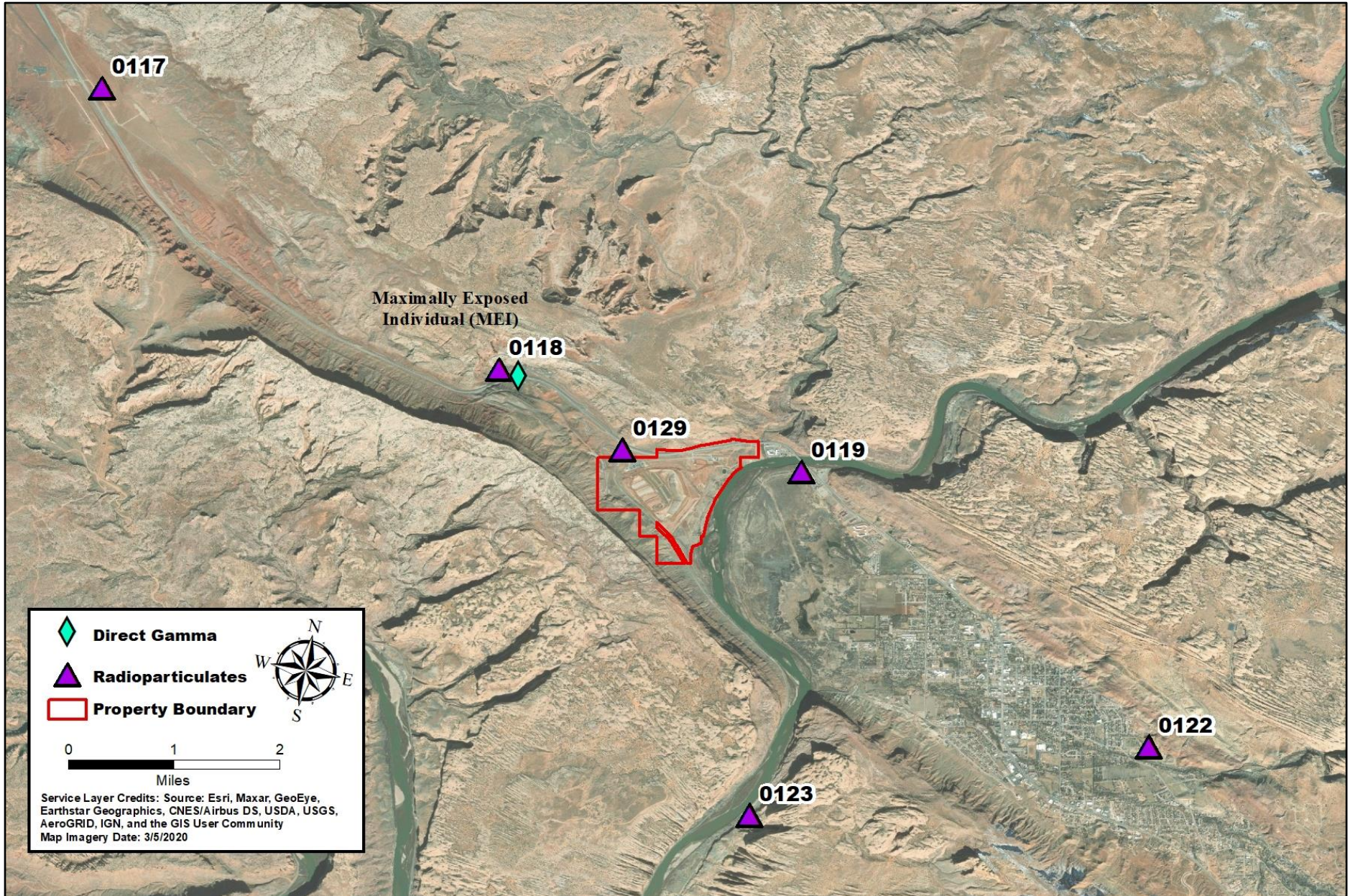


Figure 1. Moab Off-site and Maximally Exposed Individual Environmental Air Monitoring Locations

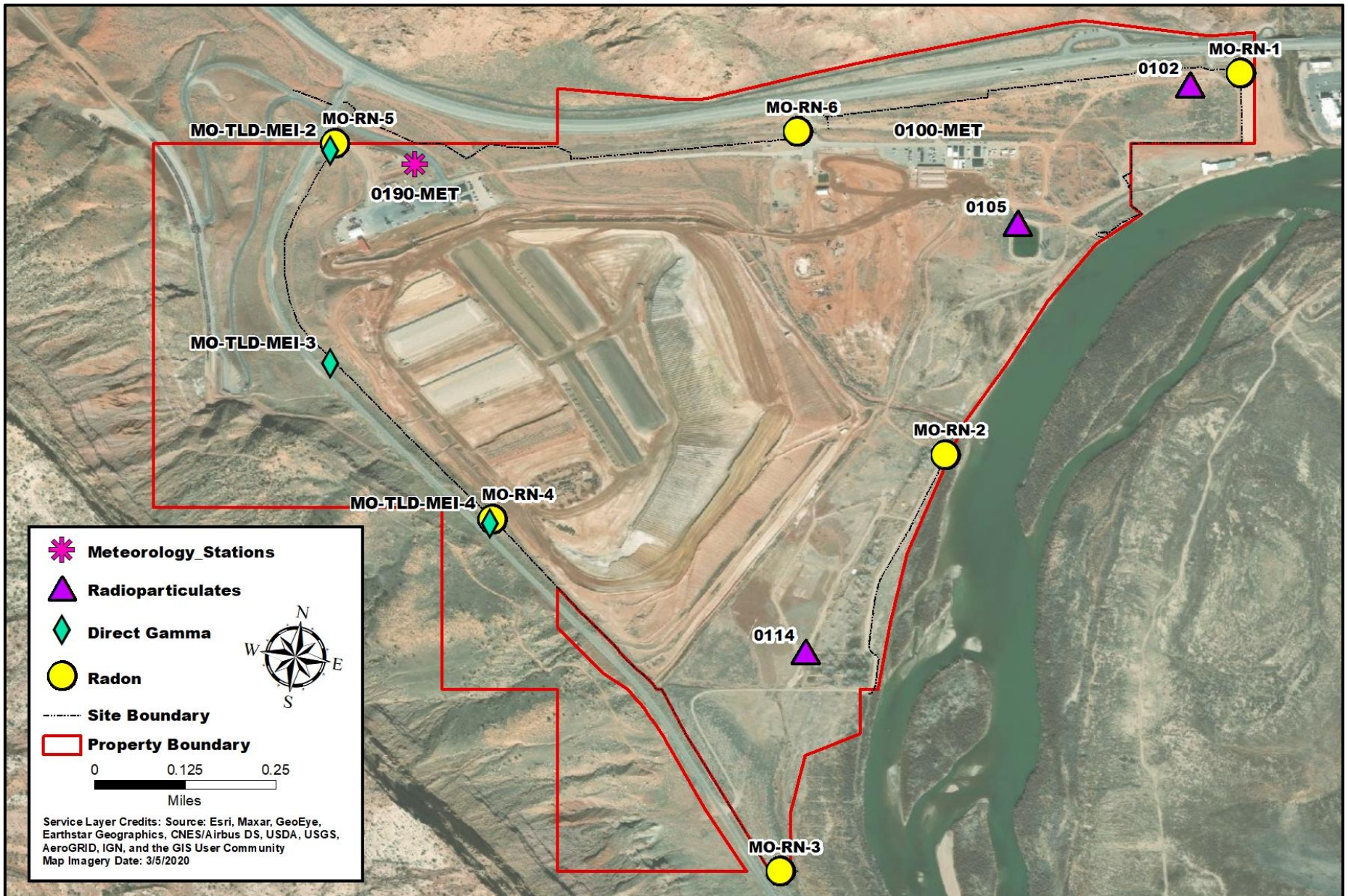


Figure 2. Moab On-site Environmental Air Monitoring Locations

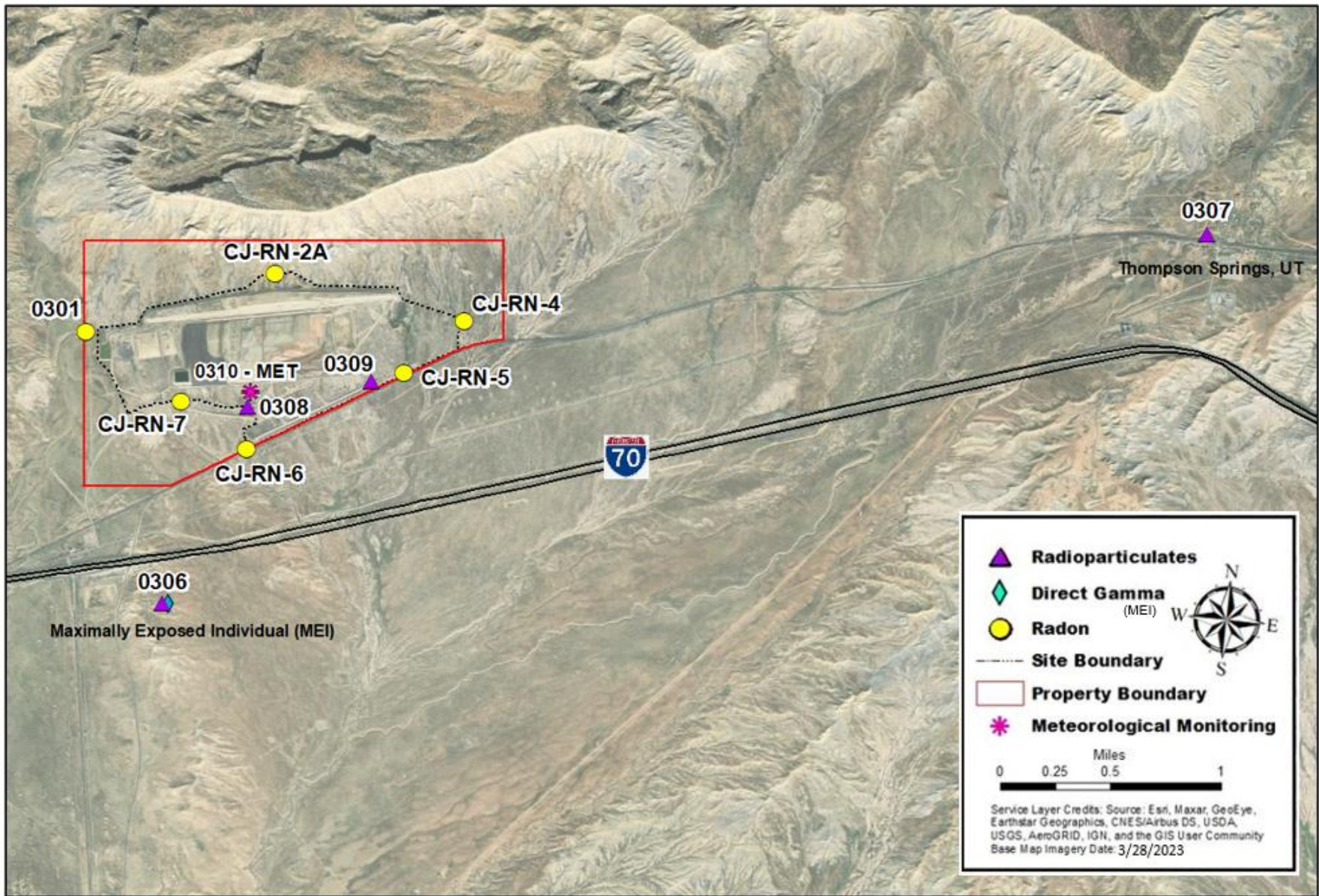


Figure 3. Crescent Junction Site Environmental Air Monitoring Locations

3.1 Radon

Radon is a radioactive, colorless, odorless, tasteless noble gas, which occurs naturally in minute quantities as an intermediate step in the normal radioactive decay chains through which thorium and uranium decay into various short-lived radioactive elements and lead. Radon is the immediate decay product of radium. The most stable isotope, ²²²Rn, has a half-life of only 3.8 days, making it one of the rarest elements. Since thorium and uranium are two of the most common radioactive elements on Earth, while also having three isotopes with half-lives on the order of several billion years, radon will be present on Earth long into the future despite its short half-life. The decay of radon produces many other short-lived nuclides, known as "radon daughters", ending at stable isotopes of lead.

The Radon network consists of 13 total radon monitors along the site boundaries: 6 monitors at the Moab site and 7 monitors at the Crescent Junction site (DOE O 458.1 4f; Figures 2 and 3). Background radon for both the Moab and Crescent Junction project sites is 0.6 pCi/L.

Moab Site Results

Table 1 and Figure 4 show quarterly and average radon results for the past four quarters at the Moab site boundary. The background value of 0.6 pCi/L has been subtracted from the past four quarters average.

Table 1. Quarterly and Average Radon Concentrations for the Moab Site for the Past Four Quarters

Station Number	First Quarter 2022 (pCi/L)	Second Quarter 2022 (pCi/L)	Third Quarter 2022 (pCi/L)	Fourth Quarter 2022 (pCi/L)	Past 4 Quarters Average (pCi/L) (Background subtracted)
MO-RN-1 (NE corner of site)	2.30	0.68	0.72	2.25	0.89
MO-RN-2 (wellfield, south of Moab Wash)	4.60	1.55	1.80	4.45	2.50
MO-RN-3 (south end of site)	1.90	0.66	0.96	2.25	0.84
MO-RN-4 (along Potash Rd)	1.40	1.10	1.90	2.80	1.20
MO-RN-5 (jct of haul road & Potash Rd)	1.30	0.76	1.20	2.40	0.82
MO-RN-6 (by main entrance)	2.80	1.30	1.60	3.30	1.65

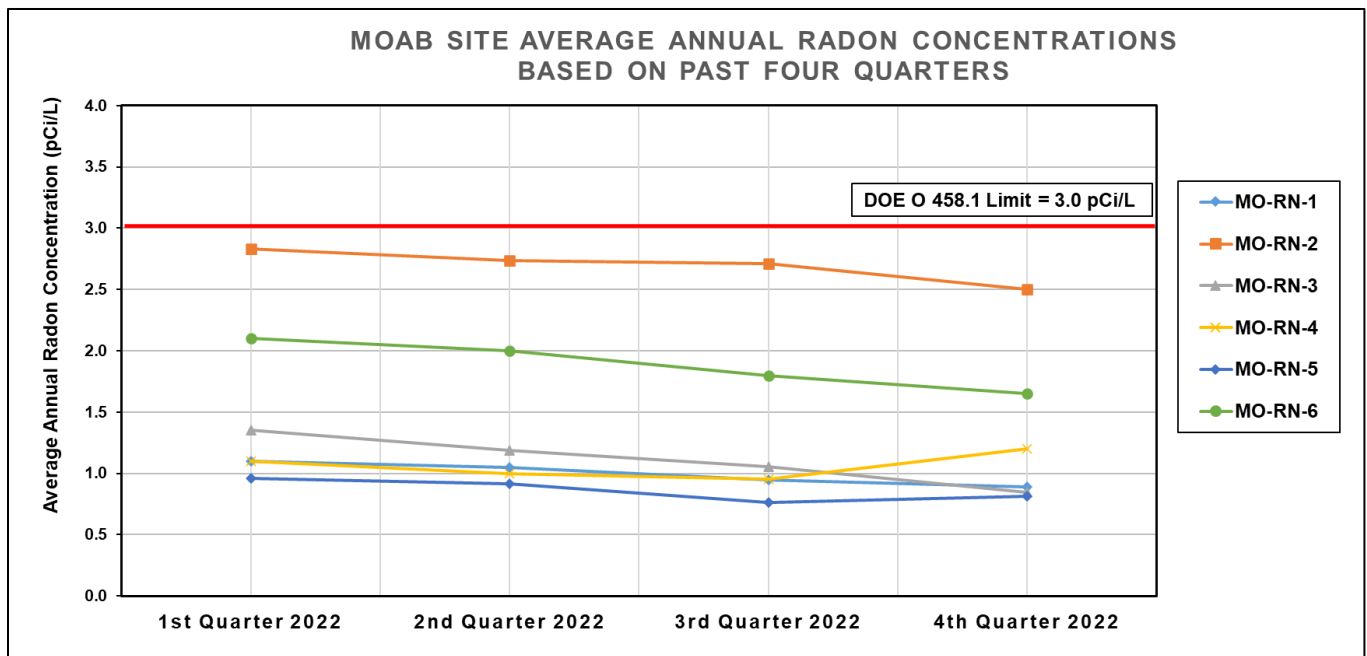


Figure 4. Moab Average Annual Radon Concentrations for Past Four Quarters

The Project’s measured annual average radon emission at the Moab site boundary is below the limit of 3.0 pCi/L. The Project is compliant with DOE O 458.1 4F.

Crescent Junction Site

The Technical Assistance Contractor (TAC) made changes to the Crescent Junction radon stations at the beginning of the fourth quarter 2022. These were made due to access and safety concerns (i.e., slips, trips, falls, etc.). The station changes are as follows:

- CJ-RN-1 was removed.
- The previous 0301 radon station was reinstalled.
- CJ-RN-2 and CJ-RN-3 were removed.
- A new station, CJ-RN-2A, was installed between the former CJ-RN-2 and CJ-RN-3 stations to maintain a station on the northern side of the site boundary (Figure 3).

Table 2 and Figure 5 show quarterly and average radon results for the past four quarters at the Crescent Junction site boundary. Background value of 0.6 pCi/L has been subtracted from the average of the past four quarters.

Table 2. Quarterly and Average Radon Concentrations for the Crescent Junction Site for the Past Four Quarters

Station Number	First Quarter 2022 (pCi/L)	Second Quarter 2022 (pCi/L)	Third Quarter 2022 (pCi/L)	Fourth Quarter 2022 (pCi/L)	Past 4 Quarters Average (pCi/L) (Background subtracted)
0301 (west side, previous station location)	ND	ND	ND	0.89	0.29 ²
CJ-RN-1 (west side)	0.57	0.19	0.43	removed	≤Background ¹
CJ-RN-2 (NW side)	0.81	0.30	0.54	removed	≤Background ¹
CJ-RN-2A (north side; new location in 4Q22)	ND	ND	ND	0.81	0.21 ²
CJ-RN-3 (NE side)	0.86	0.32	0.43	removed	0.54 ¹
CJ-RN-4 (east side)	0.84	0.26	0.42	1.05	≤Background
CJ-RN-5 (SE side)	1.35	0.58	0.74	1.50	≤Background
CJ-RN-6 (south side)	1.95	0.65	0.98	1.80	0.77
CJ-RN-7 (SW side)	1.40	0.65	0.97	2.00	0.66

ND = No Data (station not installed yet)

1 = Average is based on three quarters, not four

2 = Average is based on one quarter, not four

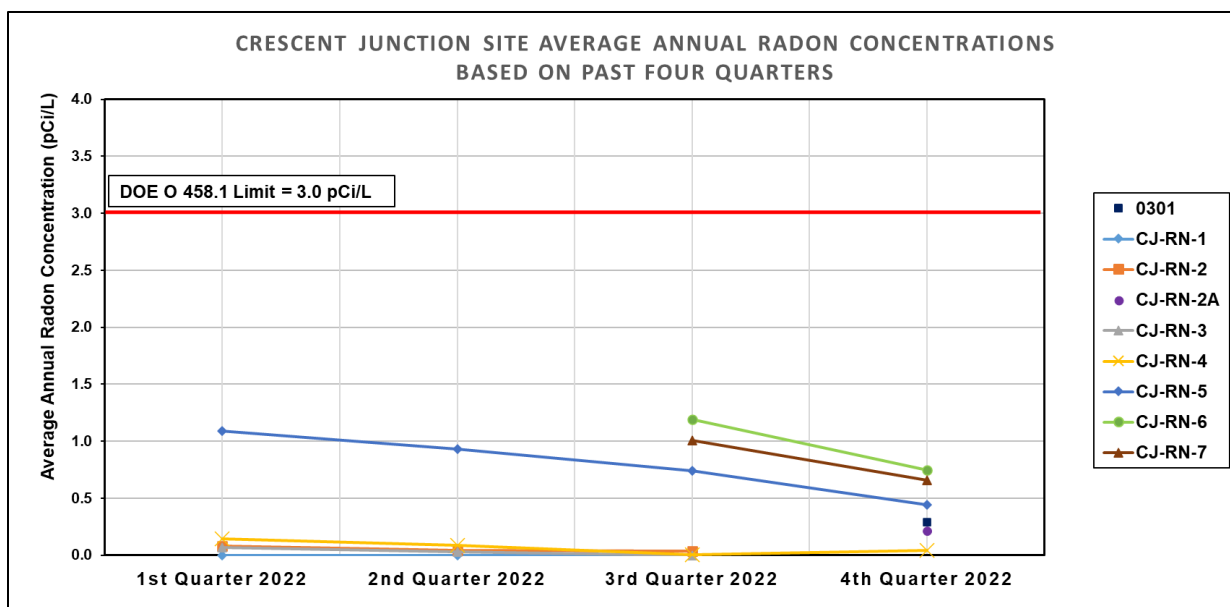


Figure 5. Crescent Junction Average Radon Concentrations for Past Four Quarters

The Project’s annual average radon emission at the Crescent Junction site boundary is below the limit of 3.0 pCi/L (DOE O 458.1 4F) and the Project is in compliance.

3.2 Direct Gamma

Gamma radiation is produced by the disintegration of radioactive atomic nuclei. Considered external dose, direct gamma is used to calculate the TED along with radioparticulates.

Direct Gamma is monitored for the Project’s Maximally Exposed Individuals (MEIs) of the general public at Moab and Crescent Junction. The MEI for the Moab Project Site is located at Arches National Park, and the MEI for Crescent Junction is a resident located within one mile of the site.

As a best management practice, the Project also monitors direct gamma for a representative person at the Moab Site. The representative person for the Moab Project Site is a hypothetical person that rides a bike past the Site along State Route 279. It is not possible or practical to monitor if a person has the assumed living habits in the scenario presented in this representative person evaluation. However, considering the high recreational activity of the area, it is not unreasonable to assume that somebody in the local community would take part in an activity that would cause them to receive a dose from the Site while in this area.

Background direct gamma is 84 mrem for Moab and 92.5 mrem for Crescent Junction, based on three years of data collected from 2006 to 2009.

Direct gamma is calculated for each station by using the following equation:

$$R1 - T - BKG = \text{Quarterly Total Dose (mrem)}$$

R1: Report dose from vendor

T: Transit dose (dose received during shipping of samples)

BKG: Background

Total dose is calculated for each direct gamma station quarterly and a total for the past four quarters.

Moab Site Results

Doses from the direct gamma results can be found in Table 3 below.

Table 3. Direct Gamma Doses for the Maximally Exposed Individual (MEI) and Representative Person at the Moab Site for the Past Four Quarters

Station Number & Description	Direct Gamma Dose Calculation	First Quarter 2022	2nd Quarter 2022	3rd Quarter 2022	4th Quarter 2022	Total Dose Based on Four Quarters (mrem)
		(mrem)	(mrem)	(mrem)	(mrem)	
MO-TLD-MEI (formerly 118) Arches	Report Dose from Vendor	16.0	44.0	28.0	27	
	Transit dose subtracted	-15.0	-42.0	-24.0	-25	
	Background subtracted	-20.5	-20.5	-20.5	-20.5	
	Total Dose	≤Backgrnd	≤Backgrnd	≤Backgrnd	≤Backgrnd	
MO-TLD-MEI-2 (formerly 112; REP 1) Potash Rd	Report Dose from Vendor	27.0	65.5	104.0	108	
	Transit dose subtracted	-15.0	-42.0	-24.0	-25	
	Background subtracted	-20.5	-20.5	-20.5	-20.5	
	Total Dose	≤Backgrnd	3.0	59.5	62.5	
MO-TLD-MEI-3 (formerly 110; REP 2) Potash Rd	Report Dose from Vendor	60.0	128.0	82.0	101	
	Transit dose subtracted	-15.0	-42.0	-24.0	-25	
	Background subtracted	-20.5	-20.5	-20.5	-20.5	
	Total Dose	24.5	65.5	37.5	55.5	

Table 3. Direct Gamma Doses for the Maximally Exposed Individual (MEI) and Representative Person at the Moab Site for the Past Four Quarters (continued)

MO-TLD-MEI-4 (formerly 109; REP 3) Potash Rd	Report Dose from Vendor	68.0	145.0	32.0	34	
	Transit dose subtracted	-15.0	-42.0	-24.0	-25	
	Background subtracted	-20.5	-20.5	-20.5	-20.5	
	Total Dose	32.5	82.5	≤Backgrnd	≤Backgrnd	

Although three stations are above the 100 mrem public limit (DOE O 458.1), the residency status of the individual must be considered. This dose represents 100% occupancy of this location for a year. For the representative person, it is a hypothetical person riding past the Site on a bicycle and not occupying this location. See Section 3.4 for the TED of the representative person, which is well below the DOE O 458.1 limit. The MEI dose is indistinguishable from background. Given this information, the Moab site is within compliance of DOE O 458.1.

Crescent Junction Site Results

Results for direct gamma from the Crescent Junction site can be found in Table 4 below. Only the MEI station collects direct gamma at the Crescent Junction site.

Table 4. Direct Gamma Doses for the Maximally Exposed Individual (MEI) at the Crescent Junction Site for the Past Four Quarters

Station Number & Description	Direct Gamma Dose Calculation	First Quarter 2022 (mrem)	Second Quarter 2022 (mrem)	Third Quarter 2022 (mrem)	Fourth Quarter 2022 (mrem)	Total Dose Based on Four Quarters (mrem)
CJ MEI	Report Dose from Vendor	18	28	27	29	
	Transit dose subtracted	-15	-42	-24	-25	
	Background subtracted	-23.1	-23.1	-23.1	-23.1	
	Total Dose	≤Backgrnd	≤Backgrnd	≤Backgrnd	≤Backgrnd	≤Backgrnd

The direct gamma result for the Crescent Junction MEI is indistinguishable from background radiation and is in compliance with DOE O 458.1.

3.3 Radioparticulates

Radioparticulates are small particles of radioactive material, which can become airborne during project activities such as excavation and loading of RRM, or by wind. Breathing these particles can result in an internal radiation dose. Radioparticulates, along with direct gamma, is used to calculate TED.

The radioparticulate monitoring network for the Moab site consists of nine continuous air samplers: six off site (Figure 1) and three on site (Figure 2). The radioparticulate monitoring network for the Crescent Junction site consists of four stations: two off site and two on site (Figure 3).

The radionuclides of concern on the Project are those inherent in the process of extracting uranium during the milling process when the mill was operational. However, because the radionuclides are part of the uranium decay series, which is naturally occurring, they are considered part of the emissions from the Project. Therefore, all radioparticulates measured at the Project's monitoring stations are assumed to be from the Project.

The uranium milling operations at the Moab site created mill tailings from the processing of extracting the uranium from the ore. The tailings, along with radioactively inert crushed rock, water, residual milling chemicals, and process-related wastes are collectively known as residual radioactive material (RRM). The physical properties of the RRM vary from a clay-like material to a sandy material. These physical properties cause the material to have a low potential to adhere to other surfaces under dry conditions; however, when moist or wet, the material will adhere to those surfaces. Dry RRM is prone to wind dispersion, especially during disturbances, such as moving the material around the pile or loading it into containers.

Moab Site Results

Table 5 and Figure 6 provide the dose from inhalation of radioparticulates for the fourth quarter and the past four quarters at the Moab site. Filters were analyzed at an approved laboratory for concentrations of total uranium, actinium-227, thorium-230, radium-226, and polonium-210. Actinium-227 and protactinium-231 are assumed to be in equilibrium. Therefore, the concentration of protactinium-231 is calculated by multiplying the actinium-227 concentration lab results by a correction factor of 0.32, which is consistent with the *Moab UMTRA Project Health Physics Plan* (DOE-EM/GJ3003).

Polonium-210 was excluded from the calculations for the first quarter 2022 due to the lab flagging the result as a false high reading. Polonium-210 was also excluded from stations 102, 105, 122, 123 and 129 from the first quarter 2022. False high readings occur when concentrations are below the detection limit. Therefore, the first and second quarter 2022 results are lower than previous quarters.

In this quarter, the actinium-227 results were below the minimum detectable concentration (MDC) and were not included in the calculations.

Table 5. Radioparticulate Dose for Moab Site for the Past Four Quarters

Station Number & Description	First Quarter 2022 (mrem)	Second Quarter 2022 (mrem)	Third Quarter 2022 (mrem)	Fourth Quarter 2022 (mrem)	Past 4 Quarters Total (mrem)
Moab Onsite Locations					
0102 (NE corner)	0.14	0.12	0.79	0.64	7
0105 (By freshwater pond)	0.12	0.21	0.66	0.90	1.89
0114 (Wellfield)	0.14	1.10	0.99	0.87	3.10
Moab Offsite Locations					
0117 (Bar M)	0.01	0.27	0.58	0.52	1.38
0118-MEI (Arches NP)	0.07	0.45	0.62	0.78	1.92
0119 (Matheson Wetlands)	0.06	0.22	0.44	0.61	1.33
0122 (Recycling Center)	0.03	0.10	0.63	0.51	1.27
0123 (Kane Creek)	0.06	0.10	0.55	0.63	1.34
0129 (Potash Rd)	0.25	1.11	1.10	0.85	3.31

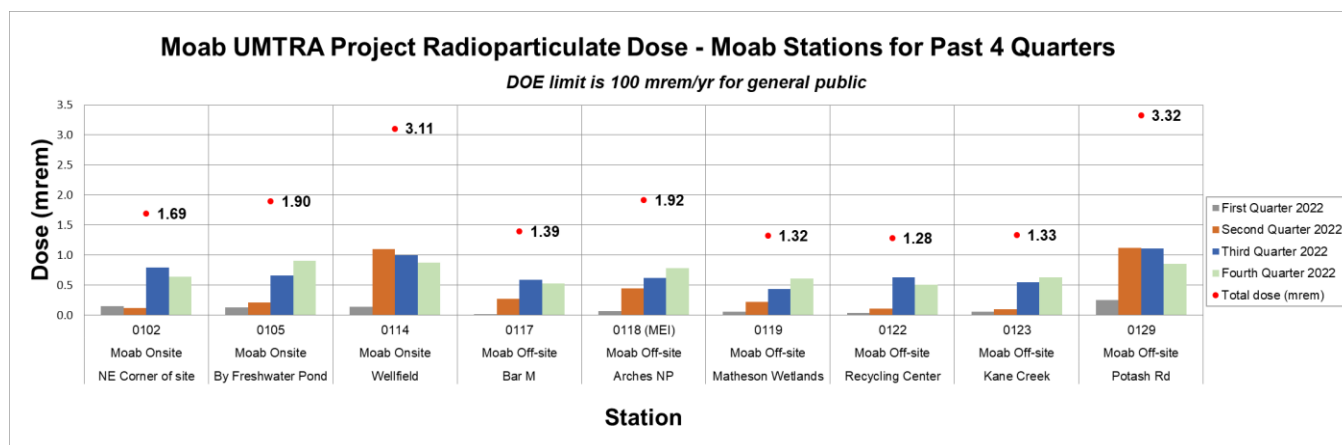


Figure 6. Quarterly and Total Radioparticulate Doses for Moab Stations for the Past Four Quarters

All radioparticulate dose results from the Moab site are below the DOE O 458.1 limit of 100 mrem/year for the general public.

Crescent Junction Results

Table 6 and Figure 7 provide the quarterly and average of past four quarters dose from inhalation of radioparticulates at the Crescent Junction site. Filters were analyzed at an approved laboratory for concentrations of total uranium, actinium-227, thorium-230, radium-226, and polonium-210. Actinium-227 and protactinium-231 are assumed to be in equilibrium. Therefore, the concentration of protactinium-231 is calculated by multiplying the actinium-227 concentration lab results by a correction factor of 0.32, which is consistent with the *Moab UMTRA Project Health Physics Plan* (DOE-EM/GJ3003).

Polonium-210 was excluded from the calculations for the first quarter 2022 due to the lab flagging the result as a false high reading. Polonium-210 was also excluded from stations 102, 105, 122, 123 and 129 from the first quarter 2022. False high readings occur when concentrations are below the detection limit. Therefore, first and second quarter 2022 results are lower than previous quarters.

Table 6. Radioparticulate Effective Doses for the Crescent Junction Site for the Past Four Quarters

Station Number & Description	First Quarter 2022 (mrem)	Second Quarter 2022 (mrem)	Third Quarter 2022 (mrem)	Fourth Quarter 2022 (mrem)	Past 4 Quarters Total (mrem)
CJ Onsite Locations					
0308 (Guard Station)	0.11	0.31	0.76	0.41	1.59
0309 (SE Boundary)	0.25	0.54	0.67	0.78	2.24
CJ Offsite Locations					
0306 (MEI) (South of site, by Hwy 191)	0.06	0.03	0.49	0.50	1.08
0307 (Thompson Springs)	0.03	0.27	1.00	0.41	1.71

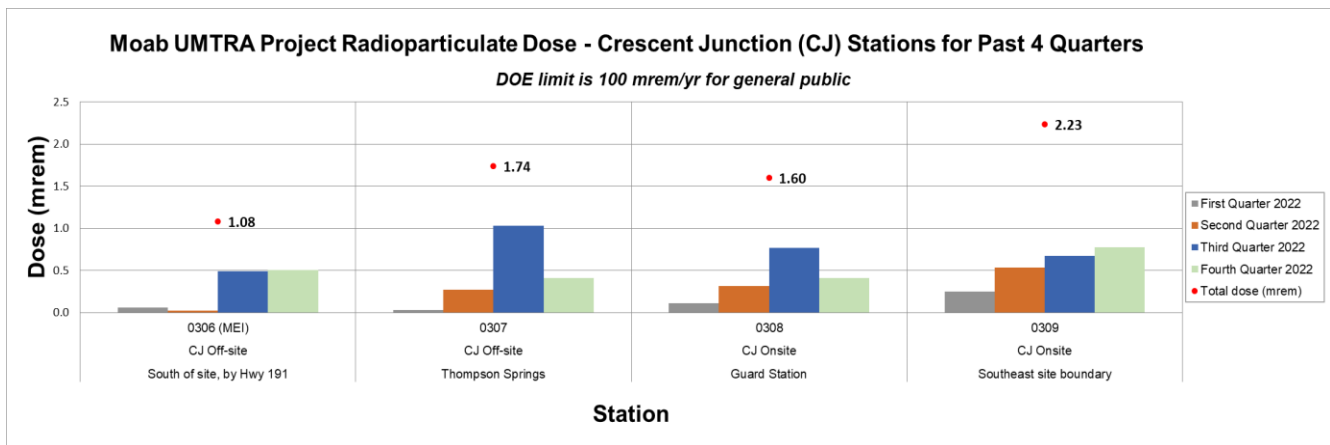


Figure 7. Quarterly and Total Radioparticulate Dose for Crescent Junction Stations for Past Four Quarters

All radioparticulate dose results from the Crescent Junction site are below the DOE O 458.1 limit of 100 mrem/year for the general public.

3.4 Total Effective Dose

Total Effective Dose (TED) for the Project is calculated for the MEI and representative person by using the following equation:

$$\Upsilon + P_1 = \text{TED (mrem)}$$

Υ : Direct Gamma Dose with background subtracted (mrem)

P_1 : Radioparticulate Dose (mrem)

Moab Site Results

For the Moab MEI, the TED for the past four quarters is calculated as the following:

$$0 \text{ mrem/yr} + 1.92 \text{ mrem/yr} = \mathbf{1.92 \text{ mrem/yr}}$$

Representative Person

Because there are no radioparticulate monitoring stations along Route 279, the representative person TED is based solely on direct gamma. For the representative person, the TED for the past four quarters is calculated with the following scenario:

- Recreational bicycling 2 days/week for 18 weeks/year.
- Estimated round trip travel distance along State Route 279 is 2.8 miles.
- It takes 14 minutes round trip to travel 2.8 miles.
- 2 days x 18 weeks x 14 minutes = 504 minutes/year
- Total minutes in one year: 365 days x 24 hrs x 60 minutes = 525,600 minutes/year

Dose Received During Trip

Applicable Monitoring Stations:

MO-TLD MEI 2 (112) = 125 mrem/yr
MO-TLD MEI 3 (110) = 183 mrem/yr
MO-TLD MEI 4 (109) = 115 mrem/yr

Average Dose per year from these three stations = 141 mrem/yr

This is calculated by the following:

$141 \text{ mrem/yr} / 525,600 \text{ min/yr} = 0.0003 \text{ mrem/min}$
 $0.0003 \text{ mrem/min} \times 504 \text{ min occupancy time} = \mathbf{0.14 \text{ mrem/yr for representative person}}$

Both TEDs are below the 100 mrem/year limit and the Moab site is in compliance with DOE O 458.1, including the dose to the lens of the eye, skin, and extremities.

Crescent Junction Results

For the Crescent Junction MEI, the TED for the past four quarters is calculated using the TED formula above:

$0 \text{ mrem/yr} + 1.08 \text{ mrem/yr} = \mathbf{1.08 \text{ mrem/yr}}$

The TED for the MEI at Crescent Junction is below the 100 mrem/year limit and is also in compliance with DOE O 458.1, including the dose to the lens of the eye, skin, and extremities.

4.0 Meteorological Monitoring and Analysis

For both sites, meteorological data are collected from onsite meteorological (met) stations where data is uploaded to Vista Data Vision (VDV), an online database for the Site. Moab and Crescent Junction met stations measure wind speed and direction, temperature, and precipitation. Precipitation is collected primarily with a heated rain gauge and a manual rain gauge is used for back-up purposes. Data is downloaded from VDV and hourly averages are analyzed. Refer to the *Moab UMTRA Project Meteorology Station Sampling and Analysis Plan* (DOE-EM/GJTAC3075) and the *Moab UMTRA Project TAC Environmental Air Monitoring Sampling and Analysis Plan* (DOE-EM/GJTAC2219) for more information.

Moab Site

In fourth quarter 2022, the winds were predominantly out of the northwest. Data shows winds out of the southeast were higher speeds but less frequent. Figure 8 displays the wind rose for this quarter, with the wedges showing the frequency, speed, and direction the wind was coming from.

The average temperature for the quarter was 44°F. The lowest recorded temperature for the quarter was 13°F, and the highest was 81°F. The Moab Site received 3.86 inches of precipitation during fourth quarter 2022. It is noted that the meteorological station lost connection to VDV between 10/1/2022 through 11/16/2022 due to battery and communication issues. Data from the manual rain gauge was used during this time period to calculate the total precipitation for this quarter.

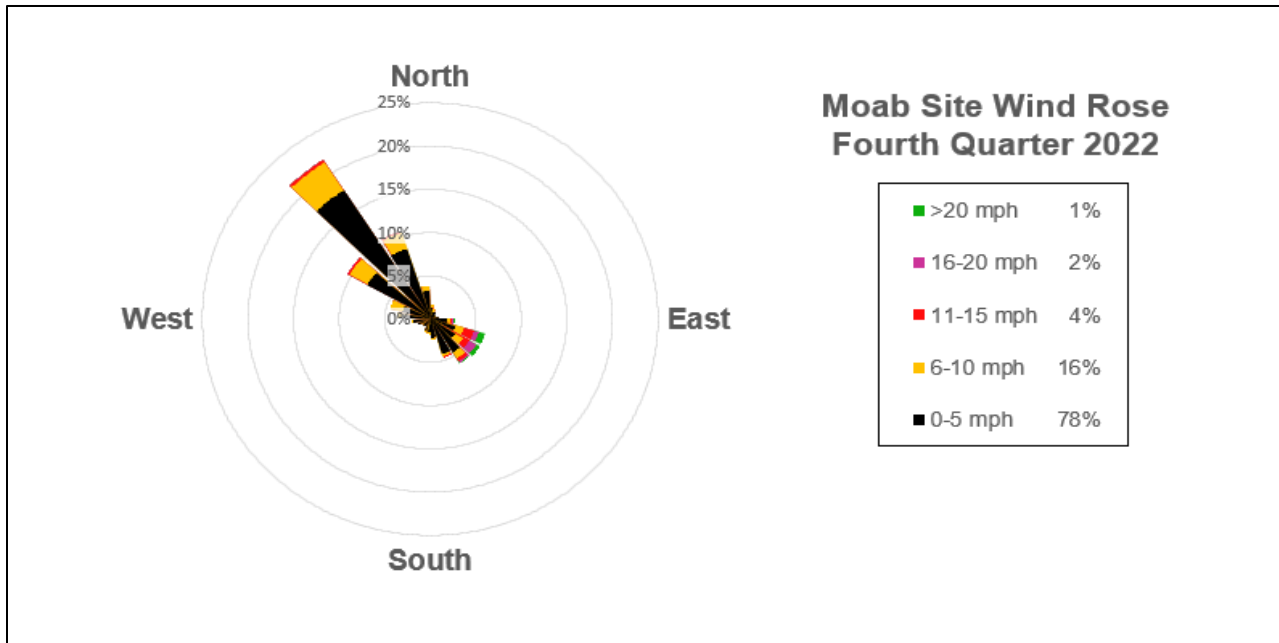


Figure 8. Moab Wind Rose for Fourth Quarter 2022

Crescent Junction Site

The onsite meteorological station at the Crescent Junction site was used to analyze temperature, wind, and precipitation data during this quarter.

In fourth quarter 2022, the prevailing winds were highly variable with the prominent winds being from the northeast, northwest, and southernly directions (Figure 9). The site received 3.87 inches of precipitation. The average temperature for the quarter was 41°F. The lowest recorded temperature for the quarter was 11°F, and the highest was 76°F.

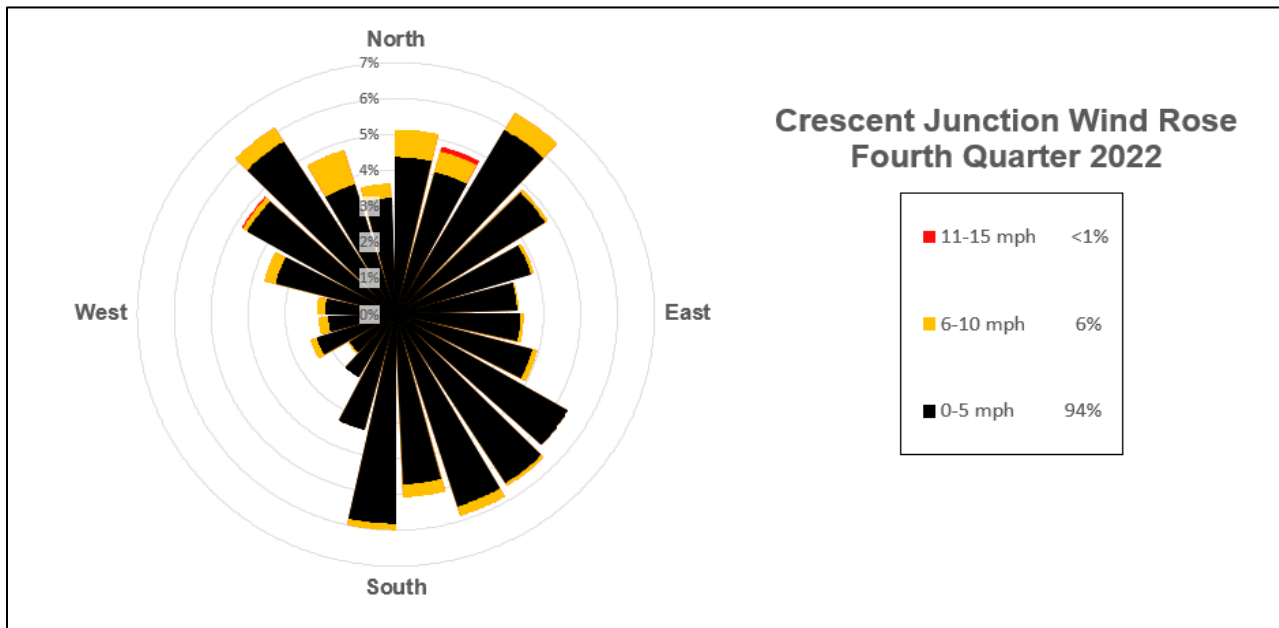


Figure 9. Crescent Junction Wind Rose for Fourth Quarter 2022

5.0 Data Quality

Radon measuring devices, optically stimulated luminescence (OSL) for gamma dose measurements, and radioparticulate sample filters were sent to approved off-site laboratories for analyses in accordance with the *Moab UMTRA Project Environmental Air Monitoring Sampling and Analysis Plan (SAP)* (DOE-EM/GJTAC2219). Qualified Project personnel evaluated the analytical data received for consistency with other data points and Quality Assurance/Quality Control samples.

5.1 Station Duplicates

Duplicate monitoring samples for radon and direct gamma were collected at both sites. Qualified personnel analyzed results and there were no significant variances between results.

5.2 Suspected Anomalies

All analytical data are reviewed for anomalous or outlying data points. Monitoring data are evaluated against historical and minimum/maximum values to determine if the reported data are within reasonable expected ranges. Any anomalous data would be investigated and documented. No anomalous data were noted for this quarter.

6.0 Conclusion

This fourth quarter 2022 report provides documentation of the compliance to DOE O 458.1 and demonstrates the dedication of the Moab UMTRA Project to the environment and public health and safety.

7.0 References

DOE (U.S. Department of Energy), *Moab UMTRA Project Environmental Air Monitoring Sampling and Analysis Plan* (DOE-EM/GJTAC2219).

DOE (U.S. Department of Energy), *Moab UMTRA Project Health Physics Plan* (DOE-EM/GJ3003).

DOE (U.S. Department of Energy), *Moab UMTRA Project Environmental Air Monitoring Data Quarterly Report for the Moab and Crescent Junction, Utah, Sites Fourth Quarter 2021 (October-December 2021)* (DOE-EM/GJTAC3074).

DOE (U.S. Department of Energy), *Moab UMTRA Project Environmental Air Monitoring Data Quarterly Report for the Moab and Crescent Junction, Utah, Sites First Quarter 2022 (January-March 2022)* (DOE-EM/GJTAC3077).

DOE (U.S. Department of Energy) Order 458.1, Admin Chg. 4, "Radiation Protection of the Public and the Environment.