DOE-EM/GJRAC3103

Moab UMTRA Project Environmental Air Monitoring Data Quarterly Report for the Moab and Crescent Junction, Utah, Sites First Quarter (January – March 2023)

Revision 1

August 2023

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number 89303322DEM000073
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Moab UMTRA Project
Environmental Air Monitoring Data Quarterly Report for the Moab and Crescent Junction, Utah, Sites First Quarter 2023 (January - March 2023)

Revision 1

Review and Approval

8/16/2023

X Katrina Lund

Katrina Lund
RAC Environmental Compliance Manager
Signed by: KATRINA LUND (Affiliate)

8/17/2023

X 

Ronald R. Daily
RAC Radiological Control Manager
Signed by: Ronald Daily

8/16/2023

X Tim Mason

Tim Mason
RAC ESH&Q Manager
Signed by: TIMOTHY MASON (Affiliate)

8/16/2023

X Greg D. Church

Greg Church
RAC Program Manager
Signed by: GREGORY CHURCH (Affiliate)

Revision History

Revision	Date	Description
0	July 2023	Initial issue.
1	August 2023	Clarified direct gamma results and corrected direct gamma doses in Table 3. Corrected total effective dose numbers in Section 3.4.

Contents

Figures

Tables

Acronyms and Abbreviations

DOE	Department of Energy
KWRS	Ken's Weather Reporting System
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 first calendar quarter of 2023 (January- March). 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.

This quarter the direct gamma radiation monitoring devices changed from thermoluminescent dosimeters (TLD) to optically stimulated luminescence (OSL) dosimeters. The Project changed dosimeter vendors and the new vendor prefers the OSL dosimeter, which is proven to be more accurate.

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.

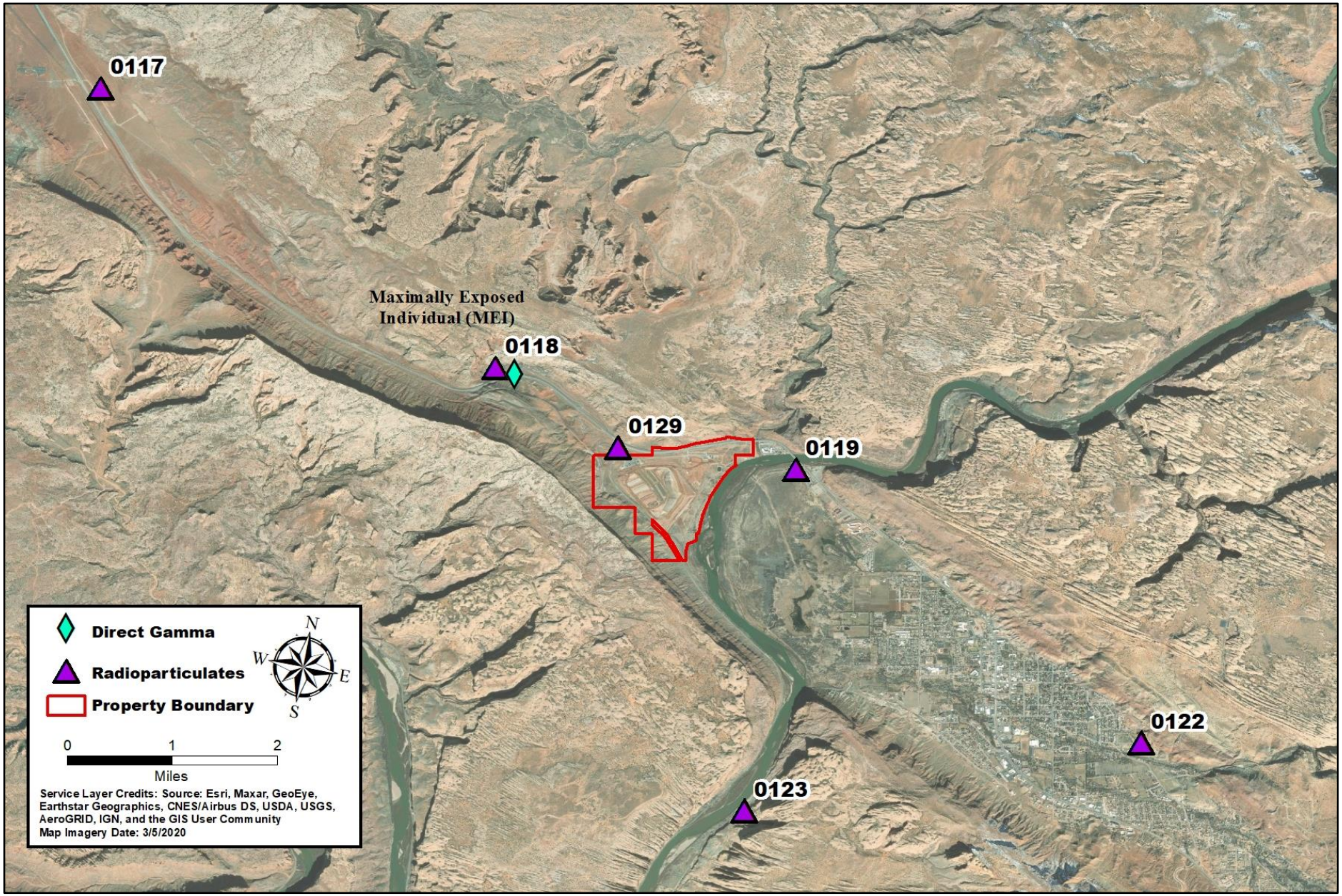

Figure 1. Moab Off-site and Maximally Exposed Individual Environmental Air Monitoring Locations

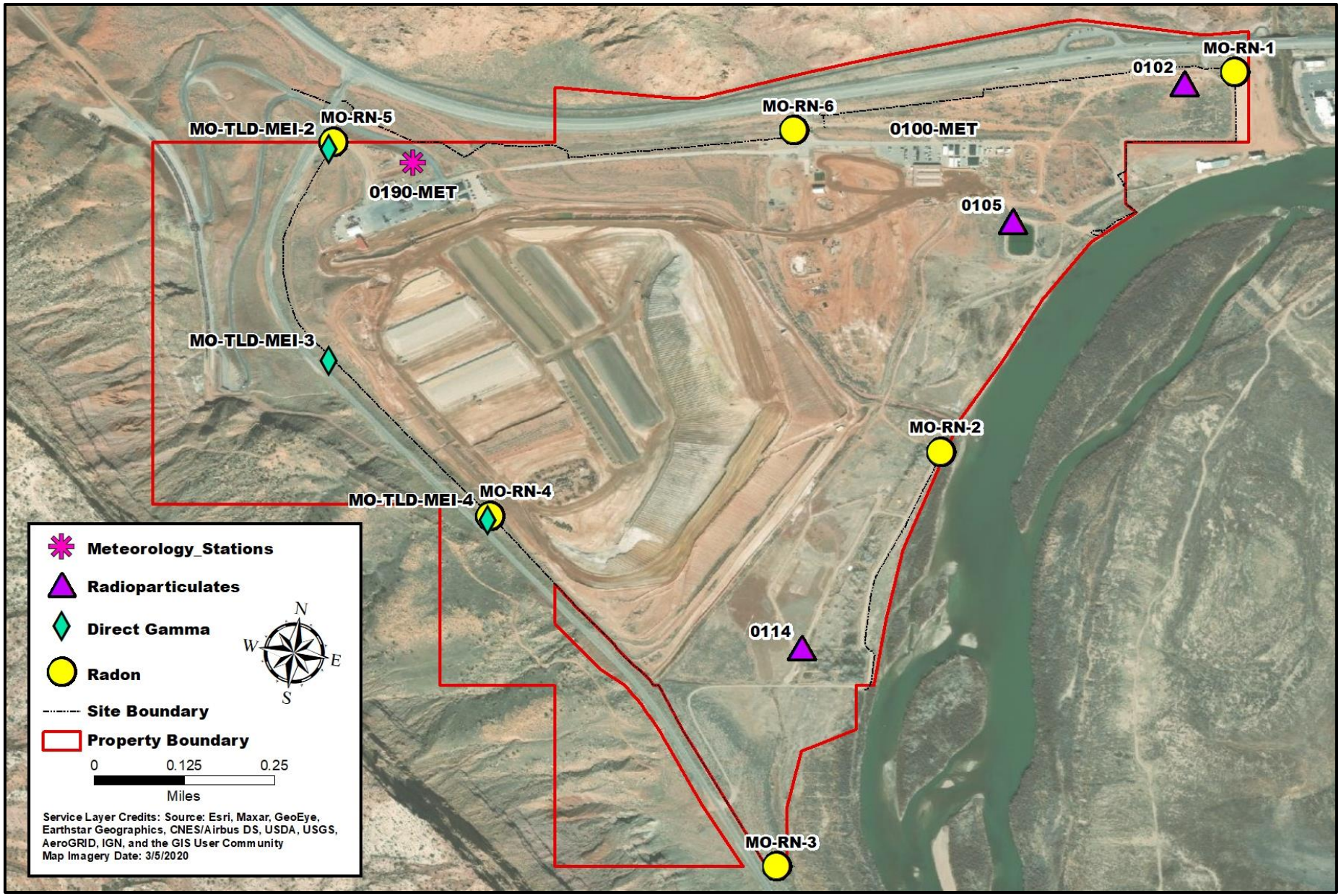

Figure 2. Moab On-site Environmental Air Monitoring Locations

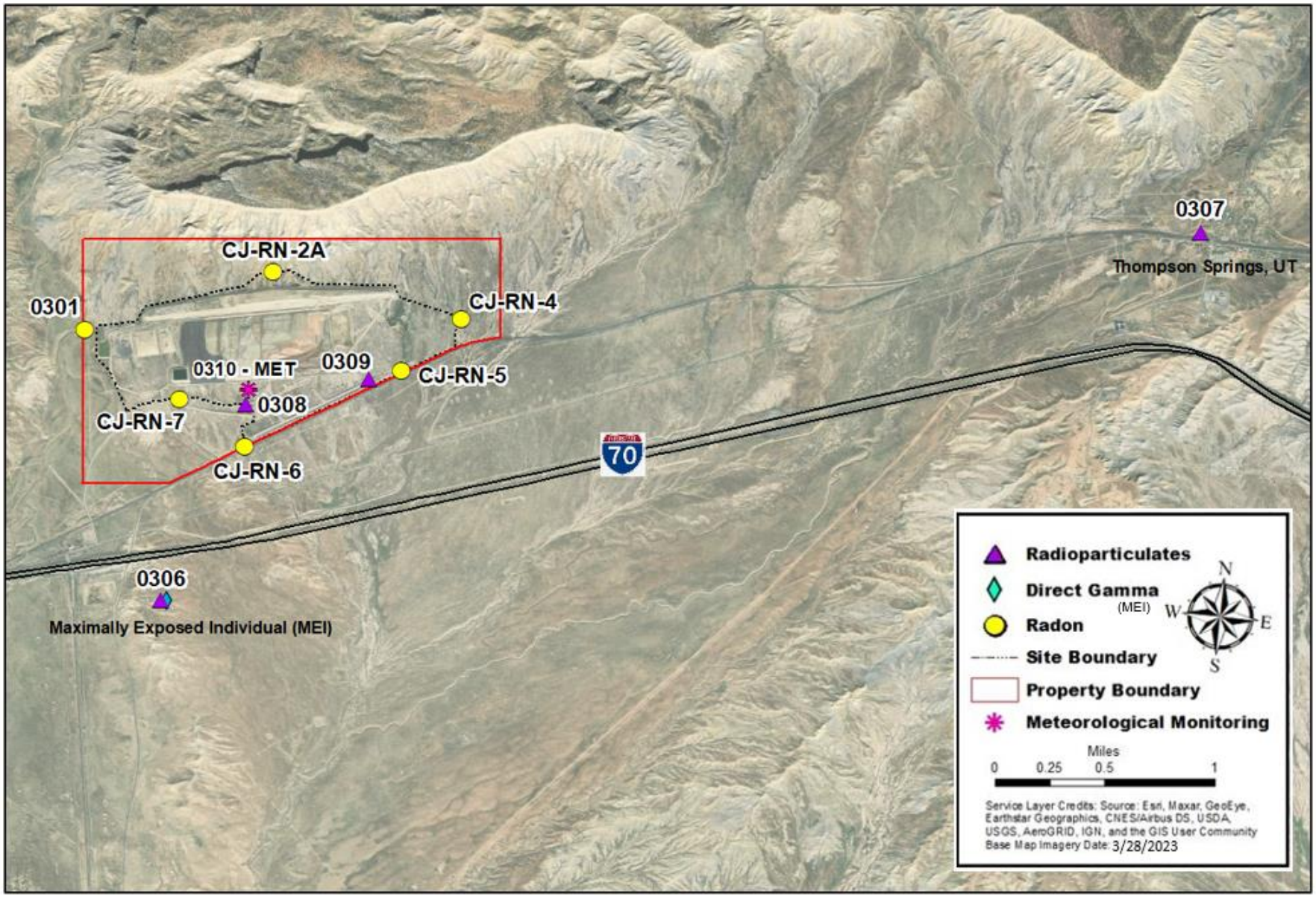

Figure 3. Crescent Junction Site Environmental Air Monitoring Locations

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 (including in the Moab project tailings) 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. As a noble gas radon does not stay in the lungs when breathed in, but it can produce a radiation dose to lung tissue while it is in the lungs when present in air we breathe.

The radon monitoring 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 shows 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	2nd Quarter 2022 (pCi/L)	3rd Quarter 2022 (pCi/L)	4th Quarter 2022 (pCi/L)	1st Quarter 2023 (pCi/L)	Past 4 Quarters Average (pCi/L) (Background Subtracted)
MO-RN-1 (NE corner of site)	0.68	0.72	2.25	0.80	**0.51**
MO-RN-2 (wellfield, south of Moab Wash)	1.55	1.80	4.45	2.30	**1.93**
MO-RN-3 (south end of site)	0.66	0.96	2.25	0.84	**0.58**
MO-RN-4 (along Potash Rd)	1.10	1.90	2.80	0.95	**1.09**
MO-RN-5 (jct of haul road & Potash Rd)	0.76	1.20	2.40	0.81	**0.69**
MO-RN-6 (by main entrance)	1.30	1.60	3.30	1.10	**1.23**

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

Table 2 shows 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	Second Quarter 2022 (pCi/L)	Third Quarter 2022 (pCi/L)	Fourth Quarter 2022 (pCi/L)	First Quarter 2023 (pCi/L)	Past 4 Quarters Average (pCi/L) (Background subtracted)
0301 (west side, previous station location)	ND	ND	0.89	0.35	**0.02**[1]
CJ-RN-1 (west side)	0.19	0.43	removed	0.35	**<Background**
CJ-RN-2 (NW side)	0.3	0.54	removed	removed	**<Background**
CJ-RN-2A (north side; new location in 4Q22)	ND	ND	0.81	0.35	**<Background**
CJ-RN-3 (NE side)	0.32	0.43	removed	removed	**<Background**
CJ-RN-4 (east side)	0.26	0.42	1.05	0.44	**<Background**
CJ-RN-5 (SE side)	0.58	0.74	1.5	0.58	**0.25**
CJ-RN-6 (south side)	0.65	0.98	1.8	0.65	**0.42**
CJ-RN-7 (SW side)	0.65	0.97	2.0	0.51	**0.43**

ND = No Data (station not installed yet)
1 = Average is based on two quarters, not four (Background subtracted is still 0.6 pCi/L)

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

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.

The annual background direct gamma dose 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 = Quarterly Total Dose (mrem)
Where:
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.

As of January 1, 2023, the Moab UMTRA Project changed the dosimetry vendor from Mirion Dosimetry Services to Landauer Inc. Due to the change in vendors, there may be some minor variation when compared to the previous dosimetry results. In addition, direct gamma background doses have been combined with transit background dose for this quarter and the combination was subtracted from the reported dose from the vendor. This is slightly different compared to previous quarters where transit and background were independently subtracted.

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	2nd Quarter 2022 (mrem)	3rd Quarter 2022 (mrem)	4th Quarter 2022 (mrem)	1st Quarter 2023 (mrem)	Total Dose Based on Four Quarters (mrem)
MO-TLD-MEI (formerly 118) Arches	Report Dose from Vendor	**44.0**	**28.0**	**27.0**	**49.5**	
	Transit/Bkg. dose subtracted	**42.0**	**24.0**	**25.0**	**51.6**	
	Total Dose	**2.0**	**4.0**	**2.0**	**0.0**	**8.0**

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

Station Number & Description	Direct Gamma Dose Calculation	2nd Quarter 2022	3rd Quarter 2022	4th Quarter 2022	1st Quarter 2023	Total Dose Based on Four Quarters (mrem)
MO-TLD-MEI-2 (formerly 112; REP 1) Potash Rd	Report Dose from Vendor	**65.5**	**104.0**	**108.0**	**161.7**	**Total Dose Based on Four Quarters (mrem)**
	Transit/Bkg. dose subtracted	**42.0**	**24.0**	**25.0**	**51.6**	
	Total Dose	**23.5**	**80.0**	**83.0**	**110.1**	**296.6**
MO-TLD-MEI-3 (formerly 110; REP 2) Potash Rd	Report Dose from Vendor	**128.0**	**82.0**	**101.0**	**149.9**	**Total Dose Based on Four Quarters (mrem)**
	Transit/Bkg. dose subtracted	**42.0**	**24.0**	**25.0**	**51.6**	
	Total Dose	**86.0**	**58.0**	**76.0**	**98.3**	**318.3**
MO-TLD-MEI-4 (formerly 109; REP 3) Potash Rd	Report Dose from Vendor	**145.0**	**32.0**	**34.0**	**56.6**	**Total Dose Based on Four Quarters (mrem**
	Transit/Bkg. dose subtracted	**42.0**	**24.0**	**25.0**	**51.6**	
	Total Dose	**103.0**	**8.0**	**9.0**	**5.0**	**125.0**

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 with 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	2nd Quarter 2022 (mrem)	3rd Quarter 2022 (mrem)	4th Quarter 2022 (mrem)	1st Quarter 2023 (mrem)	Total Dose Based on Four Quarters (mrem)
CJ MEI	Report Dose from Vendor	18.0	28.0	27.0	29.0	
	Transit/Bkg. dose subtracted	15.0	42.0	24.0	25.0	
	Total Dose	3.0	0.0	3.0	4.0	10.0

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

Radioparticules 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 provides the dose from inhalation of radioparticulates for the first quarter 2023 and the past three 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.

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	Second Quarter 2022 (mrem)	Third Quarter 2022 (mrem)	Fourth Quarter 2022 (mrem)	First Quarter 2023 (mrem)	Past 4 Quarters Total (mrem)
Moab Onsite Locations					
0102 (NE corner)	0.12	0.79	0.64	0.31	**1.86**
0105 (By freshwater pond)	0.21	0.66	0.90	0.40	**2.17**
0114 (Wellfield)	1.10	0.99	0.87	0.31	**3.27**
Moab Offsite Locations					
0117 (Bar M)	0.27	0.58	0.52	0.62	**1.99**
0118-MEI (Arches NP)	0.45	0.62	0.78	1.40	**3.25**
0119 (Matheson Wetlands)	0.22	0.44	0.61	0.44	**1.71**
0122 (Recycling Center)	0.10	0.63	0.51	0.34	**1.58**
0123 (Kane Creek)	0.10	0.55	0.63	0.25	**1.53**
0129 (Potash Rd)	1.11	1.10	0.85	0.55	**3.61**

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 provides 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.

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

Station Number & Description	Second Quarter 2022 (mrem)	Third Quarter 2022 (mrem)	Fourth Quarter 2022 (mrem)	First Quarter 2023 (mrem)	Past 4 Quarters Total (mrem)
CJ Onsite Locations					
0308 (Guard Station)	0.31	0.76	0.41	0.35	**1.83**
0309 (SE Boundary)	0.54	0.67	0.78	0.40	**2.39**
CJ Offsite Locations					
0306 (MEI) (South of site, by Hwy 191)	0.03	0.49	0.50	0.37	**1.39**
0307 (Thompson Springs)	0.27	1.00	0.41	0.26	**1.94**

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:

$\gamma + P_1$= TED (mrem)

Where:

γ: 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:

8 mrem/yr + 3.25 mrem/yr =**11.25 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 (total dose of past 4 quarters):

MO-TLD MEI 2 = 297 mrem/yr
MO-TLD MEI 3 = 318 mrem/yr
MO-TLD MEI 4 = 125 mrem/yr

Average Dose per year from these three stations = 247 mrem/yr

TED for Representative Person is calculated by the following:

247 mrem/yr / 525,600 min/yr = 0.0005 mrem/min
0.0005 mrem/min x 504 min occupancy time = **0.25 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:

10 mrem/yr + 1.39 mrem/yr **= 11.39 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 Ken's Weather Reporting System (KWRS), a site-specific online database created by the Project's Technical Assistance Contractor (TAC). This changed from Vista Data Vision (VDV) starting mid-March 2023, and affects only the front end of the database.

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 KWRS 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 and will be updated to RAC documents in the near future.

Moab Site

In first quarter 2023, the winds were predominantly out of the northwest. Data shows winds out of the southeast were higher speeds but less frequent. Figure 4 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 38° F. The lowest recorded temperature for the quarter was 15° F, and the highest was 67° F. The Moab Site received 3.72 inches of precipitation during first quarter of 2023. It is noted that the meteorological station lost connection to VDV (before databased switched to KWRS) between approximately 2/14/2023 through 02/20/2023 due to power and outlet issues. Data from the manual rain gauge was used during this time period to calculate the total precipitation for this quarter.

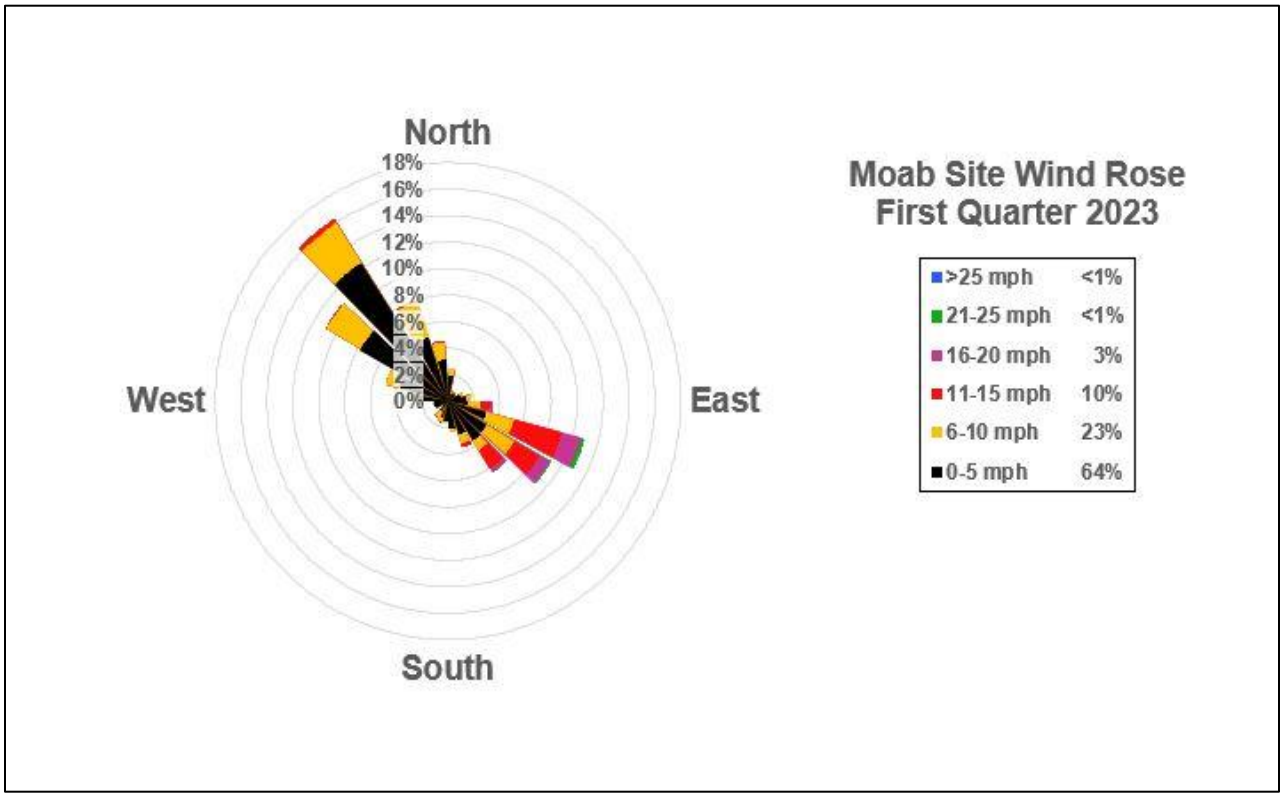

Figure 4. Moab Wind Rose for First Quarter 2023

Crescent Junction Site

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

In first quarter 2023, the prevailing winds were from the southeast direction with the occasional stronger winds coming from the northwest direction (Figure 5). The site received 5.93 inches of precipitation. The average temperature for the quarter was 34° F. The lowest recorded temperature for the quarter was 12° F, and the highest was 62° F.

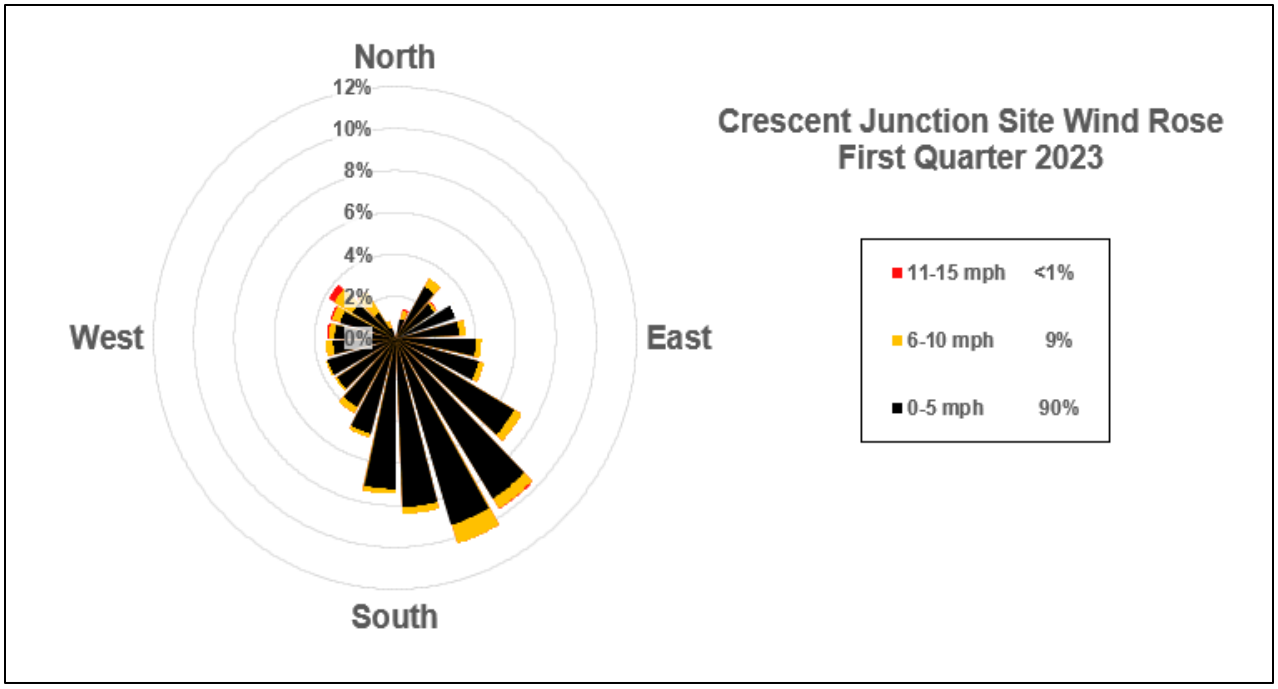

Figure 5. Crescent Junction Wind Rose for First Quarter 2023

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 first quarter 2023 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.