DOE-EM/GJTAC2219

Moab UMTRA Project
TAC Environmental Air Monitoring Sampling and Analysis Plan

Revision 1

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Moab UMTRA Project
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Revision 1

Review and Approval

9/16/2021

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Revision History

Revision	Date	Reason for Revision
0	June 2018	Initial Issue
1	September 2021	Edits and updates to procedures and maps.

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Tables

Appendices

Abbreviations and Acronyms

Ac	actinium
ALARA	As Low As Reasonably Achievable
ASTM	American Society for Testing Materials International
CJ	Crescent Junction
DCF	dose correction factor
DOE	U.S. Department of Energy
DOE O	DOE order
g	gram
HNBK	DOE Handbook
IWP	Integrated Work Plan
JSA	Job Safety Analysis
L	liter
LPM	liters per minute
MEI	maximally exposed individual
m	meters
µCi	microcuries
µg	micrograms
$\mu g/m^3$	micrograms per cubic meter
mrem	millirems
NIST	National Institute of Standards and Testing
pCi	picocuries
Pa	protactinium
$PM_{2.5}$	particulate matter 2.5 microns or smaller
Po	polonium
QA	quality assurance
QC	quality control
Ra	radium
Rn	radon
SAP	Sampling and Analysis Plan
TAC	Technical Assistance Contractor
TED	Total Effective Dose
TLD	thermoluminescent dosimeter
Th	thorium
UMTRA	Uranium Mill Tailings Remedial Action
U	uranium
yr	year

1.0 Introduction

This Sampling and Analysis Plan (SAP) describes the environmental air monitoring activities conducted in association with the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project in Utah. The Project must establish and maintain a monitoring program that complies with DOE Order (O) 458.1, Admin Chg 4, "Radiation Protection of the Public and the Environment," to ensure that any radiological activities conducted do not cause a member of the public to receive a dose that exceeds the limits as specified in the order.

The Project Environmental Air Monitoring Program consists of monitoring for radon (Rn), direct gamma radiation, and airborne radioactive particulate materials (radioparticulates) at the mill tailings site in Moab (Moab site), the disposal site near Crescent Junction (CJ site), Utah, and at various locations near the sites.

The Technical Assistance Contractor (TAC) has primary responsibility for managing the Environmental Air Monitoring Program, including sample collection and preparation of quarterly air monitoring reports.

All fieldwork performed in association with this SAP is conducted in a manner that protects workers and the public and in accordance with the *Moab UMTRA Project Health and Safety Plan* (DOE-EM/GJ1038) and applicable work control documents. TAC personnel involved in air sampling are familiar with manufacturers' manuals for the sampling equipment and follow the requirements presented in the Air Monitoring and Equipment Maintenance Integrated Work Plan/Job Safety Analysis (IWP/JSA-025).

This SAP also serves as an operations and maintenance manual for the Environmental Air Monitoring Program. The monitoring stations are expected to be operative full time. Equipment maintenance issues are addressed in this document.

1.1 Site Descriptions

The Moab site is a former uranium (U) ore-processing facility located about 3 miles northwest of Moab. The site currently encompasses 480 acres; a uranium mill tailings pile occupies much of the western portion. The site is bordered on the north and west by sandstone cliffs. The Colorado River forms the eastern boundary. U.S. Highway 191 parallels the northern site boundary, and State Route 279 transects the western portion of the site.

The CJ site is located about 1 mile northeast of the junction of U.S. Highway 191 and Interstate 70, approximately 30 miles north of the Moab site. The site occupies 936 acres and is surrounded on three sides by land administered by the U.S. Bureau of Land Management. The talus slopes of the Book Cliffs delineate the northern boundary. The Union Pacific Railroad bounds the property on the south. Thompson Springs is the nearest community, located approximately 6 miles to the east.

2.0 Basis for Sampling

According to DOE Handbook (HNBK) 1216-2015, "Environmental Radiological Effluent Monitoring and Environmental Surveillance," because air is a primary exposure pathway to humans from radionuclides released to the atmosphere, air sampling should be conducted to evaluate potential doses to populations from inhaled or ingested radionuclides or from exposure to radiation sources external to the body.

Environmental monitoring is conducted to measure releases of radioactive materials from DOE operations, to characterize the radiological condition of the environments on and around DOE activities, and to support assessment of potential public exposure through available pathways.

There are three potential pathways for radiological materials from work activities conducted on the Project sites that can expose the public:
1. Radon gas (inhaled)
2. Direct gamma radiation (exposure)
3. Radioparticulates (inhaled or ingested)

Because of the potential hazards associated with these pathways, DOE implemented a comprehensive Environmental Air Monitoring Program to continuously monitor and measure radon, gamma radiation, and radioparticulates. Monitoring was initiated at the Moab site in 2002 and in CJ in 2005.

When selecting new monitoring locations, the Project will consider prevailing wind patterns, population distributions, and previous atmospheric radon measurements. Monitoring locations that minimize the risk of damage to the monitors from traffic and vandalism will be selected.

2.1 As Low as Reasonably Achievable (ALARA) Program.

As low as reasonably achievable (ALARA) is the approach to radiation protection to manage and control exposures (both individual and collective) to the work force and the general public, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit, but a process that has the objective of attaining doses as far below the applicable limits of Title 10 Code of Federal Regulations Part 835 of CFR 835, "Occupational Radiation Protection," as is reasonably achievable.

It is the policy of the UMTRA Project to conduct site operations in a manner that will maintain radiation exposure to employees, contractors, and the public ALARA and prevent the possible spread of radioactive materials to the environment. The purpose of the Moab UMTRA Project ALARA Program is to provide guidance on meeting ALARA regulatory requirements and standards and to assist with the implementation of the ALARA Program.

An ALARA Committee was formed to hold meetings on a quarterly basis to discuss radiological safety concerns, resolve conflicts, and promote radiological safety initiatives. Quarterly environmental air monitoring data is presented at the ALARA Committee meetings and documented in the quarterly ALARA reports.

3.0 Regulatory Requirements

DOE O 458.1 establishes requirements for protection of members of the public from undue risk from radiation associated with radiological activities conducted under the control of DOE. Compliance with DOE O 458.1 may be demonstrated by calculating the dose to the maximally exposed individual (MEI) or the representative person or group from the public likely to receive the most radiation dose based on exposure pathways and parameters. The Project established an MEI for each site.

The Moab MEI was determined to be the nearest residence to the Moab site. Because there is not a radioparticulate monitoring station located at the MEI, data collected at nearby station 0102 is used to represent dose from radioparticulates at the MEI. After mill tailings disposal began in the second quarter of 2009, monitoring station 0306, a residence south of Interstate 70, became the MEI for the CJ site.

DOE O 458.1 specifies releases of radioactive material to the atmosphere from DOE activities shall not exceed an annual average concentration of 3 pCi/L of radon or its decay products, not including background, at the site boundary. On-site monitoring locations close to site boundaries or publicly accessible areas are used to demonstrate compliance at the boundary.

Background stations are located a sufficient distance from the Moab tailings pile such that any contaminants transported off site would not affect ambient air quality measurements. Background air particulate concentrations were not established. However, the specific isotopes that can only be found from the tailings pile is known and therefore all radioparticulates are assumed to be from the tailings pile. Background values for radon and direct gamma was established.

Based on data collected between 2003 and 2008 from stations 0117 and 0123, an average annual background radon concentration of 0.7 picocuries per liter (pCi/L) and annual direct gamma background of 82 millirem (mrem) was established for the Moab area. Based on data collected between 2006 and 2009, before beginning tailings disposal at CJ, the average annual background radon concentration in the CJ area was established as 0.9 pCi/L and 92.5 mrem/yr for direct gamma.

The total effective dose (TED) to members of the public allowed under DOE O 458.1 is 100 millirems per year (mrem/yr) above background. 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 direct gamma radiation and radioparticulates. Background values are subtracted from the TED.

4.0 Field Sampling

4.1 Radon

As shown in Figures 1 and 2, the Moab site radon monitoring network consists of 15 on-site locations and 12 off-site locations. The radon monitoring network for the CJ site consists of seven locations within the disposal cell site boundary and two off-site locations (see Figure 3).

Exterior radon is monitored using a single alpha-sensitive detector. The radon detector is housed in a protective environmental enclosure, which is attached to a fence line or to a metal T-post at approximately 3 feet above the ground surface. Radon detectors are exposed and collected on a quarterly basis in January, April, July, and October. The exposed detectors are sent to an analytical laboratory for analysis within 1 week of collection. Appendix A describes procedures for ordering, storing, placing, retrieving, and shipping radon detectors.

4.2 Direct Gamma Radiation

Gamma radiation monitoring locations at both sites are collocated at each of the radon monitoring locations (see Figures 1 through 3). Direct gamma radiation is measured using a thermoluminescent dosimeter (TLD) at each location. The TLD is attached to a fence line or to a metal T-post at approximately 3 feet above the ground surface. TLDs are placed and collected quarterly on the same schedule as radon detectors. Exposed TLDs are sent to an analytical laboratory for analysis within 1 week of collection. Appendix A describes procedures for ordering, storing, placing, retrieving, and shipping TLDs.

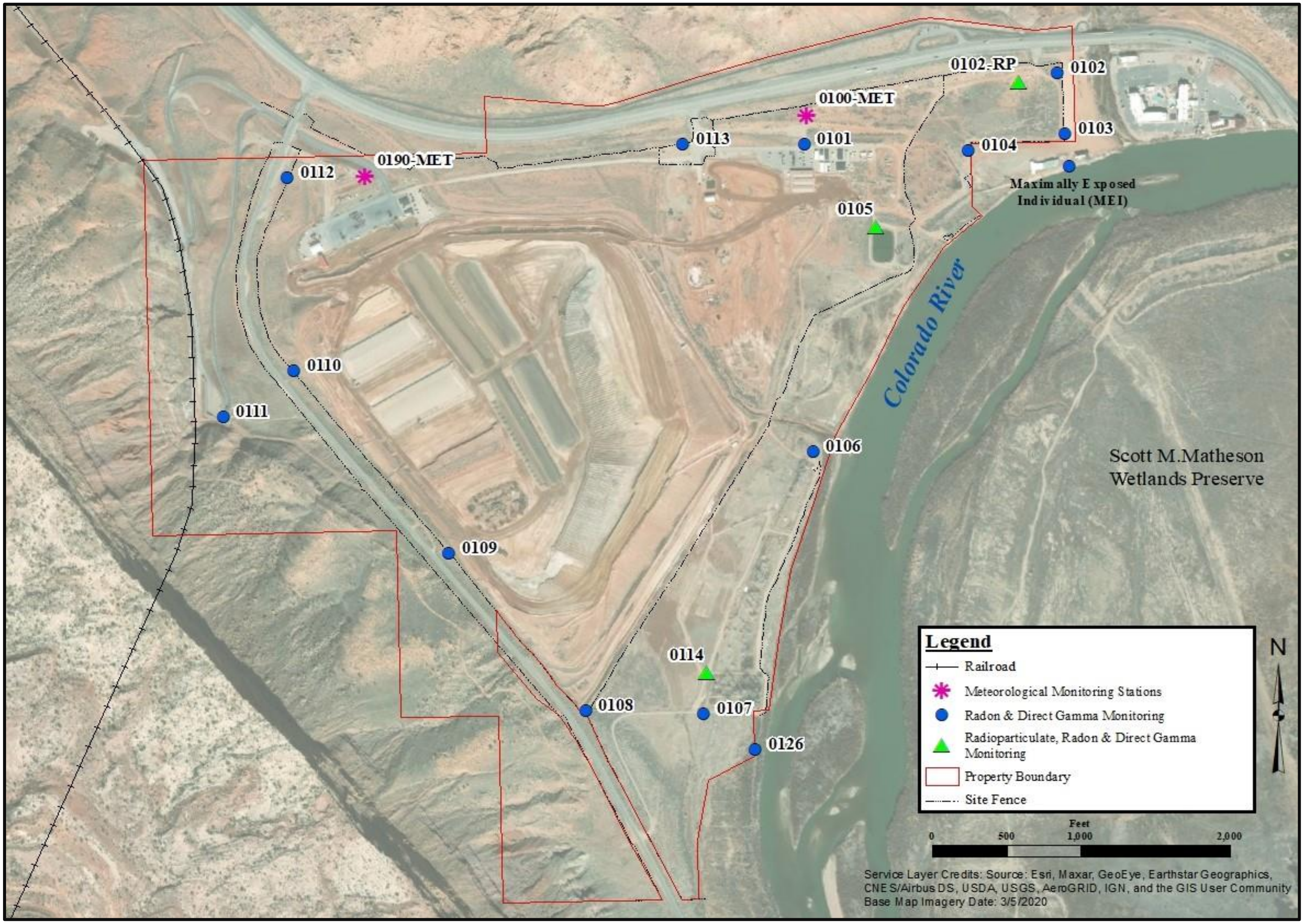

Figure 1. Moab On-site and MEI Environmental Air Monitoring Locations

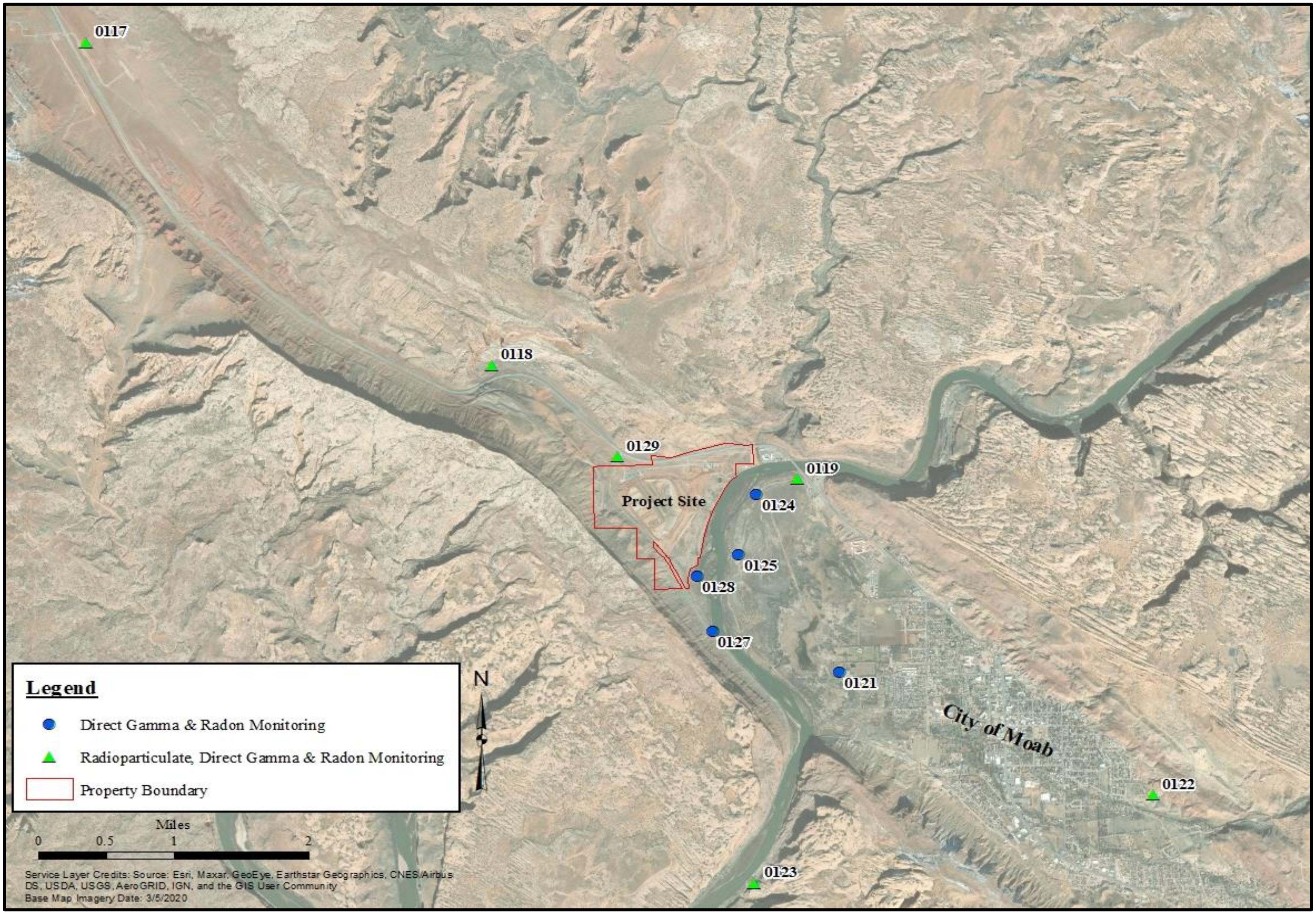

Figure 2. Moab Off-site Environmental Air Monitoring Locations

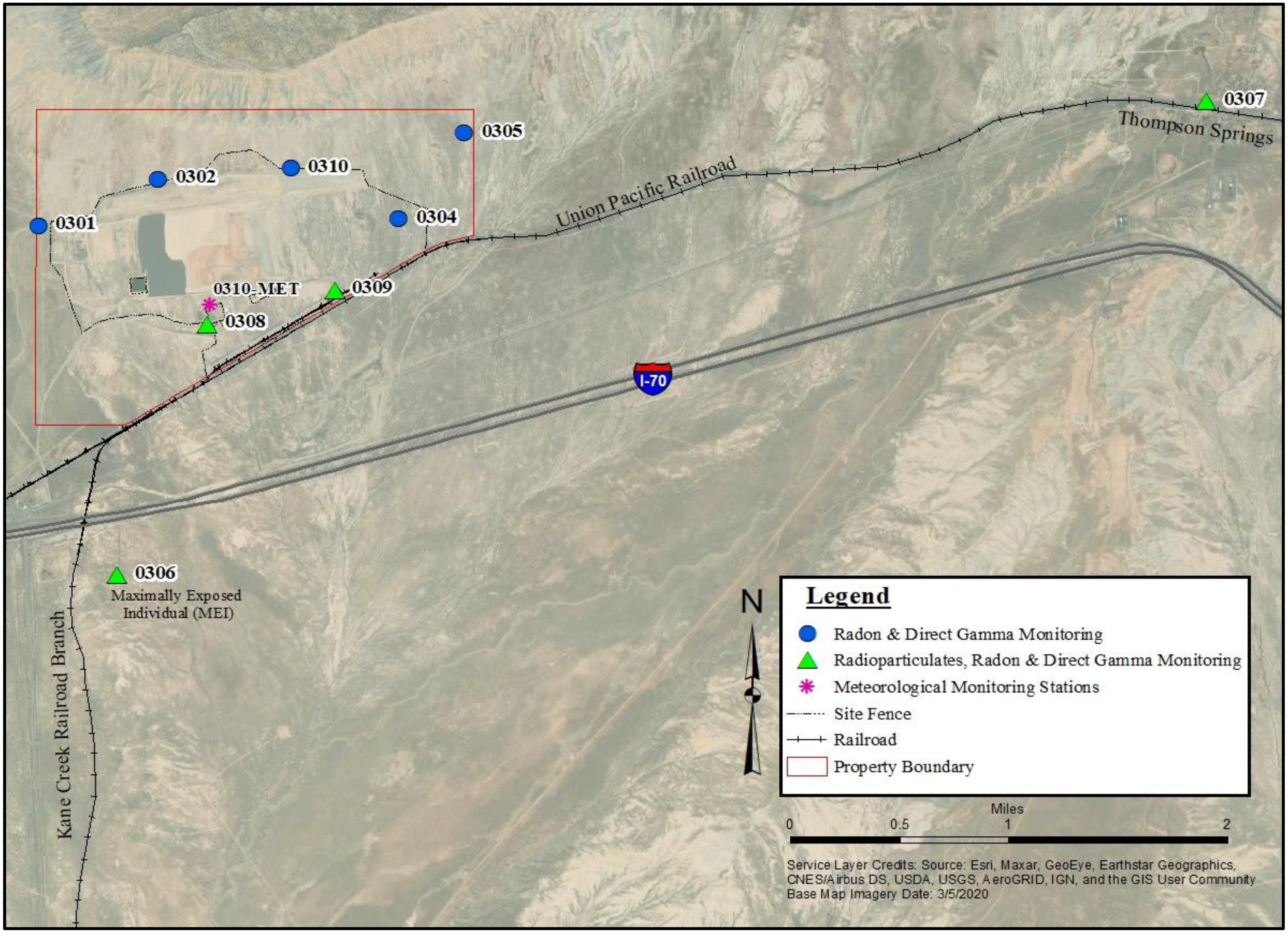

Figure 3. CJ Site Environmental Air Monitoring Locations

4.3 Radioparticulates

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

The radionuclides of concern on the Project include those inherent in the process of extracting uranium. The radioparticulate samplers used on the Project are HI-Q Environmental Products Co, Inc., Model VS23-0523CV. Each sampler runs continuously at a rate of approximately 60 liters (L) per minute (LPM).

Filters are collected and replaced on a weekly basis. To obtain the total concentration for each radioparticulate, weekly filter samples are composited and analyzed as one sample on a quarterly basis. Samples are analyzed by a third party analytical laboratory for actinium (Ac)-227, polonium (Po)-210, radium (Ra)-226, thorium (Th)-230, and total uranium. The Project also reports concentrations of protactinium (Pa)-231.

It is not possible to directly analyze the samples for Pa-231 in the laboratory; however, because Ac-227 and Pa-231 are assumed to be in equilibrium, the concentration of Pa-231 is estimated by dividing the analyzed Ac-227 concentration by a correction factor of 0.614. This estimation is consistent with the *Moab UMTRA Project Health Physics Plan* (DOE-EM/GJ3003).

Filter collection is performed in accordance with "Procedure for Sampling Radioparticulates Using a Continuous Duty, Low-volume Constant Flow Air Sampler" (see Appendix B). Field data are documented on the Radioparticulate Sampling Field Log (Appendix B).

4.4 Meteorological Data

DOE O 458.1 requires meteorological monitoring to be commensurate with radiological activities. DOE installed meteorological monitoring stations to support the Moab and CJ sites. Measured meteorological parameters include wind speed and wind direction. Both wind speed and direction are displayed in wind roses and are reported in the quarterly environmental air monitoring reports.

In July 2002, DOE installed a meteorological monitoring station (0100-MET) north of the administration offices at the Moab site. A second meteorological monitoring station (0190-MET) was installed on the tailings pile in June 2006. This station (0190-MET) was moved near the Support Area in 2011. The current locations of the two Moab site meteorological stations are shown in Figure 1. Figure 4 is a wind rose diagram using data obtained at the 0100-MET meteorological station between July 2006 and December 2020 that shows the prevailing winds at the site are generally from the west-northwest with the strongest winds are from the south-southeast.

In 2005, DOE installed a meteorological monitoring station at the Utah Department of Transportation rest area near CJ. In summer 2009, a second station was installed on site to obtain more area-specific meteorological data. The wind rose diagram (Figure 5), using data obtained at the CJ site meteorological monitoring station from June 2009 through December 2020, shows the winds are mostly variable, but generally from the west-northwest.

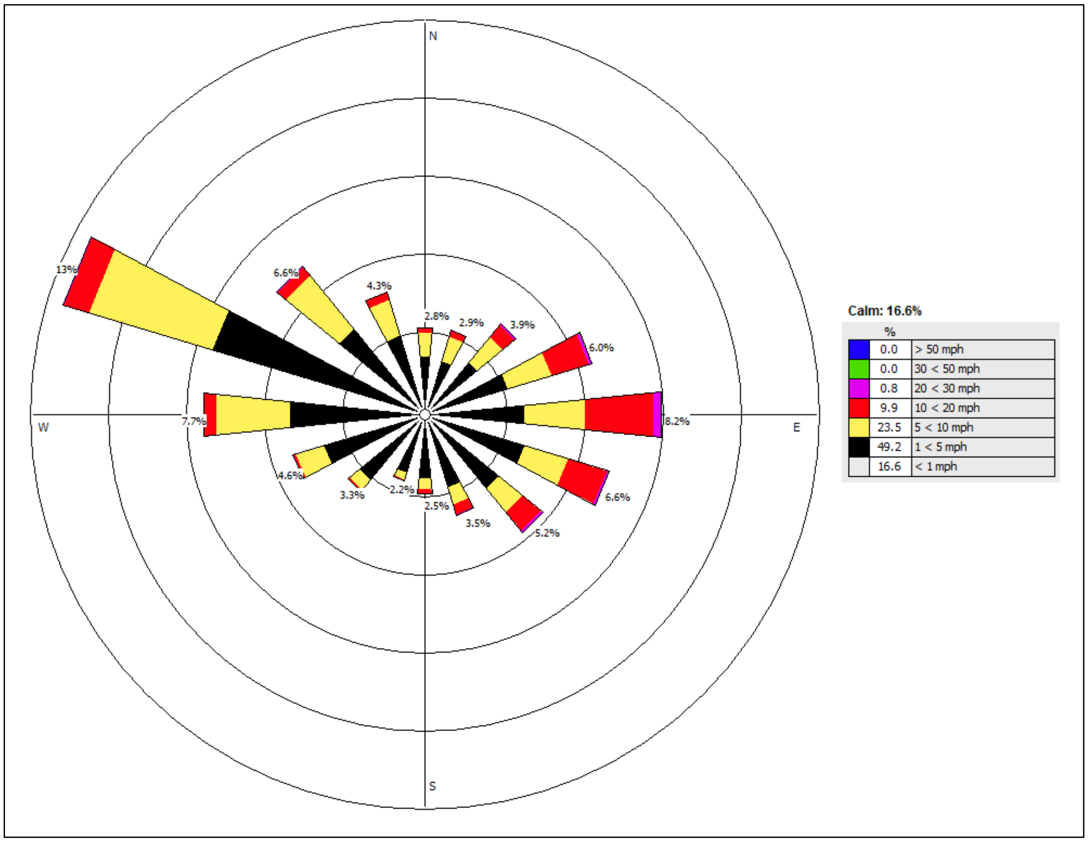

Figure 4. Moab Site Wind Rose Plot, 2006 through 2020

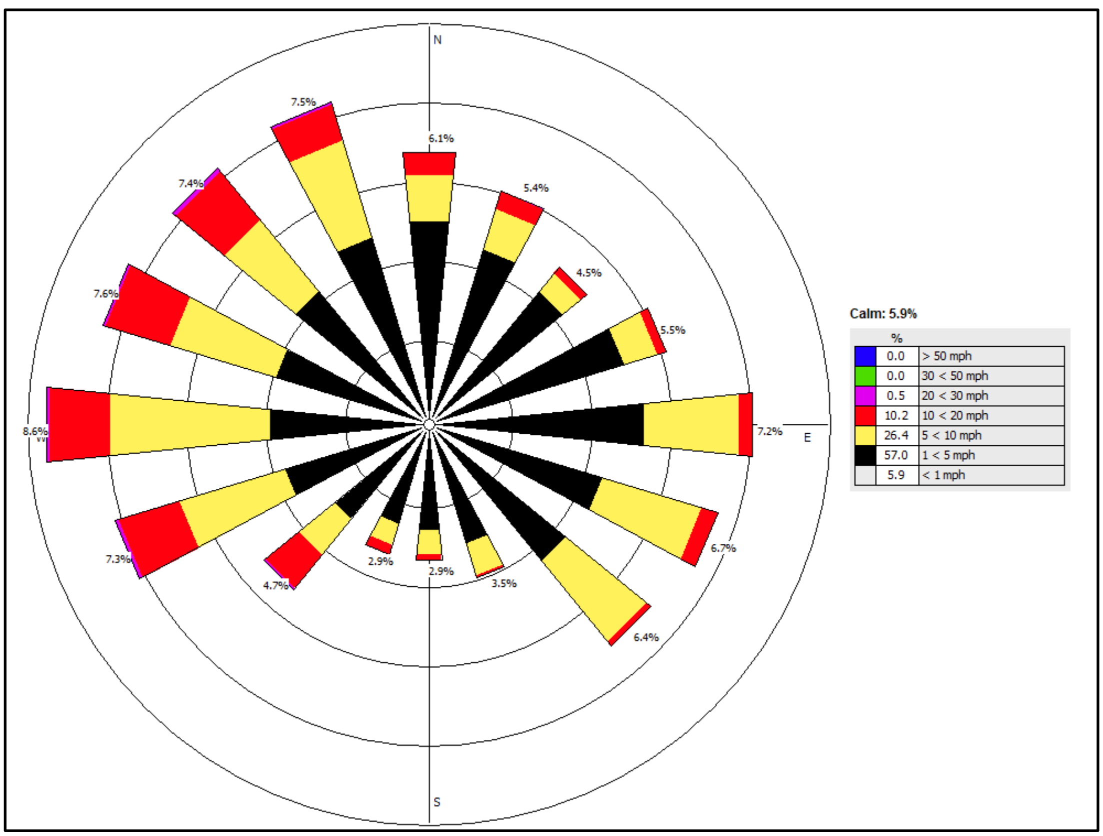

Figure 5. CJ Site Wind Rose Plot, 2009 through 2020

5.0 Quality Assurance and Quality Control

Quality assurance (QA) requirements associated with this SAP are in accordance with the *Moab UMTRA Project Technical Assistance Contractor Quality Assurance Plan* (DOE-EM/GJTAC1525). Laboratories used to analyze air monitoring filters and detectors have a documented QA program and follow all relevant laboratory procedures. QA program requirements and rights of access for verification of QA program implementation are applied to subcontracted laboratories through the appropriate procurement documents.

Analytical quality control (QC) includes, as appropriate, the analysis of trip blanks and duplicates for the radon detectors and TLDs as specified by the method. No radioparticulate blanks are used in the field because the laboratory QA is performed internally.

5.1 Sample Control

To maintain evidence of authenticity, samples are properly labeled and discernible from other similar samples. Samples are indexed by a unique sample number, location identification number, date collected, and sample period (start/end dates or total hours). Chain-of-sample-custody records are used to document all transfers in the possession of samples and to show that a sample was in constant custody from the time of collection. Once collected, samples are securely stored at the Moab site until they are shipped. Radon cups and gamma TLDs are shipped with a trip blank to assess the potential for in-transit contamination.

5.2 Sampler Calibration and Flow Checks

Each low-volume sampler is initially calibrated before field deployment and a calibration check is completed quarterly with a National Institute of Standards and Testing-traceable air flow calibrator unit. The calibrator unit is calibrated by the manufacturer annually. If the results of a calibration check reveal the pump requires calibration, then a full calibration is performed. The calibration data are recorded on the Radioparticulate Sampler Quarterly Calibration Check Log.

6.0 Analytical Protocols

Radon detectors and TLDs are analyzed by a TAC-approved laboratory according to the laboratory's internal procedures and in accordance with an approved QA manual for radon or TLD monitoring, respectively. Radioparticulate filters are analyzed by a TAC-approved laboratory according to DOE Consolidated Audit Program requirements. Reporting limits, analytical methods, and types of analyses applicable to radon, direct gamma, and radioparticulate analyses are summarized in Table 1. Analytical reporting limits are values slightly above the instrument detection limits and are used to negate the variability associated with instrument detection limits.

6.1 Sample Concentration Result Conversion to Dose Calculation

Radionuclide analytical data is provided in concentration units of pCi/sample (for Th-230, Ra-226, Po-210, and Ac-227) and microgram (µgm)/sample (for uranium) and must be converted to dose in units of millirems (mrem). The Pa-231 concentration is calculated based on the Ac-227 result, as discussed below. The dose data are included in the quarterly air monitoring reports.

Table 1. Reporting Limits, Analytical Methods, and Types of Analyses

Analyte	Reporting Limit	Analytical Method	Type of Analysis
Radon	0.3 pCi/L	Approved laboratory procedure	NA
Direct gamma radiation	1 mrem	Approved laboratory procedure	NA
Radioparticulates:			
Ac-227	0.5 pCi/sample	ASTM D3972	Alpha spectrometry
Po-210	0.3 pCi/sample	STL-RC-0210	Alpha spectrometry
Ra-226	2 pCi/filter[1]	EML RA-06-RC MOD	Gas proportional counting
Th-230	0.5 pCi/sample	EML A-01-R MOD	Alpha spectrometry
Total Uranium	0.5 pCi/sample	EPA SW-846 6020	Inductively coupled plasma/mass spectrometry

ASTM = ASTM International; EML = Extended Modal Logics; EPA = U.S. Environmental Protection Agency; STL = Superfund and Technology Liaison

[1]Reporting limit may vary depending on matrix interferences.

The air flow rate is recorded each week along with the number of hours the radioparticulate sampling pump was operational during a weekly filter change-out. All sampling pumps are calibrated to operate at a flow rate of 60 LPM. If the flow rate is 10 percent above or below 60 LPM, a calibration check is performed, and the flow rate is adjusted if necessary, as described in Appendix B.

To calculate the volume of air flowing through each sample filter collected from a radioparticulate sampling pump installed at an air monitoring station:

- The weekly air volume (L) is calculated by multiplying the weekly number of hours by the flow rate of 60 LPM. This value is then multiplied by 60 (conversion is 60 minutes/hour) to obtain the air volume (L).
- The total air volume (L) that flows through the sampling pump for each quarter is calculated by summing the total volume for each quarter over the standard 13-week time period.

The following steps describe the methodology used to convert the analytical result from a concentration to a dose. This conversion is calculated using a spreadsheet kept on the Moab UMTRA Project M: drive, which has controlled limited access to site personnel. The first step is to convert the sample concentration from pCi/sample to microcuries (µCi)/sample.

To calculate the concentration of Th-230, Ra-226, Po-210, and Ac-227 from the analytical laboratory result:

- Divide the analytical result (provided in units of pCi/sample) by 1,000,000 to obtain the concentration in units of µCi.

It is not possible to directly measure the presence of Pa-231 in the laboratory; however, this analyte can be derived from the Ac-227 result.

To calculate the concentration of Pa-231 from the analytical laboratory result:

- Divide the Ac-227 result obtained from the laboratory (provided in units of pCi/sample) and divide by 0.614 (this conversion factor was calculated and provided by the Moab UMTRA Project Radiological Control Manager).
- As with Ac-227, divide by 1,000,000 to obtain the concentration in the units of µCi.

To accurately calculate the uranium concentration from the analytical laboratory result, additional steps are required compared to the other analytes. Based on data collected through 2017 from the Project tailings pile by Radiological Control staff, the distribution of U-234, U-235, and U-238 (the three main isotopes of interest) are 0.005 percent, 0.72 percent, and 99.3 percent, respectively.

The following steps are necessary to accurately calculate the uranium concentration:

- Convert the uranium analytical laboratory result (in units of µgm/sample) to gm/sample by dividing by 1,000,000.
- To determine the percentage of each isotope, multiply this result (in units of gm/sample) by 0.00005 to obtain the mass of U-234 present by 0.0072 to obtain the mass of U-235 and by 0.993 to obtain the mass of U-238.
- Once the mass of each is calculated, divide the values by the atomic weights of each isotope (U-234, U-235, and U-238) to calculate the number of moles and then by Avogadro's number (6.022E23) to determine the number of atoms of each isotope.
- To calculate the total radiation (units of decays/second) for each isotope, multiply the number of atoms by the respective isotope decay constant:

Uranium Isotope	Decay Constant
U-234	8.97E-14
U-235	3.12E-17
U-238	4.91E-18

Source: *Annals of the ICRP, Dose Coefficients for Intakes of Radionuclides by Workers*, The International Commission on Radiological Protection, Vol. 24, No 4, 1995

- The U-234, U-235, and U-238 isotope total radiation is then divided by the conversion factor of 3.7E10 (3.7E10 decays/second = 1 Ci) to obtain the activity in units of curies.
- To convert these activities (in units of Ci to units of pCi), multiply by 1.0E12 (1 curie = 1.0E12 pCi).
- The total uranium activity (pCi) is calculated by summing the activity of all three isotopes.
- Divide the total activity by 1,000,000 to obtain the concentration in the units of µCi.

To calculate the dose (mrem) from the concentration (µCi):

- The following dose correction factors (DCFs) were provided by the Moab UMTRA Project Radiological Control Manager and are applied to each isotope:

Isotope	DCF Value
Uranium	2.3E+03
Thorium-230	2.7E+04
Radium-226	4.4E+04
Polonium-210	8.1E+03
Actinium-227	2.33E+06
Protactinium-231	3.29E+05

Source: *Annals of the ICRP, Dose Coefficients for Intakes of Radionuclides by Workers*, The International Commission on Radiological Protection, Vol. 24, No 4, 1995

- These correction factors were calculated by multiplying the associated value listed for each isotope in *Annals of the ICRP, Dose Coefficients for Intakes of Radionuclides by Workers*, The International Commission on Radiological Protection, Vol. 24, No 4, 1995, Table B-1, by 1.0E5 (1 becquerel = 1.0E5 µCi), and then dividing by 2.7E-5 (1 sievert = 2.7E-5 mrem).
- The isotope concentration (in µCi) is multiplied by these correction factors to convert the concentration to dose (in mrem).
- The total dose for each annual quarter for a particular location is calculated by adding the dose associated with each of the six isotopes.

7.0 Environmental Air Monitoring 1-3-5 Year Plan

Below, Table 2, describes the intended goals for the Environmental Air Monitoring Program. These goals include the use of a computer software model to bolster the program and plan for addition monitoring as the Project clean up changes.

Table 2. 1-3-5 Year Environmental Air Monitoring Program Goals

Environmental Air Monitoring Plan	
Program Goals	
1-Year (CY 2022)	By the end of 2022 all proposed air monitoring network changes have been completed.
	Begin reviewing the Radioparticulate (RP) Air Monitoring Network with dispersion modeling software.
	Revise the quarterly reports to improve ease of reading and increase understanding of information to provide DOE and the public.
	Conduct an in-depth inspection on each radioparticulate stations to ensure equipment is functioning properly (e.g. hoses are replaced, weather housings are stable, fans are cleaned etc…).
	By the end of CY 2022 all proposed meteorology station updates have been made.
3-Year (CY-2025)	Increase awareness and use of the radioparticulate air monitoring stations and increase priority of radioparticulate monitoring/evaluation with the use of air dispersion modeling and particulate size study.
	Utilize 'grab sampling' equipment to evaluate impacts of dust suppression efforts and dose from RPs on high wind days.
	Propose particulate matter monitoring and follow the National Ambient Air Quality Standards (NAAQS).
	Reevaluate entire network to reflect changes to CA excavation operations and changes to Moab demographics (if any).

Table 2. 1-3-5 Year Environmental Air Monitoring Program Goals (continued)

3-Year (CY-2025)	Evaluate the need for monitoring other airborne emissions as excavation operations change.
	Reevaluate the MEI to continue following best management practices even if significant changes in Moab have not occurred to warrant a prior evaluation.
	Radioparticulate and particulate matter monitoring is the primary focus of the Environmental Air Monitoring Program along with continuing to monitor radon at the boundary and TED to the MEI.
5-Year (CY 2027)	Evaluate the need for monitoring other airborne emissions as excavation operations change.

8.0 Data Review and Reporting

Data collected during field sampling activities and reported by the analytical laboratories are entered into a database. On receipt of analytical data reports from the laboratory, the TAC performs data validation to compare results with historical data and seasonal variations. The data validation process includes the comparison of the radon and gamma duplicate results to the corresponding monitoring location results. The locations where the duplicates are collected are documented on the Radon Cup and TLD Sampling Logs (Forms 1083 through 1086).

Analytical data are published in quarterly air monitoring reports and are summarized and presented in annual site environmental reports in accordance with the requirements of DOE O 231.1B Admin Chg 1, "Environment, Safety, and Health Reporting." The quarterly and annual reports are posted on the Project public website at *www.gjem.energy.gov/moab.*

All monitoring data are made available to other organizations as needed. That is, on-site gamma exposure data may be used by the health and safety organization for determining occupational exposures; Project management is immediately notified if monitoring data indicate any occurrences of noncompliance.

If quarterly calibration of radioparticulate air samplers requires greater than 10 percent flow adjustment, data are flagged with a qualifier as estimated values.

9.0 Records

All documentation created as a result of compliance with this Plan is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545), which follows DOE orders, policies, and regulations for retention and maintenance of records.

All entries on the calibration and field log forms are made with indelible ink and are legible, accurate, complete, and traceable to the monitoring location. If an error is made when recording field data, a line is drawn through the error, and the correct information is entered. All corrections are initialed and dated. When practical, errors are corrected by the person who made the entry.

Field logs should provide sufficient data and observations to enable reconstruction of events that occurred during the field sampling activities. All information/data gathered during fieldwork are maintained in a Moab working file, which protects them from loss or damage, and become part of the permanent record file.

A copy of each chain-of-sample-custody form is retained at the Moab site for traceability in case the sample is lost or destroyed. The copy received by the subcontracted laboratory is included in the final analytical report.

10.0 References

DOE (U.S. Department of Energy), Handbook 1216-2015, "Environmental Radiological Effluent Monitoring and Environmental Surveillance" (DOE-HDBK-1216-2015).

DOE (U.S. Department of Energy), *Moab UMTRA Project Health and Safety Plan* (DOE-EM/GJ1038).

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

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

DOE (U.S. Department of Energy), *Moab UMTRA Project Technical Assistance Contractor Quality Assurance Plan* (DOE-EM/GJTAC1525).

DOE (U.S. Department of Energy) Order 231.1B Admin Chg 1, "Environment, Safety, and Health Reporting."

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

IRCP (International Commission on Radiological Protection), "Annals of the ICRP, Dose Coefficients for Intakes of Radionuclides by Workers," Vol. 24, No 4, 1995.

Title 10 Code of Federal Regulations Part 835, "Occupational Radiation Protection Program"

Appendix A.

Procedure for Obtaining Exterior Radon and Direct Gamma Radiation Measurements

Appendix A. Procedure for Obtaining Exterior Radon and Direct Gamma Radiation Measurements

A1.0 Purpose

This procedure provides instructions for ordering, storing, placing, retrieving, and shipping alpha-track Rn-222 detectors and direct gamma radiation TLDs.

A2.0 Definitions

Alpha-track radon detector—a monitor consisting of an alpha-track detector enclosed in a porous container. Alpha particles from radon and its decay products produce damage tracks on this material during the period of exposure. The density of tracks is proportional to the radon concentration.

Duplicate detector or TLD—a second detector or TLD placed at a preselected monitoring location and sent to the laboratory with the other detector or TLD from that location. Analytical results of the two devices are compared as part of the data validation process.

Thermoluminescent dosimeter (TLD)—a device used to measure direct gamma radiation. It stores energy when struck by ionizing radiation. When heated, it emits light proportional to the amount of radiation to which it has been exposed. The Project uses a calcium sulfate dysprosium TLD.

Trip blank—a detector left unexposed and shipped with exposed detectors to the laboratory as part of the QC process.

A3.0 Equipment and Materials

1. Exterior alpha-track radon detectors
2. TLDs
3. Environmental enclosures
4. Radon Detector and TLD Sample Logs
5. Monitoring location maps
6. Personal protective equipment (e.g., safety glasses, safety shoes)

A4.0 Ordering and Storing Radon Detectors and TLDs

1. Order enough radon cups and TLDs to supply the estimated needs for one quarter and place additional small orders, as needed, to limit the time the detectors are stored before placement.
2. Each radon detector is in a sealed plastic wrap, and the box of radon cups and TLDs is stored in a lockable metal cabinet in the air monitoring technician’s office until used to reduce potential exposure to ambient radon or direct gamma exposure.

Appendix A. Procedure for Obtaining Exterior Radon and Direct Gamma Radiation Measurements (*continued*)

3. Before use, verify the quantity of detectors received matches the number ordered and check the wrapping of each detector for damage. Return detectors that have damaged packages.

A5.0 Collecting Radon Detectors and TLDs

1. Remove the radon detector from the environmental enclosure (see example in Figure A-1). Inspect the detector for damage. Note its condition on Form 1083.
2. Record the retrieval date on the sample log next to the appropriate monitoring location and verify the detector's serial number.
3. Install a replacement detector according to Section 6.0.
4. Detach the TLD from the metal T-post.
5. Record the serial number of the collected TLD on Form 1084 to the appropriate monitoring location and confirm the serial number matches the previous log showing the placed TLD. Record the retrieval date on the sample log.
6. Seal and/or pack the detector for shipment to the laboratory as recommended by the vendor.
7. Install a replacement TLD according to Section 6.0.
8. Repeat steps one through nine for all sampling locations. Sign and date the bottom of the completed sample logs.
9. Store all exposed detectors in the lockable metal cabinet in the air monitoring technician's office until they are shipped to the laboratory.

Figure A-1. Example of TLD (top) and Radon Detector Environmental Enclosure

A6.0 Placing Radon Detectors and TLDs

1. Remove the needed radon detector(s) and TLD(s) from the storage boxes.
2. Remove the radon detector from the sealed wrapping material at the monitoring location. Place the detector the same day its sealed wrapper is opened. Do not use if the seal is damaged.
3. Inspect the radon cup. Do not use any radon detectors.
4. Record the serial number and date of installation next to the appropriate monitoring location on the Sample Log Forms.
5. Place the detector in the protective environmental enclosure and ensure the enclosure is tightly closed.
6. Attach a TLD to the metal T-post using a zip-tie and record the serial number next to the appropriate monitoring location on the TLD Sample Log.
7. Place duplicate radon detectors and TLDs at preselected monitoring locations.

A8.0 Shipping Radon Detectors and TLDs

1. Collect all field and duplicate radon detectors and TLDs from the storage boxes. Add the date removed to the sample log.
2. Package the radon detectors and TLDs according to the vendor’s instructions.
3. Prepare a radon detector data information sheet using data from the sample logs, showing only the detector’s serial number, date installed, and date retrieved. Include dates for the trip blank by approximating the dates of shipping time.
4. Complete the appropriate analytical laboratory services paperwork.
5. Ship detectors within 7 days of detector retrieval.

A9.0 Records

All documentation created as a result of compliance with this Plan is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545), which follows DOE orders, policies, and regulations for retention and maintenance of records.

Send originals of analytical laboratory reports and sample logs to Records Management; copies are placed on the site M: drive.

Appendix A. Procedure for Obtaining Exterior Radon and Direct Gamma Radiation Measurements (*continued*)

UMTRA Project

Moab Radon Cup Sample Log

Samples Collected for Qtr: Year: **Samples Placed for Qtr: Year:** **Field Reps: ___________________________**

Station ID	Collected Serial #	Date Placed	Serial # Confirmed	QA/ QC'd	Date Collected	Replaced with (Serial #)	Date Placed	Comments
0101								
0102								
D-0102								
0103								
0104								
0105								
0106								
0107								
0108								
D-0108								
0109								
0110								
0111								
D-0111								
0112								
0113								
0114								

SAMPLE

Form 1083
Rev 0, January 2018

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Appendix A. Procedure for Obtaining Exterior Radon and Direct Gamma Radiation Measurements *(continued)*

MOAB UMTRA Project

Moab TLD Sample Log

Samples Collected for Qtr: Year: Samples Placed for Qtr: Year: Field Reps: ____________

Station ID	Collected Serial #	Date Placed	Serial # Confirmed	QA/ QC'd	Date Collected	Replaced with (Serial #)	Date Placed	Comments
0101								
0102								
D-0102								
0103								
0104								
0105								
0106								
0107								
0108								
D-0108								
0109								
0110								
0111								
0112								
0113								
0114								
0117								
0118								

SAMPLE

Form 1084
Rev 1, April 2020

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Appendix B.

Procedure for Sampling Radioparticulates Using a Continuous Duty, Low-volume Constant Flow Air Sampler

Appendix B. Procedure for Sampling Radioparticulates Using a Continuous Duty, Low-volume Constant Flow Air Sampler

B1.0 Purpose and Scope

This procedure provides instructions for calibration, filter installation and removal, and maintenance of a continuous duty, low-volume constant flow air sampler. This procedure applies to the use of HI-Q Model VS23-0523CV air sample pumps.

B2.0 Definition

***Low-volume constant flow air sampler*—**an air pump for sampling ambient air in for a specified time at a specified low volume flow rate.

B3.0 Equipment and Materials

- HI-Q Model VS23-0523CV pump
- 47-millimeter (mm)-diameter glass fiber filters (e.g., HI-Q Part Number FP-2063-47)
- Coin envelopes
- Radioparticulate Sampler Quarterly Calibration Check Log and Radioparticulate Sampling Field Log
- HI-Q Model D-AFC-04 portable calibrator

B4.0 Field Calibration

An air sampling pump calibration check is completed at least quarterly in accordance with the manufacturer operation and maintenance manual and is recorded on the Radioparticulate Sampler Quarterly Calibration Check Log. The preset sample flow rate is 60 LPM; therefore, operational range (with 10 percent drift) is 54 to 66 LPM. If flow rate is not within operational range, calibration is performed as soon as possible before quarterly calibration check.

Air sampling pump calibration and calibration checks are completed using a HI-Q Model D-AFC-04 portable calibrator that is capable of measuring 14 to 100 LPM with better than ±5 percent accuracy. A single-point calibration check is sufficient for the sampling pumps, but a three-point calibration check may be performed if necessary. The calibration points chosen must be within the range of the flow controller.

Sampling Pump Calibration Check

These checks are performed quarterly, typically within a month of quarterly sample collection. Before completing a calibration check, the "As Found" conditions of the pump are documented using Form 1088. This includes the flow rate of the pump based on the rotameter and the flow rate measured by the calibrator. In addition, the temperature (^{o}F) and barometric pressure (mm Hg) measured by the calibrator are documented.

To measure the flow rate using the HI-Q calibrator:

1. Connect flow calibrator to inlet of pump or inlet of inline filter and cartridge holder with cartridge and/or filter paper used in actual sampling.
2. Turn on air sampling pump and allow it to run for approximately 15 minutes if it was not already running prior to calibration.
3. Record the flow rate (in LPM) and compare to the rotameter reading in the “As Found” column on Form 1088.
4. If either are above or below 60 LPM, alter the pump flow rate (following the manufacturer’s instructions) by adjusting the flow control valve.
5. When an adjustment to the flow control valve changes the flow to 60 LPM on the calibrator and the rotameter also reads 60 LPM, the calibrator check is complete.
6. Document the flow rate of both the rotameter and the calibrator under the “As Left” columns on Form 1088.

Sampling Pump Calibration

When the adjustment using a calibration check (described above) does not result with both the rotameter and the calibrator reading a value of 60 LPM, the sampling pump rotameter needs calibration:

1. Set the calibrator to a flow rate of 60 LPM, and then adjust the rotameter (following the manufacturer’s instructions) to read the same flow rate.
2. If this adjustment cannot be made for some reason, the pump must be taken out of service for maintenance and a calibrated replacement pump must be installed.
3. Document the calibration on Form 1089.

B5.0 Procedures

Filter Collection and Replacement

1. Unlock air monitoring station box.
2. Ensure the air sampling pump is in good working condition per manufacturer’s requirements.
3. Complete Radioparticulate Sampling Field Log as described in Section 6.0, documenting the flow rate and hour meter reading and re-setting the hour meter on Form 1087.
4. Unscrew the combination filter holder at the O-ring.
5. Place the filter holder front plate on a flat, clean surface.
6. Remove the filter with tweezers and place in an individual 2 ¼ x 3 ½ inch envelope that contains the date and location the filter was collected from. All filters collected will be transported to the site by the sampling technician and placed in a secure location.
7. Turn off the pump by flipping the silver switch on the timer box down.
8. Remove a new, visibly clean, 47-mm filter from a box containing the new filters from the manufacturer and place the rough side of the filter such that it is exposed to the air in the combination filter holder. Grip the paper on the side to minimize contact with the filter.
9. Replace the combination filter holder to the O-ring end.

10. Turn pump on and record the rotameter reading. Double-check that a new filter is properly in place.
11. Relock and secure air monitoring station box
12. Repeat steps one through nine for each sampling location.
13. At the end of each quarter all collected filters will be grouped by location and submitted to the analytical laboratory, with the individual filters remaining inside the envelopes they were first placed in.

Abnormal Filter Collection Events

During certain occasions filters my need to be collected on a more frequent basis. Wildfire smoke or extremely dusty conditions can cause filters to become overloaded and diminish in effectiveness when monitoring for radioparticulates. To minimize filter overloading during abnormal air quality conditions, Table 3 provides actions to be taken with associated ambient conditions, and Table 4 is the visual criteria for collecting filters during abnormal occasions. Follow the same collection steps in B5.0 and note the reason for off schedule collection. PurpleAir.com should be use to get local daily particulate matter 2.5 microns or smaller ($PM_{2.5}$) concentrations.

Table 3: Conditions that initiate a filter check or collection

Condition	Action
Moab	
Raw $PM_{2.5}$ daily concentrations are >30 µg/m^3	On-site stations will be checked for potential filter collection at all Moab air stations including off-site.
Raw $PM_{2.5}$ daily concentrations are >20 µg/m^3 for 3 consecutive days.	All Moab on- and off-site filters will be checked and collected as needed based on criteria in table 2.
Raw $PM_{2.5}$ daily concentrations are >45 µg/m^3	All Moab filters will be collected.
Crescent Junction	
Raw $PM_{2.5}$ daily concentrations are >60 µg/m^3	All filters will be collected (Moab and Crescent Junction).

Table 4: Visual Inspection Criteria for Collecting Filters

Visual Inspection Criteria		
Filter	**Pump Flowmeter**	**Action**
Light gray to white	Between 54-66 LPM	No Action
Gray to light gray	Between 54-66 LPM	No Action
Dark gray to gray	Between 54-66 LPM	No Action
	Out of 10% operation range (<54 LPM or >66 LPM)	Collect and replace filter
Black to dark gray with or without visible ash	Between 54-66 LPM	Collect and replace filter.

Maintenance
Air samplers are designed to be fairly maintenance-free; however, carbon vane pumps do wear and require maintenance. Observations of carbon buildup in the muffler or abnormally high pump head pressure readings at a particular flow rate are signs that maintenance is needed.

Most routine maintenance can be performed in the field; however, if a repair cannot be performed readily in the field, the technician will replace the unit with a spare pump to minimize the station down time. All work on the sample pumps is documented, signed, and dated by the technician performing the work on Form 1008.

Annual preventive maintenance is also conducted (annually at minimum) to extend the lifespan of the sampling equipment and ensure accurate data are collected. Power cords for the air samplers will be checked for crimps, cracks, or exposed junctions at the time of weekly filter collection.

Air sampler inspection:
- Verify gaskets are properly sealed; replace if necessary.
- Verify the sampler and filter holder are free of dirt; clean any dirt buildup.
- Verify quick disconnect works correctly and makes a good seal.
- Check power on/off switch and fuse holder for proper operation; replace fuse or reset GFCI switch as required.
- Check for loose fittings and leaks in tubing connections; repair as needed.
- Check rotameter for foreign matter within the flow tube and observe rotameter for cracks that may cause air leaks; replace rotameter as needed.
- Check timer weekly for consistent time reading.
- Verify air monitoring station is free of debris, including sand, insects, and foreign matter.

Monthly checks on the GFCIs located inside the weather housings are completed and documented using Form 1014, and quarterly checks on the other air station housing equipment (including all intake and discharge hoses) are documented using Form 1097.

B6.0 Radioparticulate Sampling Field Log

Complete the top of the log with the month, year, and the name of the person who collected the sample.

For each sample filter collected:
1. Record the sampling date (mm/dd/yy) on Form 1087.
2. Record the sample flow rate in liters per minute.
3. Check that the flow rate is within operational range, mark “Y” or “N.” If flow rate is not within operation range, refer to Section 4.0 for calibration or calibration check.
4. Record the current total hour reading.
5. Mark “Y” or “N” whether the sampler hour meter was reset.
6. Record comments regarding unusual conditions about the filter collection or about the air sampling pump in the Form 1087 “Comments” section.

MOAB UMTRA Project

Radioparticulate Air Pump Calibration Check Log

Year: ________________ Calibrator Unit Serial No: ____________________ Unit Calibration Date: ___________________

Serial Number	Date	Station Number	Calibrator		As Found Rate (LPM)		Adj Rotameter? (Y/N)	As Left Rate (LPM)		Performed By (Employee ID)	Comments
			Temp (°F)	Pressure (mm Hg)	Rotameter	Calibrator		Rotameter	Calibrator		
28369											
28370											
28371											
28372											
28373											
28374											
28384											

SAMPLE

Form 1088
Rev 2, July 2020

File Code Index No.: 18.2.2
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Appendix B. Procedure for Sampling Radioparticulates Using a Continuous Duty, Low-volume Constant Flow Air Sampler (*continued*)

MOAB UMTRA Project

TAC Air Radioparticulate Sampler Calibration Record

Date:	Station Number:	Pump Serial Number:
Reason for Calibration:		
Pump Replaced?	New Pump Serial Number:	

Calibrator Information	
Type:	Serial Number:
Calibration Date:	Calibration Due Date:
Temperature (°F):	Pressure (mmHg):

As Found Conditions

SAMPLE

Calibration Date: ____________________

Next Calibration Due Date: ____________________

Rotameter Reading: ____________________

Calibrator Reading: ____________________

Attach Old Calibration Sticker Here if Undamaged

*Initials:*_____

As Left Conditions

Rotameter Reading: ____________________

Calibrator Reading: ____________________

Calibration Date: ____________________

Next Calibration Due Date: ____________________

Rotameter Adjusted: ☐ Yes ☐ No

Comments:

Performed By: ______________________________ Employee ID #____________ Date: ____________

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Rev 1, February 2020

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MOAB UMTRA Project

Air Radioparticulate Sampling Pump Maintenance Record

Pump Location:	Pump Model/Serial No.:	Calibration Date:	
		Next Calibration Date:	

Reason for Service: ☐ Scheduled Calibration ☐ Repairs ☐ Other:

Pump Inspection

Sat	Unsat	N/A		Remarks *(for Unsat)*
☐	☐	☐	Electrical Cord	
☐	☐	☐	Controls	
☐	☐	☐	Flow Meter	
☐	☐	☐	Calibration Sticker	
☐	☐	☐	Motor	
☐	☐	☐	Casing	
☐	☐	☐	Timer	
☐	☐	☐	Filters	
☐	☐	☐	Other	

Remarks:

SAMPLE

MAINTENANCE CHECKLIST

	N/A	*Completed*		*N/A*	*Completed*
Unplug from power outlet	☐	☐	Clean exterior surface	☐	☐
Remove felt filters	☐	☐	Unscrew muffler box and remove	☐	☐
Unscrew end plate and remove	☐	☐	Clean and inspect interior surfaces	☐	☐
Inspect carbon vanes, replace annually	☐	☐	Reassemble with new gaskets	☐	☐
Remove metal muffler to clean/replace	☐	☐	Install new filter *(and O-rings, if needed)*	☐	☐
Perform calibration	☐	☐	Inspect flow sensor	☐	☐
Other:	☐	☐	Clean and inspect photo sensor *(if needed)*	☐	☐

Parts Used:

Pump "AS LEFT" Conditions

Calibrator Type:		Calibration Date:		Temp.:	
Serial Number:		Calibration Due:		Pressure:	

Calibrator is traceable to NIST Standards.

Remarks:

	Pump	Calibrator	Pump Calibration Date	Due Date
Flow Rate				

Performed By:

(printed name) *(signature)* *(date)*

Form 1008
Rev 1, January 2018

File Code Index No.: ________

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Air Monitoring
GFCI Monthly Inspections

Date: ____________________ Inspector: ____

If a GFCI does not pass due to incorrect wiring, then please record/write the error code lit up on the GFCI & Circuit Tester

SAMPLE

MOAB	QTY	PASS	FAIL	NOTES
Location 102	1	☐	☐	*Inside Station*
	2	☐	☐	*Outside Station 1*
	3	☐	☐	*Outside Station 2*
Location 105	1	☐	☐	*Inside Station*
Location 114	1	☐	☐	*Inside Station*
Location 117	1	☐	☐	*Inside Station*
	2	☐	☐	*Outside Station*
Location 118	1	[illegible]	[illegible]	*Ins[illegible]e Station*
	2	[illegible]	[illegible]	*Ou[illegible]de Station*
Location 119	[illegible]	[illegible]	[illegible]	*Ins[illegible]n*
Location 122	1	☐	☐	*Inside Station 1*
	2	☐	☐	*Inside Station 2*
Location 123	1	☐	☐	*Inside Station*
	2	☐	☐	*Outside Station*
Location 129	1	☐	☐	*Inside Station*
	2	☐	☐	*Outside Station*

CRESCENT JUNCTION	QTY	PASS	FAIL	NOTES
Location 306	1	☐	☐	*Inside Station*
Location 307	1	☐	☐	*Inside Station*
Location 308	1	☐	☐	*Inside Station*
	2	☐	☐	*Outside Station*
Location 309	1	☐	☐	*Inside Station*

Form 1014
Rev 2 July 2019

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MOAB UMTRA Project

TAC Air Radioparticulate Sampling Station Maintenance Record

Station Number:	Date:	Performed By:

Pump Serial Number:	Calibration Date:	Calibration Due Date:

Item	Yes	No	N/A	Comments
Station Undamaged?	☐	☐	☐	
Lock Properly Working?	☐	☐	☐	
Ground Around Station Base Free of Vegetation?	☐	☐	☐	
Station Properly Ventilated?	☐	☐	☐	
Station Properly Anchored?	☐	☐	☐	
Hoses Free of Kinks/Cracks?	☐	☐	☐	
Floor Free of Dust/Debris?	☐	☐	☐	
Electrical Sockets Damage Free?	☐	☐	☐	
Fan Working Properly?	☐	☐	☐	
Exhaust Hose Properly Connected?	☐	☐	☐	

SAMPLE

Additional Comments:

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Rev 0, February 2018

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Appendix B. Procedure for Sampling Radioparticulates Using a Continuous Duty, Low-volume Constant Flow Air Sampler (*continued*)

MOAB UMTRA Project

Radioparticulate Sampling Field Log

Month: ______________ Quarter/Year: ___________ Samplers: ____

Sample Location Number	Date	Pump Serial Number	Current Reading (hr)	Hour Meter Reset? (Y/N)	Flow Rate (lpm) Stop	Flow Rate (lpm) Start	Within Op Range? 54-66 lpm (Y/N)	Comments
0102-RP (On-site East)								
0105-RP (On-site Berm)								
0114-RP (Well Field)								
0117-RP (Handlebar Ranch)								
0118-RP (Arches National Park)								

SAMPLE

Notes:

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Rev 2, February 2020

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