DOE-EM/GJTAC3070

Moab UMTRA Project
Environmental Air Monitoring Data Quarterly Report for the Moab and Crescent Junction, Utah, Sites
Third Quarter 2021 (July - September 2021)

Revision 0

February 2022

U.S. Department of Energy

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Review and Approval

2/22/2022

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Revision History

Revision	Date	Description
0	February 2022	Initial issue.

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Acronyms and Abbreviations

DOE	Department of Energy
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MEI	maximally exposed individual
mrem	millirems
O	Order
pCi	picocurie
pCi/L	picocurie per liter
SAP	Sampling Analysis Plan
TED	total effective dose
TLD	thermoluminescent dosimeter
UMTRA	Uranium Mill Tailings Remedial Action

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 third quarter of 2021. 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 total effective dose 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 total effective dose 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 a MEI for the Moab and Crescent Junction Project sites.

3.0 Results for July through September 2021

Monitoring data are reported quarterly for radon, direct gamma radiation, and Site specific radioparticulates. Off-site monitoring locations for the Moab site are shown on Figure 1, and on-site and MEI locations are shown on Figure 2. Monitoring locations for the Crescent Junction site are shown on Figure 3.

3.1 Moab Site

There is a total of 27 air monitoring stations equipped with radon and gamma detectors associated with the Moab site. Fifteen of these stations are located within the site boundary, while the additional 12 are located at relevant locations off-site. Of these 27 stations, three on-site and six off-site stations are also equipped with air sampling pumps to measure air radioparticulates.

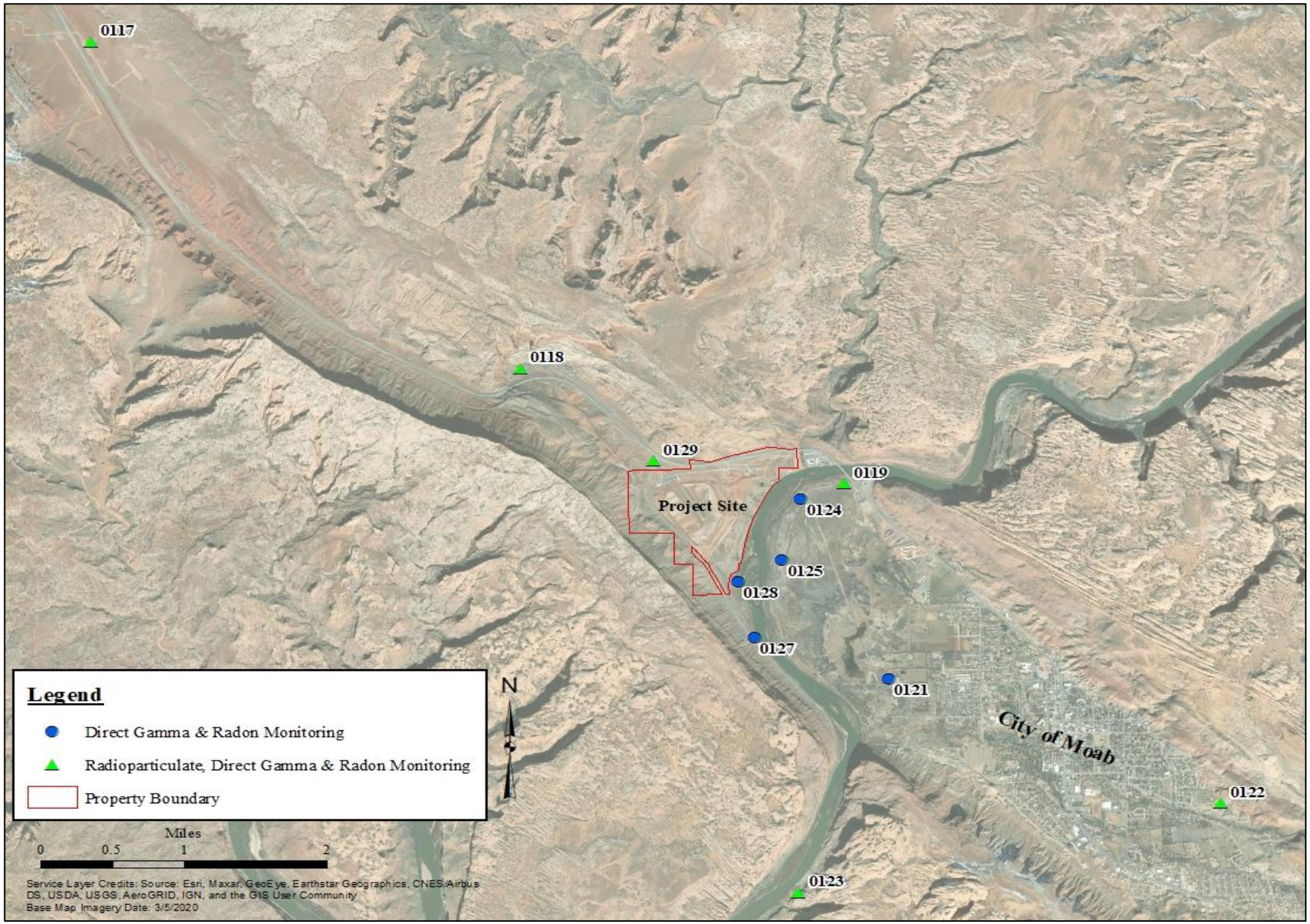

Figure 1. Moab Off-site Environmental Air Monitoring Locations

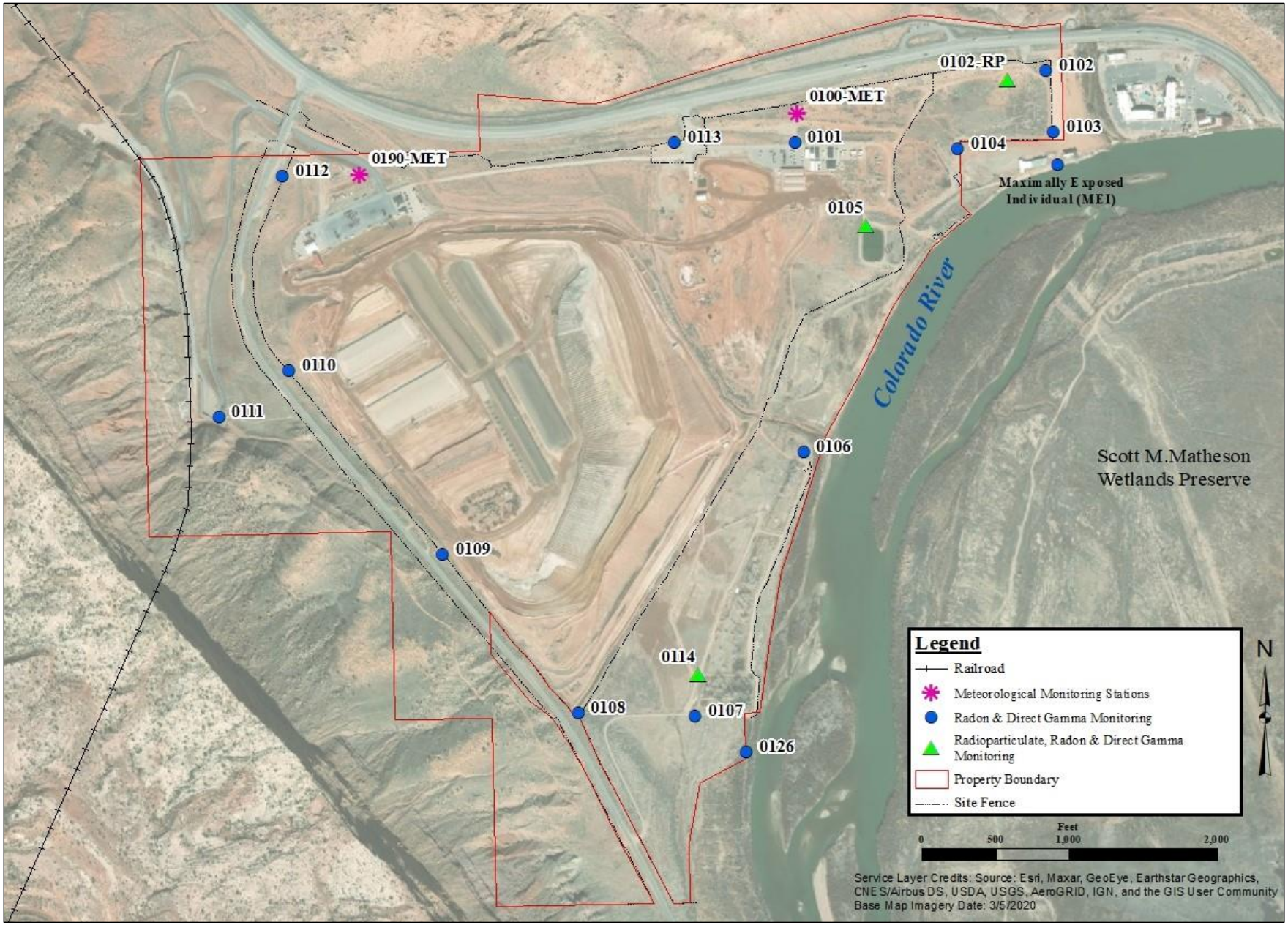

Figure 2. Moab On-site and Maximally Exposed Individual Environmental Air Monitoring Locations

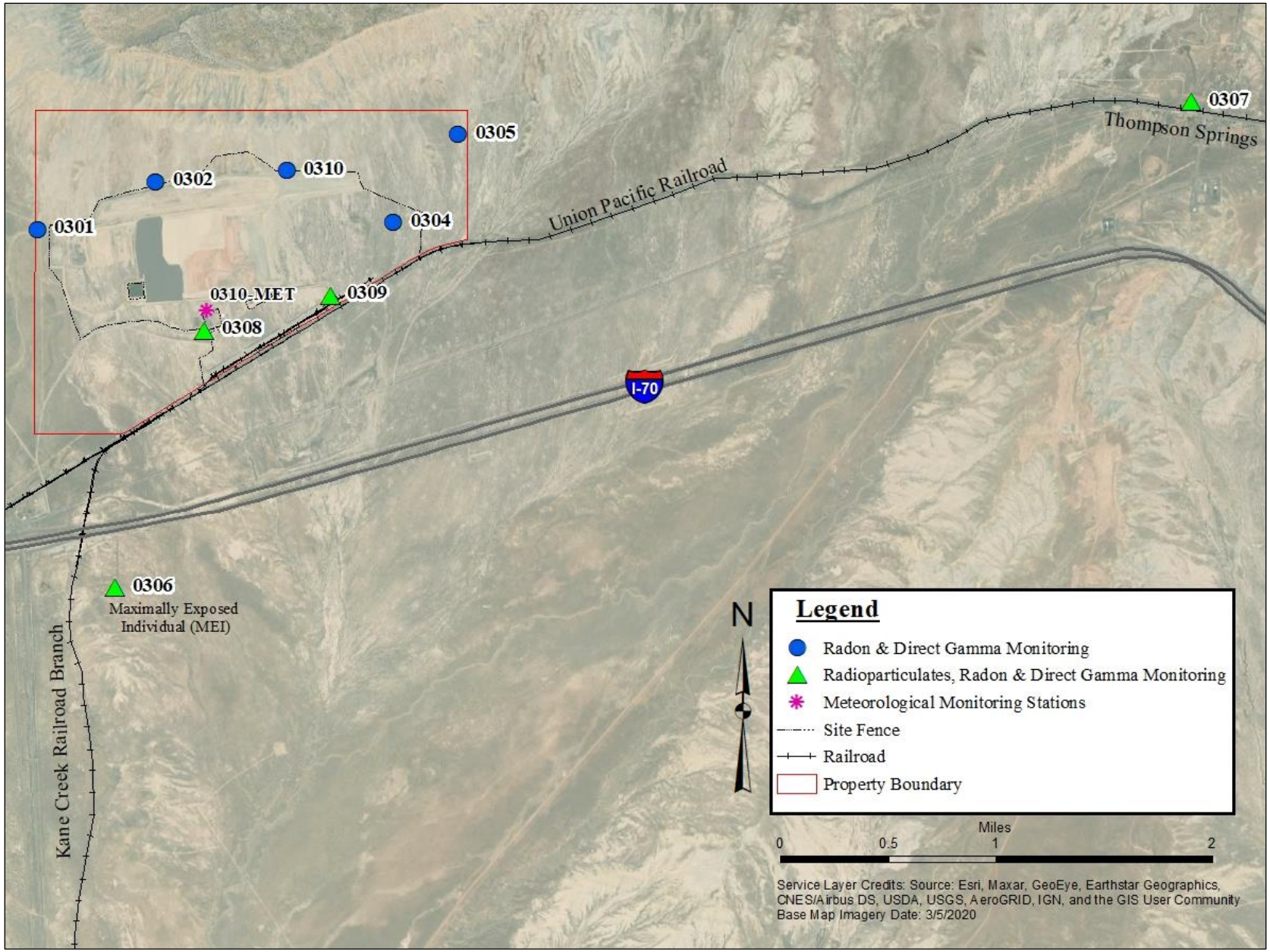

Figure 3. Crescent Junction Site Environmental Air Monitoring Locations

3.1.1 Meteorological Analysis

Meteorological data were collected from the on-site meteorological station (0190-Met) and downloaded from the Vista Data Vision online database, where meteorological data are uploaded from the Site. Hourly averages were analyzed. Figure 4 displays the wind rose for this quarter, with the wedges on the wind rose showing which direction the wind is coming from. In third quarter 2021, the winds were primarily out of the northwest with the strongest winds from the southeast. The average temperature for the quarter was 81°F. The lowest recorded temperature for the quarter was 45°F, and the highest was 110°F.

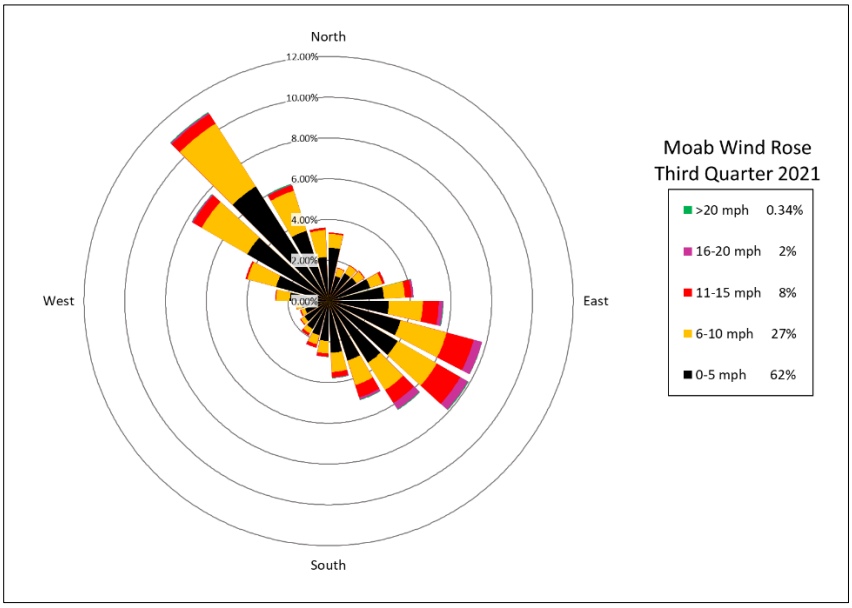

Figure 4. Moab Wind Rose for Third Quarter 2021

The Site received 2.73 inches of precipitation during Third quarter 2021. Figure 5 presents the Moab ten-year average (based on data collected from 2010 through 2020) along with 2020 and 2021 cumulative precipitation. As this graph displays, third quarter 2021 precipitation is less than the Site's ten-year average.

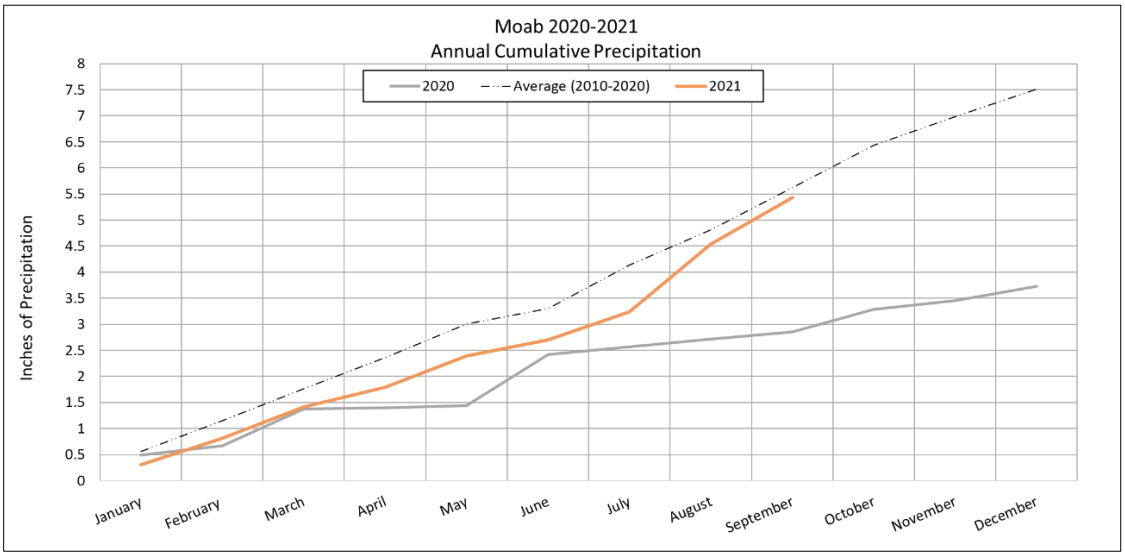

Figure 5. Moab Average, 2020, and Third Quarter 2021 Cumulative Precipitation

3.1.2 Radon

Based on five years of data collected between 2003 and 2008 from stations 0117 and 0123, the average background concentration of radon in the Moab area was established as 0.7 pCi/L. Therefore, the Project's annual average radon emission limit at the Moab site boundary is 3.7 pCi/L. On-site monitoring locations close to the site boundary or publicly accessible areas are used to demonstrate compliance at the boundary. Table 1 shows quarterly and annual radon results for the past year (including background) for on- and off-site locations.

Table 1. Radon Concentrations for the Moab Site for the Past Year

Station Number	Fourth Quarter 2020 (pCi/L)	First Quarter 2021 (pCi/L)	Second Quarter 2021 (pCi/L)	Third Quarter 2021 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
On-site Locations					
0101	5.1	2.3	1.4	2.0	**2.7**
0102	2.8	2.0	0.9	1.1	**1.7**
0103	3.0	1.6	0.8	1.0	**1.6**
0104	4.5	2.1	1.2	1.7	**2.4**
0105	5.2	2.4	1.4	1.9	**2.7**
0106	6.6	3.5	1.9	1.9	**3.5**
0107	5.0	3.1	1.5	2.2	**3.0**
0108	5.5	2.9	2.1	3.0	**3.4**
0109	2.2	1.4	1.5	2.1	**1.8**
0110	2.1	1.2	0.9	1.5	**1.4**
0111	1.0	0.7	0.4	0.6	**0.7**
0112	2.8	1.4	1.0	1.8	**1.7**
0113	5.1	2.1	1.7	2.4	**2.8**
0114	5.6	3.5	1.8	2.3	**3.3**
0126	4.2	2.5	1.2	1.5	**2.4**
Off-site Locations					
0117	0.7	0.5	0.2	0.4	**0.4**
0118	0.9	0.7	0.3	0.6	**0.6**
0119	1.5	1.2	0.5	0.6	**0.9**
0121	0.9	0.6	0.3	0.4	**0.5**
0122	0.5	0.5	0.2	0.3	**0.4**
0123	0.7	0.5	0.2	0.3	**0.4**
0124	2.2	1.4	0.6	0.8	**1.3**
0125	2.3	1.6	0.8	1.0	**1.4**
0127	1.7	1.1	0.4	0.7	**1.0**
0128	4.1	2.3	1.3	1.5	**2.3**
0129	2.6	1.2	0.9	1.6	**1.6**
MEI	2.8	1.5	0.7	0.9	**1.5**

Background has not been subtracted from annual values

The Moab locations with the highest annual average radon concentrations as of third quarter 2021 are displayed in Figure 6. Locations 0106, 0107, 0108, 0113, and 0114 continue to have the highest annual average from the last quarter. When compared to the previous quarter, the data indicate third quarter 2021 concentrations at all locations increased as much as 0.9 pCi/L, except station 0106 which indicated no change.

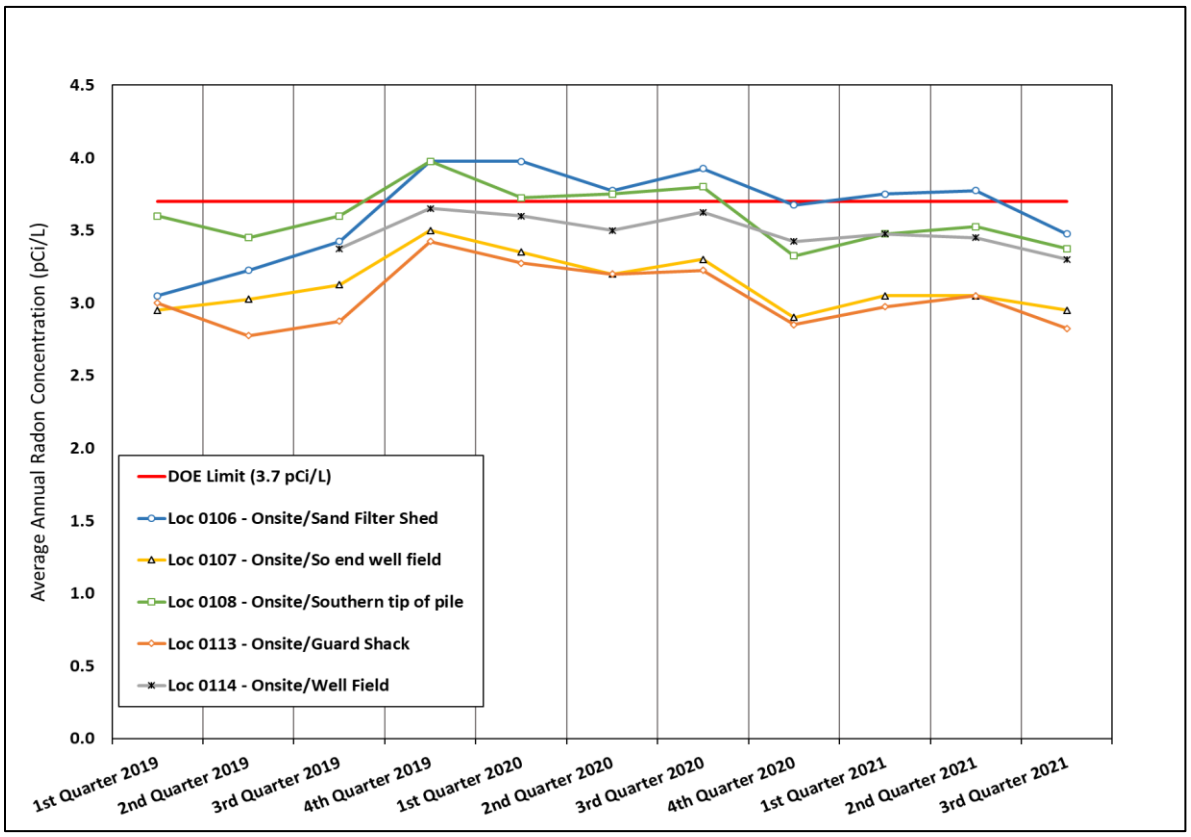

Figure 6. Moab Locations with Highest Third Quarter 2021 Average Annual Radon Concentrations

3.1.3 Direct Gamma Radiation

The average annual background (based on five years of data collected between 2003 and 2008) of direct gamma radiation effective dose for the Moab area was established as 82 mrem/year. Table 2 provides quarterly and annual gamma results for the past year, including background, at on- and off-site locations. The annual gamma dose represents the dose an individual would receive from occupying a location continuously for an entire year.

Compared to the previous quarter, this quarter's results indicate the dose increased at four on-site locations as much as 2 mrem, while nine on-site locations decreased as much as 16 mrem (location 0109). Two on-site location results indicated no change from the previous quarter. All off-site location results decreased as much as 7 mrem.

Table 2. Gamma Radiation Effective Doses for the Moab Site for the Past Year

Station Number	Fourth Quarter 2020 (mrem)	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations					
0101	44	40	43	45	**172**
0102	27	29	25	26	**107**
0103	28	28	27	26	**109**
0104	30	31	31	28	**120**
0105	31	30	29	27	**117**
0106	38	41	37	36	**152**
0107	32	34	33	33	**132**
0108	46	48	50	42	**186**
0109	112	109	122	106	**449**
0110	96	97	98	93	**384**
0111	40	NS	41	36	**NA**
0112	52	51	51	48	**202**
0113	44	37	38	38	**157**
0114	36	37	34	35	**142**
0126	31	34	34	30	**129**
Off-site Locations					
0117	28	30	29	26	**113**
0118	25	28	29	26	**108**
0119	25	32	30	28	**115**
0121	24	26	25	23	**98**
0122	22	25	23	22	**92**
0123	23	26	25	23	**97**
0124	29	28	29	28	**114**
0125	32	33	31	30	**126**
0127	26	29	28	26	**109**
0128	29	31	29	28	**117**
0129	33	34	37	30	**134**
MEI	28	26	28	26	**108**

Background has not been subtracted from annual values

NS = No Sample collected from this location, TLD missing upon collection (unknown cause)

NA = Not Applicable, insufficient data to calculate a representative annual dose

3.1.4 Radioparticulates

The effective background dose from inhalation of radioparticulates was not determined, therefore, all effective dose from radioparticulates measured at the Project's monitoring stations are assumed to be from the Project. Table 3 provides the calculated quarterly and annual effective dose from inhalation of radioparticulates for the past year for the Moab site. Filters were analyzed for concentrations of total uranium, actinium-227, thorium-230, radium-226, and polonium-210. Since actinium-227 and protactinium-231 are assumed to be in equilibrium, the concentration of protactinium-231 is estimated by dividing the analyzed actinium-227 concentration by a correction factor of 0.614, which is consistent with the Moab UMTRA Project Health Physics Plan (DOE-EM/GJ3003). Polonium-210 was omitted from the results. Results from the lab were biased high due to having low chemical yields that result from high recovery values. Section 4.1 describes full detail of the polonium-210 results.

Table 3. Radioparticulate Effective Doses for the Moab Site for the Past Year

Station Number	Isotope	Fourth Quarter 2020 (mrem)	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
On-site Locations						
0102-RP (MEI)	Total Uranium	0.003	0.002	0.003	0.003	**4.92**
	Thorium-230	0.043	0.021	0.025	0.056	
	Radium-226	0.088	0.013	0.035	0.023	
	Polonium-210	0.773	0.716	0.407	0.000	
	Actinium-227	0.536	0.072	0.513	0.699	
	Protactinium-231	0.123	0.017	0.118	0.161	
0105-RP	Total Uranium	0.005	0.003	0.004	0.005	**5.82**
	Thorium-230	0.160	0.080	0.083	0.104	
	Radium-226	0.101	0.101	0.101	0.123	
	Polonium-210	0.895	0.790	0.554	0.000	
	Actinium-227	0.629	ND	0.373	0.606	
	Protactinium-231	0.145	ND	0.086	0.139	
0114-RP	Total Uranium	0.004	0.003	0.005	0.006	**7.98**
	Thorium-230	0.115	0.131	0.165	0.200	
	Radium-226	0.141	0.185	0.211	0.154	
	Polonium-210	0.895	0.895	0.505	0.000	
	Actinium-227	0.839	0.816	0.653	0.839	
	Protactinium-231	0.193	0.188	0.150	0.193	
Off-site Locations						
0117-RP	Total Uranium	0.003	0.002	0.003	0.003	**4.60**
	Thorium-230	0.021	0.014	0.011	0.015	
	Radium-226	0.044	0.020	0.029	0.023	
	Polonium-210	0.602	0.700	0.301	0.000	
	Actinium-227	0.839	0.149	0.051	0.193	
	Protactinium-231	0.193	0.034	0.012	0.045	
0118-RP	Total Uranium	0.003	0.002	0.003	0.003	**3.27**
	Thorium-230	0.048	0.012	0.064	0.061	
	Radium-226	0.075	0.003	0.092	0.114	
	Polonium-210	0.562	0.513	0.350	0.350	
	Actinium-227	0.233	ND	0.217	0.217	
	Protactinium-231	0.054	ND	0.050	0.050	
0119-RP	Total Uranium	0.004	0.002	0.003	0.003	**4.13**
	Thorium-230	0.035	0.025	0.016	0.021	
	Radium-226	0.023	0.053	0.025	0.048	
	Polonium-210	0.692	0.724	0.334	0.000	
	Actinium-227	0.443	0.373	0.028	0.163	
	Protactinium-231	0.102	0.086	0.006	0.038	
0122-RP	Total Uranium	0.003	0.002	0.003	0.003	**3.84**
	Thorium-230	0.024	0.019	0.019	0.017	
	Radium-226	0.048	0.012	0.040	0.040	
	Polonium-210	0.651	0.659	0.317	0.000	
	Actinium-227	0.326	0.233	0.231	0.443	
	Protactinium-231	0.075	0.054	0.053	0.102	

Table 3. Radioparticulate Effective Doses for the Moab Site for the Past Year (continued)

Station Number	Isotope	Fourth Quarter 2020 (mrem)	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
Off-site Locations (*continued*)						
0123-RP	Total Uranium	0.003	0.002	0.003	0.003	**3.14**
	Thorium-230	0.021	0.020	0.023	0.017	
	Radium-226	0.016	0.027	0.032	0.053	
	Polonium-210	0.602	0.651	0.317	0.000	
	Actinium-227	0.280	0.168	0.103	0.156	
	Protactinium-231	0.064	0.039	0.024	0.036	
0129-RP	Total Uranium	0.005	0.003	0.005	0.006	**6.31**
	Thorium-230	0.184	0.104	0.264	0.266	
	Radium-226	0.158	0.132	0.128	0.251	
	Polonium-210	0.635	0.684	0.366	0.000	
	Actinium-227	0.536	0.396	1.235	0.886	
	Protactinium-231	0.123	0.091	0.284	0.204	

ND = not detected; analyte concentration below detection limit

These analytical results are used to calculate the effective dose from the inhalation of radioparticulates. The annual dose associated with the stations closest to the site operations (0102, 0105, 0114, and 0129) is higher compared to the remaining stations. Even though polonium-210 was not included in the final results, all stations, except one off-site location (0129), saw an increase in annual dose (up to 1.189 mrem) compared to the previous quarter's annual dose. Station 0129 decreased as much as 1.024 mrem.

3.1.5 Total Effective Dose

The Project must ensure the annual total effective dose from gamma radiation and radioparticulates from Project activities does not exceed 100 mrem above background. The MEI annual total effective dose for this quarter was 30.92 mrem, which is well below the DOE limit. This value was calculated by subtracting the background dose of 82 mrem from the MEI annual gamma radiation dose of 108 mrem and then adding the radioparticulate total dose of 4.92 mrem from location 0102, the closest radioparticulate station to the MEI. Nearly all of the dose to the MEI is due to direct gamma radiation. The dose to the lens of the eye, skin, and extremities is the same as a full body dose and is below the regulatory limit of 1500 mrem in a year to the lens of the eye and 5000 mrem in a year to the skin or extremities. Figure 7 shows total effective dose measured at the Moab site since 2019.

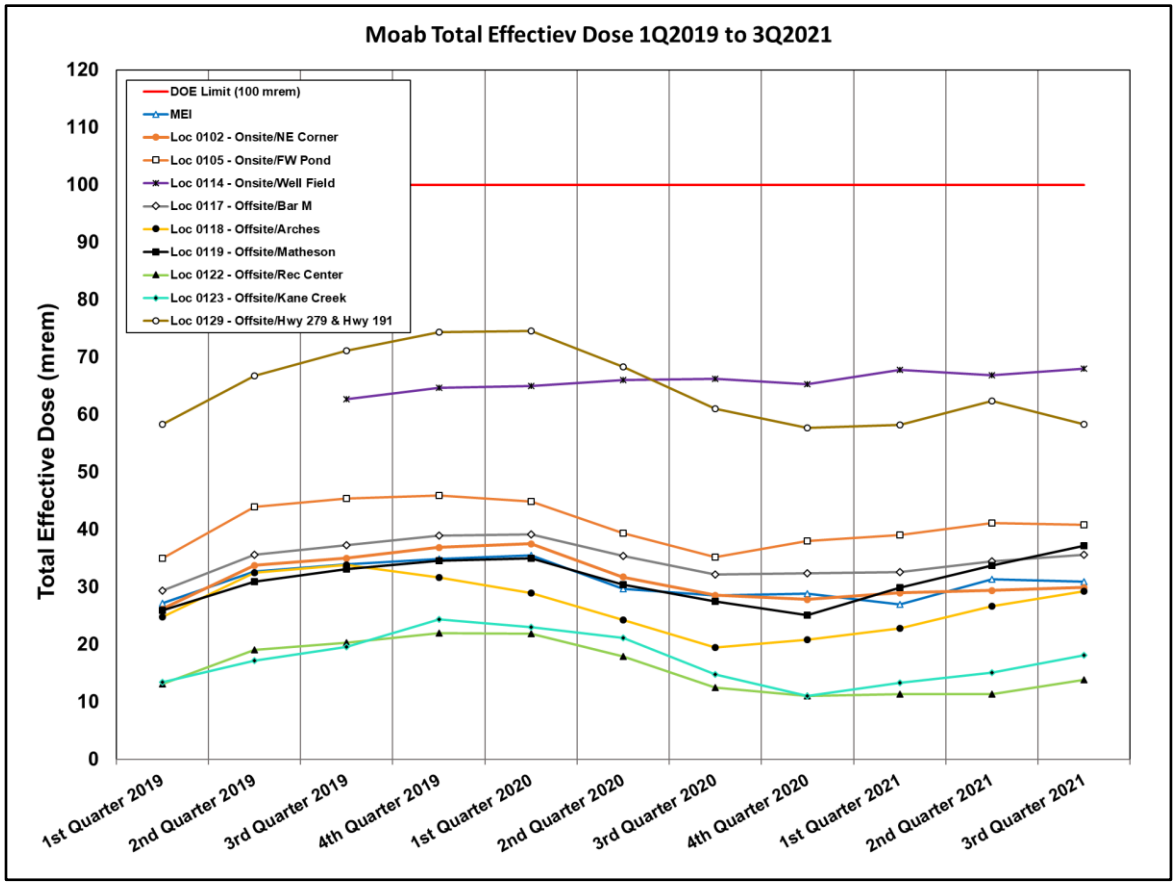

Figure 7. Total Effective Dose Measured at Moab Locations Since 2019

3.2 Crescent Junction Site

There are nine air monitoring stations associated with the Crescent Junction Site, two located off- site and seven on-site. All nine are equipped with radon and gamma detectors. Two on-site and two off-site stations are also equipped with air sampling pumps to measure air radioparticulates. After mill tailings disposal began in the second quarter of 2009, the Crescent Junction monitoring location 0306 became the MEI.

3.2.1 Meteorological Analysis

Meteorological data were collected from the on-site meteorological station and downloaded from the Vista Data Vision online database, where meteorological data are uploaded from the Site. Hourly averages were analyzed. Figure 8 displays the wind rose for this quarter, with the wedges on the wind rose showing which direction the wind is coming from. In third quarter 2021, the prevailing winds were primarily out of the east. The site received 2.95 inches of precipitation during the third quarter 2021. Figure 9 presents the Crescent Junction average (based on data collected from 2010 through 2020) in addition to the 2020 and 2021 cumulative precipitation. The average temperature for the quarter was 78°F. The lowest recorded temperature for the quarter was 47°F, and the highest was 105°F.

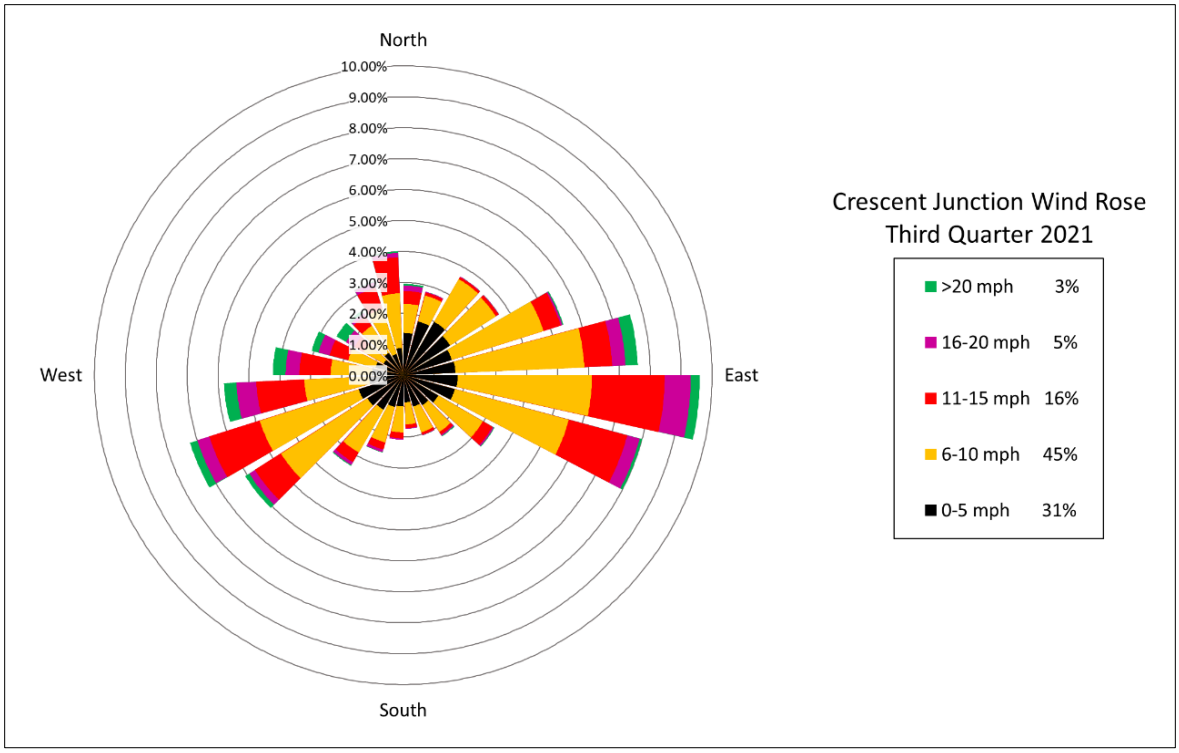

Figure 8. Crescent Junction Wind Rose for Third Quarter 2021

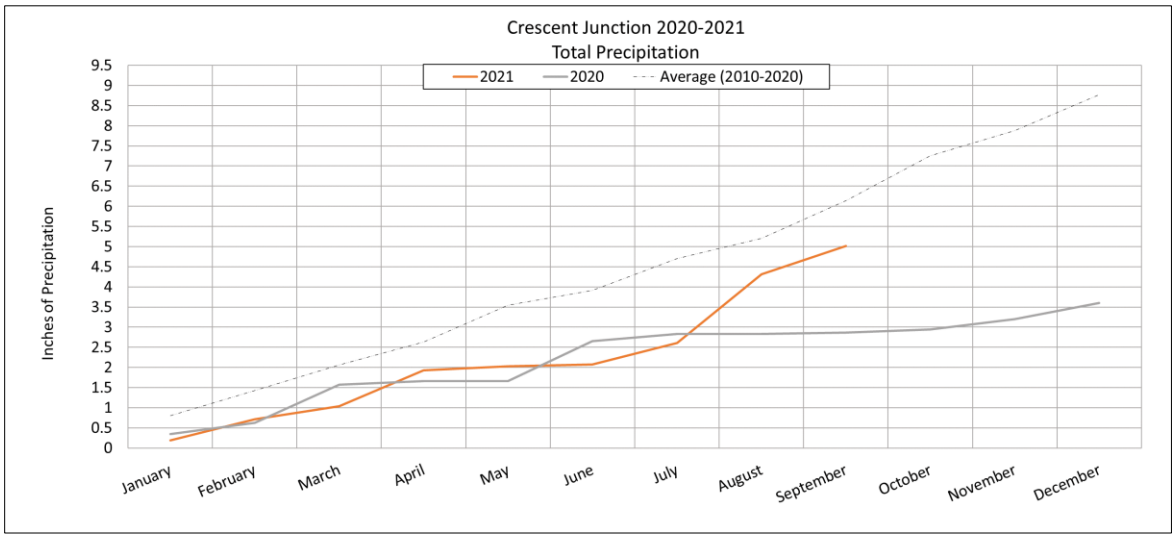

Figure 9. Crescent Junction Average, 2020, and Third Quarter 2021 Cumulative Precipitation

3.2.2 Radon

Based on three years of data from 2006 to 2009, the background concentration of radon in the Crescent Junction area was established as 0.9 pCi/L. Therefore, the Project must limit radon emissions at the Crescent Junction site boundary (withdrawal area) to 3.9 pCi/L. None of the on- or off-site stations exceeded the limit of 3.9 pCi/L in third quarter 2021. Locations 0301 and 0305 are used to demonstrate compliance with the public dose limit in DOE O 458.1 at the site boundary. Table 4 shows quarterly and annual radon results for the past year, including background for on- and off-site locations.

Table 4. Radon Concentrations for the Crescent Junction Site for the Past Year

Station Number	Fourth Quarter 2020 (pCi/L)	First Quarter 2021 (pCi/L)	Second Quarter 2021 (pCi/L)	Third Quarter 2021 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
On-site Locations					
0301	0.7	0.6	0.2	0.5	**0.5**
0302	1.1	0.7	0.5	0.6	**0.7**
0304	1.0	0.8	0.5	0.8	**0.8**
0305	0.8	0.5	0.3	0.5	**0.5**
0308	4.4	2.1	1.3	2.1	**2.5**
0309	2.8	1.8	1.2	1.5	**1.8**
0310	1.0	0.7	0.5	0.7	**0.7**
Off-site Locations					
0306 (MEI)	0.8	0.5	0.3	0.5	**0.5**
0307	0.7	0.5	0.2	0.3	**0.5**

Background has not been subtracted from annual values.

Compared to the previous quarter, the quarterly radon concentrations at all stations increased as much as 0.8 pCi/L. The Crescent Junction locations with the highest annual average radon concentrations during the second quarter are shown on Figure 10, which displays the annual average concentrations results for these locations since the first quarter of 2019.

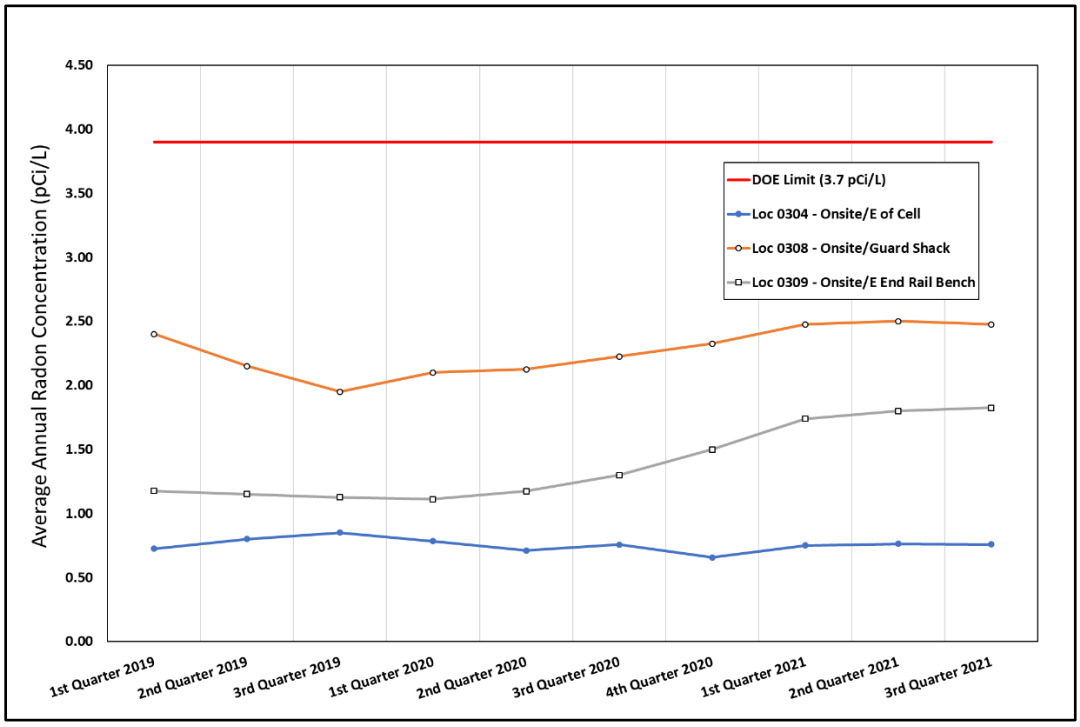

Figure 10. Crescent Junction Locations with Highest Third Quarter 2021 Average Annual Radon Concentrations

3.2.3 Direct Gamma Radiation

The average annual background direct gamma radiation exposure dose for the Crescent Junction area was established as 92.5 mrem based on three years of data collected from 2006 to 2009.

Table 5 shows quarterly and annual results for the past year, including background for on- and off-site locations. The annual gamma dose represents the dose an individual would receive from occupying a location continuously for an entire year.

This quarter's analytical results compared to the previous quarter's indicated that the gamma radiation dose decreased at all onsite locations (as much as 4 mrem), except at station 0302, which resulted in no change. The dose decreased at one off-site location (4 mrem), and the other off-site location resulted in no change.

Table 5. Gamma Radiation Effective Doses for the Crescent Junction Site for the Past Year

Station Number	Fourth Quarter 2020 (mrem)	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
On-site Locations					
0301	27	30	29	27	**113**
0302	28	31	27	27	**113**
0304	29	32	31	27	**119**
0305	28	32	31	28	**119**
0308	30	31	32	28	**121**
0309	27	33	34	33	**127**
0310	29	29	30	28	**116**
Off-site Locations					
0306 (MEI)	25	30	27	27	**109**
0307	30	31	33	29	**123**

Background has not been subtracted from annual values

3.2.4 Radioparticulates

The effective background dose from inhalation of radioparticulates at the Crescent Junction site was not determined. Therefore, all effective dose measured at the Project's monitoring stations is assumed to be from the Project. Samples were collected at the four monitoring locations at or near the Crescent Junction site to determine the air particulate concentrations of total uranium, thorium-230, radium-226, polonium-210, actinium-227, and protactinium-231 (based on the actinium-227 concentration, as described in Section 3.1.4). Polonium-210 was omitted from the results. Results from the lab were biased high due to having low chemical yields that result from high recovery values. Section 4.1 describes full detail of the polonium-210 results. All the Crescent Junction locations saw a decrease in annual dose, as much as 0.780 mrem. Table 6 shows radioparticulate effective doses for the Crescent Junction site for the past year.

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

Station Number	Isotope	Fourth Quarter 2020 (mrem)	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
On-site Locations						
0308-RP	Total Uranium	0.003	0.003	0.003	0.003	**3.85**
	Thorium-230	0.077	0.069	0.077	0.069	
	Radium-226	0.092	0.092	0.123	0.088	
	Polonium-210	0.562	0.684	0.326	0.000	
	Actinium-227	0.373	0.049	0.373	0.490	
	Protactinium-231	0.086	0.011	0.086	0.113	
0309-RP	Total Uranium	0.005	0.003	0.003	0.003	**4.92**
	Thorium-230	0.104	0.141	0.101	0.080	
	Radium-226	0.172	0.216	0.114	0.097	
	Polonium-210	0.586	0.651	0.317	0.000	
	Actinium-227	0.536	0.536	0.490	0.326	
	Protactinium-231	0.123	0.123	0.113	0.075	
Off-site Locations						
306-RP MEI	Total Uranium	0.002	0.002	0.002	0.002	**1.97**
	Thorium-230	0.013	0.015	0.017	0.009	
	Radium-226	0.039	0.030	0.002	NA	
	Polonium-210	0.505	0.627	0.285	0.000	
	Actinium-227	0.131	0.154	0.023	0.033	
	Protactinium-231	0.030	0.035	0.005	0.008	
0307-RP	Total Uranium	0.002	0.002	0.003	0.003	**1.59**
	Thorium-230	0.008	0.013	0.021	0.010	
	Radium-226	0.017	0.009	0.015	0.005	
	Polonium-210	0.488	0.521	0.269	0.000	
	Actinium-227	0.168	ND	ND	0.000	
	Protactinium-231	0.039	ND	ND	0.000	

ND = not detected; analyte concentration below detection limit

3.2.5 Total Effective Dose

The annual total effective dose to the Crescent Junction MEI was 18.47 mrem, which is well below the annual limit of 100 mrem. This is calculated by subtracting the background dose of 92.5 mrem from the MEI (location 0306) gamma radiation dose of 109 mrem, and then adding the radioparticulate dose of 1.97 mrem for the MEI. Figure 11 is a plot of the total effective dose from the four Crescent Junction locations since 2019. In Figure 11, the background was subtracted from the total effective dose calculations, therefore, the DOE limit is shown as 100 mrem. Nearly all of the dose to the MEI is due to direct gamma radiation. The dose to the lens of the eye, skin, and extremities is the same as a full body dose and is below the regulatory limit of 1500 mrem in a year to the lens of the eye and 5000 mrem in a year to the skin or extremities.

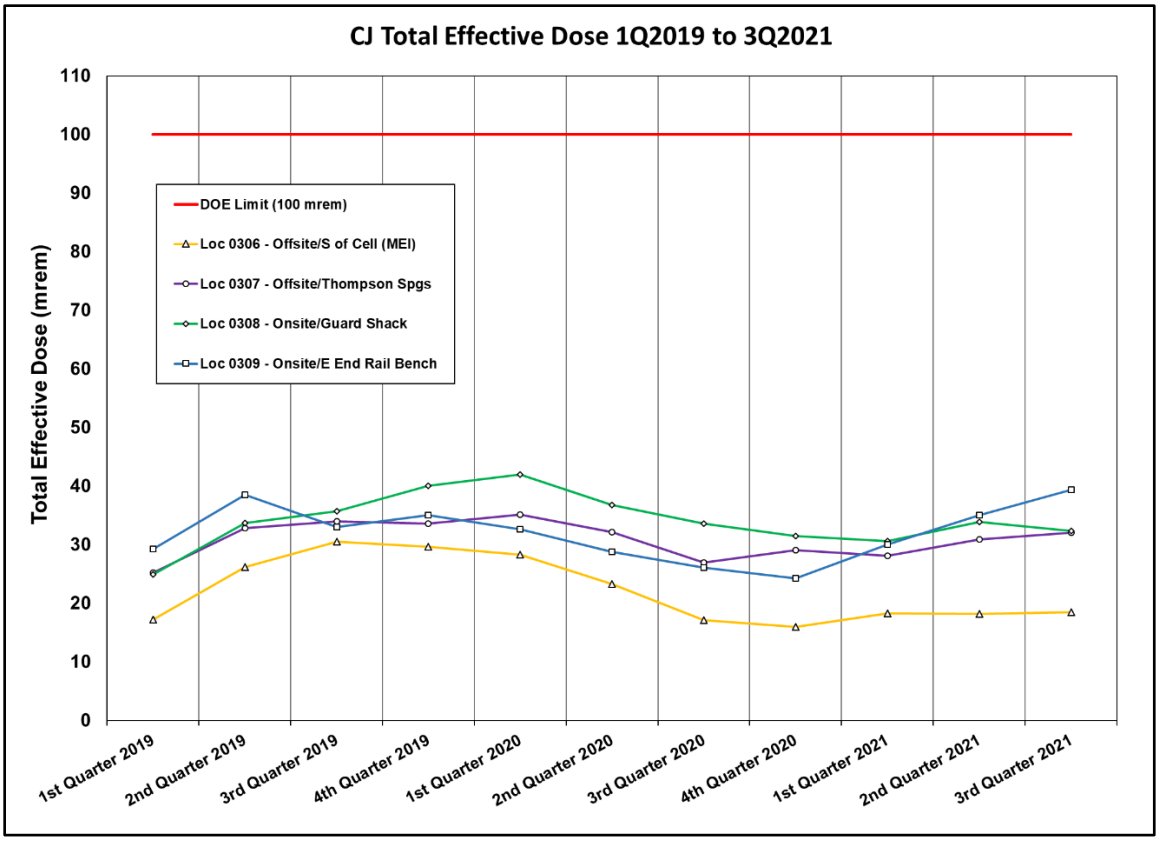

Figure 11. Total Effective Dose Measured at Crescent Junction Locations Since 2019

4.0 Data Assessment

Radon detectors, thermoluminescent dosimeters used for continuous dose measurements, and radioparticulate sample filters were sent to qualified 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.

4.1 Quality Assurance/Quality Control Sampling

Duplicate samples for radon were collected at Moab locations 0102, 0108, and 0111, and at Crescent Junction locations 0303 and 0308. In addition, duplicate direct gamma samples were collected at Moab locations 0102, 0108, and 0129 and Crescent Junction locations 0301 and 0305. All results associated with the duplicate sampling are provided in Table 7. No duplicate samples were collected for radioparticulate samples, per the SAP.

As Table 7 displays, the five locations that included duplicate radon samples were within 0.2 pCi/L of each other. The five locations equipped with duplicate gamma detectors were all within three mrem of each other. These radon and gamma duplicate results are within the acceptable ranges, and the data are considered valid based on these results.

Table 7. Duplicate Results for Third Quarter 2021

Location	Result	Duplicate Result
Moab		
Radon:	pCi/L	pCi/L
0102	1.1	1.0
0108	3.0	2.8
0111	0.6	0.65
Gamma:	mrem	Mrem
0102	26	26
0108	42	45
0129	30	31
Crescent Junction		
Radon:	pCi/L	pCi/L
0308	2.1	2.1
0310	0.7	0.7
Gamma:	mrem	mrem
0301	27	27
0305	28	27

Control samples measured the dose for gamma and radon while being shipped from the site to the respective analytical laboratories. Transit values for direct gamma was at or below background levels. The Radonova lab subtracts the average transit exposure from the reported radon concentrations. The radon transit values are shown in Table 8.

Table 8. Shipment Control Sample Results for Third Quarter 2021

Sample	Result
Radon:	pCi/L
In-transit 1	7 +/- 9
In-transit 2	14 +/- 14
In-transit 3	10 +/- 9

The polonium-210 results for third quarter 2021 were biased high and was therefore removed from the overall radioparticulate results. The lab preformed a non-conformance review of the data and procedures. Below is a description of what lead to the elevated results.

Event Explanation:

"The radiometric recoveries for the laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) for the batch are above 117% control limit at 193% and 204% respectively. The high recoveries are likely due to low chemical yields as determined by the Po-209 tracer. It is believed that the Po-209 tracer used for these samples was compromised and the same was as seen by all the yields for the batch ranging from 19.2% to 42.3%. Yields for Po-210 samples typically range from 70-90%. Two other Po-210 batches were prepared around the same time as this batch and yielded similar results with low chemical recoveries and high radiometric recoveries in the LCS. Due to the high recoveries in the LCS and LCSD, it is believed the Po-210 results for all samples in the batch are biased high by as much as 2X. No sample volume remains for re-preparation."

Action to Prevent Recurrence:
"Removed Po-209 Tracer 1132.4243.77 from the lab. The new Po-209 tracer will be used moving forward."

Table 9. Omitted Polonium Lab Results for Third Quarter 2021

Station Location	Po-210 results (pCi/sample)	Po-210 results (mrem)
0102-RP	300 (+/- 24)	2.442
0105-RP	250 (+/- 20)	2.035
0114-RP	280 (+/- 22)	2.279
0117-RP	200 (+/- 16)	1.628
0118-RP	240 (+/- 19)	1.954
0119-RP	230 (+/- 18)	1.872
0122-RP	210 (+/- 16)	1.709
0123-RP	210 (+/- 16)	1.709
0129-RP	270 (+/- 21)	2.198
0306-RP	210 (+/- 17)	1.709
0307-RP	200 (+/- 16)	1.628
0308-RP	230 (+/- 18)	1.872
0309-RP	250 (+/- 19)	2.035

4.2 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. No anomalous data were noted for this quarter.

4.3 Summary

Data collected during the third quarter of 2021 met the applicable laboratory control criteria for their respective analyses. The results were within the acceptable limits associated with each matrix. Data in this report are considered validated and may be treated as final results.

5.0 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) Order 458.1, Admin Chg. 4, "Radiation Protection of the Public and the Environment.