REPORT

PROJECT RADIATION PROTECTION PLAN

Painted Desert Solar Project
Cameron, Arizona

Submitted to:

AES Clean Energy Development, LLC

Submitted by:

WSP USA Inc.

4840 Pearl East Circle, Suite 300W, Boulder, Colorado 80301

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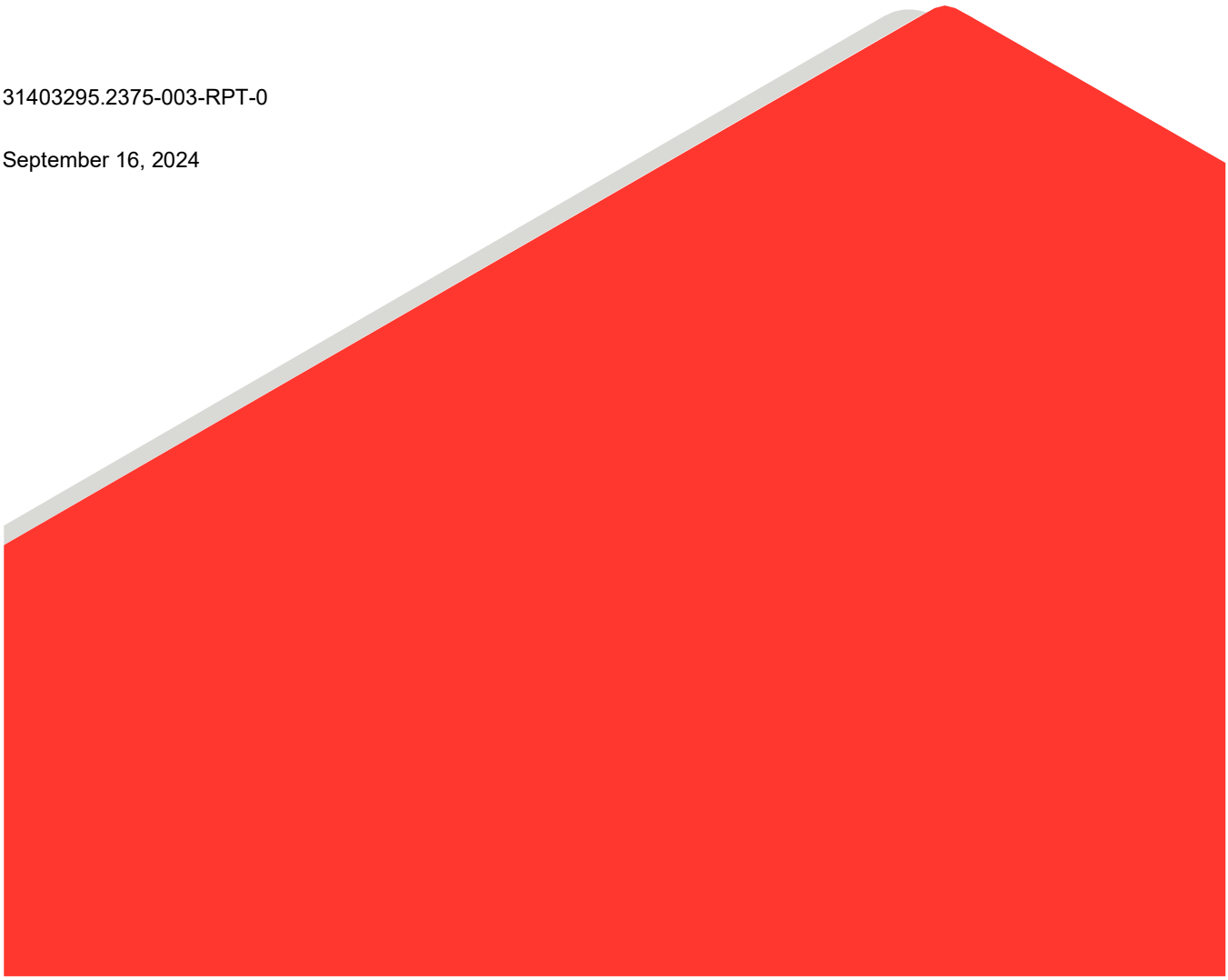

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ACRONYMS AND ABBREVIATIONS

AES	AES Clean Energy Development, LLC
ALARA	As Low as Reasonably Achievable
AUM	abandoned uranium mine
cm^2	square centimeters
cpm	counts per minute
DAC	Derived Air Concentration
DOE	Department of Energy
dpm	disintegrations per minute
EPA	US Environmental Protection Agency
GERT	General Employee Radiation Training
H&S	Health & Safety
HPT	Health Physics Technician
MDC	Minimum Detectable Concentration
mm	millimeters
mrem	millirem
mrem/yr	millirem per year
NIST	National Institute of Standards and Technology
NORM	Naturally Occurring Radioactive Material
NRC	US Nuclear Regulatory Commission
pCi/g	picocuries per gram
PPE	personal protective equipment
PRSO	Project Radiation Safety Officer
RAM	Radioactive Material
RMA	Radioactive Material Area
ROC	Radionuclides of Concern
RPP	Radiation Protection Plan
RWP	Radiation Work Permit
RWT	Radiation Worker Training
µCi/mL	microcurie per milliliter
µR/hr	micro Roentgen per hour
U-nat	natural uranium
WSP	WSP USA Inc.

1.0 PURPOSE AND SCOPE

1.1 Scope and Applicability

WSP USA, Inc. (WSP) prepared this Radiation Protection Plan (RPP) for the initial construction phase of Painted Desert Power Project, near Cameron, Arizona. This RPP is applicable exclusively to this project. The goal of this work scope is to support the construction of a solar power plant at the project location.

Project work will include:

- excavation of materials
- road construction
- running of electrical lines
- installation of wells
- dust suppression activities
- installation of supplemental structural supports

Source material in the form of natural uranium (U-nat) is expected to be present on the project site, particularly within the vicinity of the abandoned uranium mines (AUM) on the premises. Due to the project site being located on Navajo Nation Lands, the US Nuclear Regulatory Agency (NRC) will have regulatory authority on source materials generated on the site. AES Clean Energy Development, LLC (AES) identified a potential for workers to be exposed to Naturally Occurring Radioactive Material (NORM) during execution of this scope of work resulting in the need for measures to control and monitor workers' exposures to radiation originating from the source material on site.

1.2 Work Areas with Potential Radiological Impacts

This RPP establishes the control measures and radiological monitoring planned to support the execution of the scope of work. The April 30, 2020 Technical Memorandum by Haley & Aldrich, Inc. outlines areas with known elevated gamma readings on the project site, primarily located around the AUMs. Further areas with elevated gamma levels will be identified through ongoing surveys. Locations of the AUMs are shown in Figure 1.

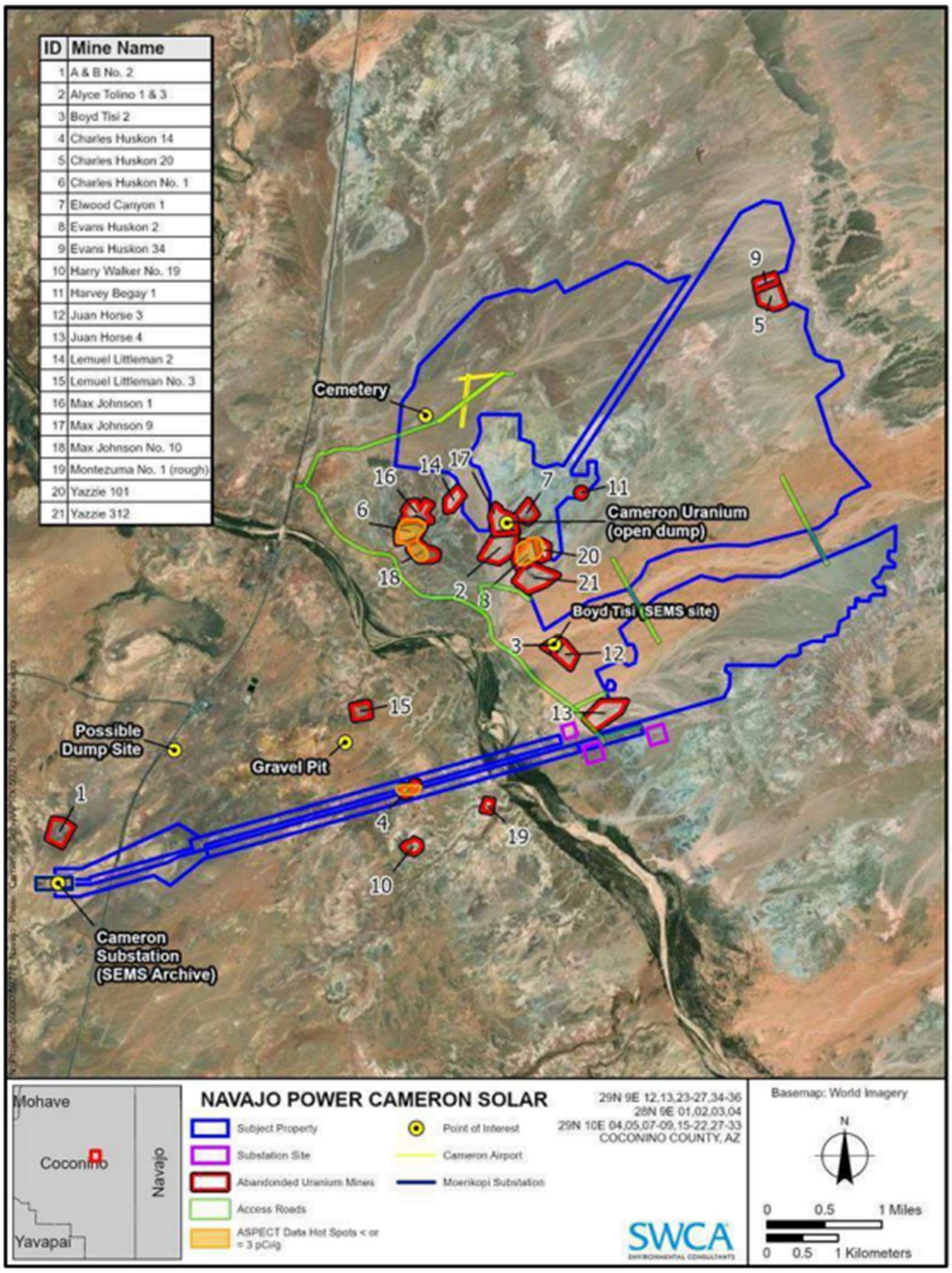

Figure 3: Location of Abandoned Uranium Mines

Construction activities will be conducted across the site. Depending on the proximity of the construction to the elevated areas, the probability of generating radioactive materials increases. The location of projected construction is included below in Figure 2. The areas where the construction scope of work is in proximity to areas with the highest potential for radioactive contamination are highlighted in red and pink.

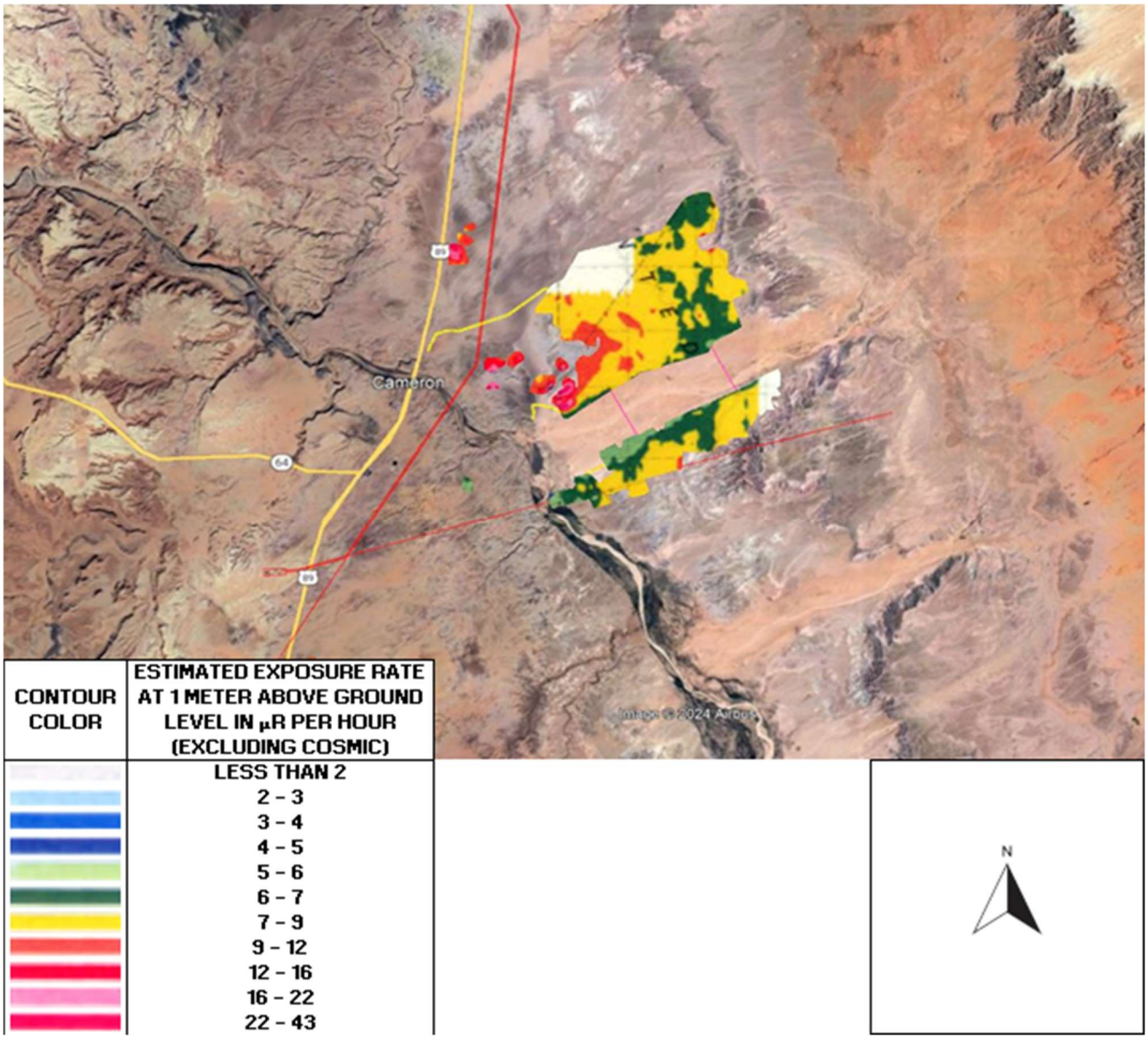

Figure 4: Project Construction Areas Overlayed with Aerial Gamma Survey Data

Intrusive subsurface activities are defined as those activities that could reasonably liberate volumetrically deposited radioactivity from radiologically impacted soils.

1.3 Objectives of the Project Radiation Protection Plan

The objectives of the RPP are to anticipate, identify, evaluate radiological hazards, and establish appropriate and commensurate hazard control and mitigation measures to ensure that the work is carried out within the bounds of applicable and established radiation protection standards and regulations.

The RPP establishes the project requirements for radioactive material control, monitoring for potential exposures to radiation, radiation protection of personnel involved in site work, measures to ensure the health and safety of the general public, and control measures designed to protect the environment during site activities.

1.4 Format of the Radiation Protection Plan

This RPP is intended for implementation in the field. As such, some sections may duplicate information that was previously presented. This is done with purpose so that most of the relevant information needed for a decision or explanation is contained within the section related to the inquiry.

2.0 RADIATION SAFETY POLICY

2.1 ALARA – As Low as Reasonably Achievable

The As Low as Reasonably Achievable (ALARA) philosophy is based on the supposition that radiation dose increases one's risk of cancer – the higher the dose, the higher the risk. ALARA is an approach to radiation protection that seeks to manage and control individual and collective dose to people and the environment to levels that are as low as reasonable, considering social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit, but a philosophy designed to maintain radiation doses as far below the applicable limits as is reasonably achievable. This RPP will use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to control radiation doses to levels that are ALARA and provide the tools to ensure that no exposure to workers will occur without the expectation of an overall benefit from the activity.

Radiation exposures to workers and members of the public arising from the execution of this project are estimated and projected to be well below the applicable regulatory limits and the project ALARA goal. Therefore, a formal, documented ALARA program is not warranted. However, training will include discussion on ALARA principles and their application.

2.2 RPP Related Approved Plans and Procedures

- Painted Desert Excavation Plan
- Project Specific Operating Procedures

3.0 RESPONSIBILITIES AND LINES OF AUTHORITY

3.1 Project Radiation Safety Officer

The Project Radiation Safety Officer (PRSO) is the individual who has been designated as having the primary responsibility for implementing the RPP. The PRSO has a direct reporting line to the project manager making him responsible to the project for the implementation of the radiological controls described in the approved RPP as they relate to the execution of the project scope of work and for guidance to the project management team.

The PRSO:

- Is responsible for aspects of the day-to-day radiological operations and activities conducted at the site.
- Works with the site safety personnel to coordinate RPP requirements and radiation protection procedures with other applicable Health & Safety (H&S) requirements.
- Addresses radiological conditions that may require a revision to the RPP.
- Will be on site full time for field activities that pose the risk of exposure to radioactive materials.
- Conducts site-specific radiation safety training and ensures that field personnel have completed required radiation safety training.
- Ensure subcontractor compliance with the RPP.
- Stopping work if unacceptable health or safety conditions exist and taking necessary action to re-establish and maintain safe working conditions.
- Maintains control of radiological materials (e.g., radioactive check sources, radioactive waste).
- Recommend corrective actions for identified deficiencies for radiological issue in coordination with the project manager and H&S personnel.
- Oversee radiological corrective actions and track any radiological safety and health deficiencies to ensure they are not repeated.
- Ensures field documentation is completed daily and reviewed.
- Completes supervisory review, assessment of the data to evaluate the radiological conditions and verify that controls, mitigation methods, and monitoring remain appropriate.
- Will have HAZWOPER training and radiation training equivalent to Department of Energy (DOE) Radiation Worker II.

3.2 Health Physics Technician(S)

Health Physics Technician(s) (HPT) are responsible for assisting the PRSO in implementing the RPP-specific duties of the HPT that include:

- Performing radiological H&S monitoring in accordance with the RPP and at the direction of the PRSO.
- Ensuring that radiological field data and activities are documented and recorded using approved forms.
- Presenting documented records of radiological field data and activities to the PRSO for review and approval.
- Stopping work if unacceptable health or safety conditions exist and taking necessary action to re-establish and maintain safe working conditions.
- Coordinating, as necessary, with the PRSO regarding site-specific radiation protection procedures and issues.

- Implementing the RPP and making PRSO-approved adjustments to ensure worker, visitor, public and environmental exposures are maintained ALARA.
- Assisting with the delivery of site-specific radiation safety training.
- Will have HAZWOPER training and radiation training equivalent to DOE Radiation Worker II.

3.3 Site Workers

Site workers are AES employees and its subcontractors who perform work on the project site. Site workers who perform work in areas posted for radiological controls, who directly handle radioactive materials, or who may receive exposures in excess of that permitted for a member of the public (Section 3.4) are classed as Occupational Radiation Workers and must be trained accordingly (Section 4.0). Site workers will ensure they have read, understand, and will comply with all applicable radiation safety documents including the RPP, Radiation Work Permits (RWPs) and directions of the project radiological protection staff (PRSO and HPTs). They shall notify the health physics staff of conditions or concerns that may impact radiation protection.

3.4 Members of the Public

A “member of the public” in the context of this RPP, and the associated radiation protection standards, means any individual who has not received the training for or accepted the responsibility to be designated as an occupational radiation worker. In order to receive occupational radiation doses in excess of that permitted for any member of the public (100 millirem [mrem] in one year), one must be trained as an occupational radiation worker (Section 4.2). Persons who do not receive Project-specific Radiation Safety Training are considered “members of the public.”

4.0 RADIATION SAFETY TRAINING

Training is an essential mitigation tool for managing and controlling workplace hazards. This is especially true for radiation hazards as most workers are infrequently involved in work tasks where they encounter radioactive materials and the potential for radiation exposures. For this project, there are two levels of project radiation safety training. General Employee Radiological Training (GERT) is for visitors or suppliers who require unescorted access to the work site as well as site personnel that will not be directly exposed to radioactive material. Project-specific Radiation Worker Training (RWT) is required of those who directly handle radioactive material or whose work requires unescorted access to areas that are posted and controlled for radiation protection purposes. All radiological training will be conducted by the Health Physics Staff and documented.

4.1 General Employee Radiological Training

GERT will be provided to personnel who perform work on the project property. It is designed to provide awareness of the radiological hazards that could be encountered on the site and how those hazards are communicated. GERT is an awareness training that provides the level of knowledge that is required for a non-radiation worker to work safely on a site where they may encounter radiological controls such as postings, signs, labels.

4.2 Project-Specific Radiation Worker Training

Project-specific RWT will be provided to individuals who will be performing work under a RWP, those who directly handle radioactive material, or whose work requires unescorted access to areas that are posted and controlled for radiation protection purposes.

If the trainee has not had a practical exam or on-the-job training, it will be done before this training is considered complete.

5.0 RADIOLOGICAL HAZARD/RISK ANALYSIS

An important element of the RPP is the radiological hazard/risk analysis. The radiological hazard/risk analysis is designed to assess the magnitude of the exposures that might reasonably be expected to occur given WSP's understanding of the radionuclides of concern, the historical radiological data provided, and the activities that will occur in the execution of the scope of work. The objective of the radiological hazard/risk analysis is to identify, anticipate, and project radiological health and safety hazards that may be incurred in performing the work, such that appropriate monitoring and mitigation measures can be prescribed.

584 picocuries per gram (pCi/g) U-nat were identified as the concentration of source material which has the potential to result in exposures to site personnel of over 100 millirem per year (mrem/yr) when proper material storage and effective dust suppression are employed.

5.1 Radionuclides of Concern

The assumption is made that U-nat and its progeny will be the primary Radionuclides of Concern (ROC) due to the proximity to several AUMs, however, characterization samples will be taken at the site to the proper waste stream and disposal options of wastes generated by the site and the control levels need for these materials. The selected ROCs will be revisited if laboratory analytical results indicate that additional isotopes which pose a significant risk to site personnel are present.

5.2 Radiological Limits and Thresholds

Federal Radiation Limits to Occupational Workers and Members of the Public are published in 10 CFR 20 Subparts C and D and are summarized in Table 1. Surface Contamination Limits are published in 10 CFR 835 Appendix D.

Table 6: Whole Body Radiation Limits

Exposed Person Category	Annual Dose Limit (NRC) (mrem)	Project ALARA Goal (mrem)	Part of Body Exposed
Occupational Radiation Workers - General	5,000	100	Whole Body (TEDE)
Embryo Fetus - Declared Pregnant Occupational Radiation Worker	500	50	Internal + External (evenly distributed throughout gestation)
Occupational Exposed Minor[1]	100	N/A1	Whole Body
Member of the Public	100	100	Whole Body

[1]Minors, persons under the age of 18, will not be authorized to work on this project.

5.2.1 External Gamma Radiation Limits/Thresholds

- Restricted Area – Areas in which a member of the public (anyone not trained as an occupational radiation worker) could receive in excess of 2 mrem in 1 hour from external radiation must be controlled to ensure that the annual public dose limit is not exceeded. This RPP assumes that all AUMs will be marked as restricted areas.
- "Radiation Area" posting – Areas in which a person could receive in excess of 5 mrem in 1 hour from external radiation must be demarcated and posted.

5.2.2 Inhalation of Radioactivity Limits/Thresholds

The primary source of internal exposure on the project will be through inhalation of radioactive particles which become airborne.

- "Airborne Radioactivity Area" posting – Areas in which airborne radioactive materials exist in concentrations that:
  1) exceed the Derived Air Concentration (DAC) limits, or
  2) would result in an individual present in the area without respiratory protection exceeding 12 DAC-hours (30 mrem) in 1 week.

Due to work at this project taking place almost exclusively outdoors and the anticipated relatively low concentrations of source material, needing to establish an Airborne Radioactivity Area is considered unlikely.

Table 7: Airborne Radioactivity Concentration Limits

ROC	Inhalation ALI (µCi)	DAC (µCi/mL)	Air Effluent Limit (µCi/mL)
U-nat	5E-2	2E-11	9E-14

µCi/mL – microcurie per milliliter

Personnel monitoring – personnel monitoring for exposure to airborne radioactivity is required when it is likely that a worker will receive in excess of 10% of the annual dose limit (500 mrem, 200 DAC-hours) in 1 year.

5.2.3 Ingestion of Radioactivity Limits/Thresholds

Table 8: Oral Ingestion Limits

ROC	Oral Ingestion ALI (µCi)
U-nat	1E+1

Personnel monitoring – personnel monitoring for exposure to ingested radioactivity is required when it is likely that a worker will receive in excess of 10% of the annual effective dose equivalent limit (500 mrem, 10% of the ALI) in 1 year.

5.2.4 Surface Contamination Limits/Thresholds

Table 9: Surface Contamination Limits

Nuclides	Average	Maximum	Removable
U-nat, U-235, U-238, and associated decay products	5,000 disintegrations per minute (dpm) α/ 100 cm^2	15,000 dpm α/ 100 cm^2	1,000 dpm α/ 100 cm^2

cm^2 – square centimeters

- Removable contamination can be thought of as the amount of radioactive material that comes off the surface of an object when it is wiped with an absorbent paper with moderate pressure.
- Measurements of average contaminant should not be averaged over more than 1 square meter. For object of less surface area, the average should be derived for each such object.
- The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified.
- The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper (e.g., a smear or swipe), applying moderate pressure, and assessing the amount of removable radioactive material on the wipe with an appropriate instrument of known efficiency (Section 7.4.1.2). When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally, and the entire surface should be wiped.

5.2.5 ALARA Goals

The project ALARA goal for site workers has been set at 100 mrem/yr. This is a highly conservative value and is a fraction of the allowable limit for Occupational Radiation Workers (Section 5.2).

5.3 Historical Radiological Data

The historical data considered in the radiological hazard/risk analysis were provided by US Environmental Protection Agency (EPA), Stantec, and Haley & Aldrich, Inc and show several areas with known elevated gamma levels. The previously identified elevated areas around the AUMs shall be set up as restricted areas if they have not been already.

5.4 Need for Radiological License

This RPP is written under the assumption that there will be no need for a specific radiological materials license.

5.5 Project Work Activities

As described in the sections below, project work activities will include:

- soil excavation
- road construction
- running of electrical lines
- installation of wells
- dust suppression activities.
- installation of supplemental structural supports

The work activity with the highest potential to expose workers to radioisotopes will be the excavation of material in areas with known elevated gamma levels (Figure 2 - Project Construction Areas Overlayed with Aerial Gamma Survey Data), additional areas with elevated gamma levels may be identified through ongoing gamma surveys during the course of construction. This work will be performed under the guidance of an RWP with real time monitoring from HPTs. Soil samples will be collected in these elevated areas when material that is suspected of being over 584 pCi/g U-nat is disturbed. The exact location of the samples will depend on ground level gamma scans and real time coverage surveys by HPTs during excavation.

Work performed outside of known areas with elevated gamma levels will have a lower potential to encounter radioactive materials. Best practice to minimize potential worker exposures will be periodic monitoring from HPTs during excavation in these areas.

5.5.1 Soil Excavation

Previous survey efforts have identified areas of the project site with elevated gamma readings. Although the levels outside of the boundaries of AUMs are likely not high enough to cause external exposures over the ALARA goal, if inhaled, these materials could have the potential to cause exposures over 100 mrem/year.

To mitigate the risk of source material becoming airborne during excavation activities, dust suppression will be utilized.

Excavation being performed in areas with known elevated gamma levels will be controlled by an RWP and require real time HPT coverage as well as work zone air sampling.

Soil samples collected for analysis will be controlled as Radioactive Material (RAM) unless screening efforts indicate they contain less than 584 pCi/g U-nat.

There is potential to encounter significant concentrations of source material in areas which have not been identified as having elevated gamma levels. Although the expected radiological hazard in these areas is lesser than that of areas with known elevated gamma levels, periodic HPT coverage will be performed as a best management practice to ensure that soil with concentrations of over 584 pCi/g is not accidentally handled.

5.5.2 Dust Suppression

The main inhalation hazard for the project will come from dry material with elevated levels of source material becoming respirable. To minimize this hazard, dust suppression will be done with the use of water trucks. Due to the prevalence of uranium and other naturally-occurring radioisotopes in the area, there is a chance for any wells dug on the project site to have significant concentrations of radioisotopes which could present a hazard to personnel on site when this well water is used for dust suppression.

Environmental sampling will ensure that the water being used for dust suppression is not causing excessive exposure to site workers. While the details of well water sampling is beyond the scope of this document, it is assumed that the well water used for dust suppression will be periodically tested for ROCs.

Well water shall not be for human consumption under any circumstance.

6.0 CONTROL OF RADIOLOGICAL HAZARDS IN WORK ZONES

The majority of the project work will be done outside the areas with known elevated gamma levels, where residual radioactivity is not expected to be a primary concern. The work areas presenting the highest hazard for exposure are:

- Work around the areas directly outside of boundaries for AUMs.
- Intrusive subsurface activities taking place in areas which have been identified as having elevated gamma levels.

The PRSO will establish radiological control measures through the use of RWPs when work in areas with elevated radiological hazards is performed.

No work will be performed inside the boundaries of AUMs.

6.1 Demarcation and Posting

The following types of areas shall be clearly marked. Site personnel should be familiar with all radiological signage from the GERT:

- AUM Signs
- Radioactive Material Areas (RMAs)
- Restricted Areas

These signs shall clearly communicate the level of radiological hazard the area presents. It is not anticipated that areas will need to be posted as radiation areas or contamination areas. If changing conditions indicate that these postings are required, additional training of site personnel will be needed. Additional signage will be posted when required by the RPP, for example, stockpiling excavated material that requires storage inside an RMA.

6.1.1 Abandoned Uranium Mines

The AUMs located in the vicinity of the project site will be clearly marked with the following sign or equivalent:

AUMs on site property shall be marked and delineated so personnel cannot unknowingly access areas within 100 feet of them. If AUMs are directly adjacent to the property, but not on it, the immediate path to the AUM shall be clearly marked to keep personnel at least 100 feet away from AUMs. AUMs shall not be entered by site personnel outside of emergency situations.

6.1.2 Radioactive Material Areas

RMAs will be clearly marked on all sides with signage posted at least every 50 feet. The following RMA sign or equivalent shall be used:

RMAs should only be entered by personnel who have completed RWT (Section 4.2). RMAs shall be surveyed on a monthly basis, at a minimum, to ensure that dose rates at the boundary are less than 50 micro Roentgen per hour (µR/hr). If deposition of contaminated soils causes boundary conditions to exceed the 50 uR/hr threshold, the material inside must either be disposed, or the boundary must be expanded until activity levels are below the threshold. Personnel leaving an RMA should, at a minimum, have their hands and feet surveyed.

6.2 Radiation Work Permitting

The activities identified in Section 6.0 present a greater radiological hazard and will require the creation and use of an RWP approved by the PRSO. These RWPs shall cover, at a minimum:

- RWP number
- Radiological Source (Alpha or Beta/Gamma)
- Airborne Radioactivity
- Surface Contamination

- Radiation Levels
- Pre-Job Survey Information
- Personal Protective Equipment (PPE)
- Respiratory Protection
- Training Level
- Dosimetry
- Monitoring
- Radiological Hold Points
- Special Instructions
- Frisking Requirements

The RWP will have a sign in and sign out sheet to show who is currently working under the RWP. This can be electronic or a physical sheet. See Attachment A for an example RWP. Workers shall have appropriate task-specific training on the RWP that includes the following.

- Physical hazards of the job.
- Engineering controls.
- Instrumentation to be used.
- Limits and radiological hazards identified above.

6.3 Personal Protective Equipment

The RWP will specify the required PPE for each job. Activities which are not covered by an RWP will not have a radiological PPE requirement, however H&S PPE may still be required.

6.4 Radiological Monitoring, Sampling, and Surveys

6.4.1 Work Zone Area Monitoring

The RWP will specify the required air sampling for each job, if necessary.

Work Zone air samplers (Section 7.5.1) shall be set up in the general vicinity of the work area, not upwind of the work, and ran at a rate and duration at which the Minimal Detectable Concentration (MDC) for air sample counting will achieve 10% of the DAC.

If the RWP requires Work Zone air sampling, the sampler shall be operated for the entire duration of the associated work. If the air sampler stops functioning properly, work will be put into a safe condition and paused until air sampling has resumed.

6.4.2 Equipment and Material Monitoring

Equipment and material monitoring requirements should be included in the RWP that covers the work. Equipment which cannot be surveyed below the release limits (section 5.2.4) shall be stored in an RMA until it has been decontaminated and release surveys have been completed by an HPT and reviewed. Highly contaminated (10 x the release limit) portions of equipment shall be wrapped until decontamination is performed to limit the spread of contamination. Surveys for equipment leaving restricted areas shall be documented and retained for the life of the project.

Decontamination is a process used to reduce, remove, or neutralize radiological or chemical contamination to reduce the risk of exposure. Decontamination may be accomplished by cleaning or treating surfaces to reduce or remove the contamination. This can be achieved through the use of cleaning products, pressurized water, hand tools, etc. Care must be taken not to create airborne radioactive particles during decontamination; performance of this process should be controlled under an RWP (Section 6.2 of RPP).

Material monitoring will include excavation control surveys performed by HPTs in the field as well as soil samples sent to an off-site lab for analysis. Excavation control trigger levels (described in the Painted Desert Excavation Plan) will determine if material needs to be segregated and controlled as RAM until soil samples are analyzed. If soil sample results are less than 584 pCi/g U-nat, the applicable material may be removed from the RMA and treated as if it is not radioactive material. The Excavation Plan describes material monitoring, both excavation control surveys and soil sampling.

6.4.3 Personnel Monitoring

Radiation dosimetry records generated as a result of personal exposure monitoring are sensitive and private information that are subject to the control and disclosure restrictions defined in the Federal Privacy Act. Personal exposure monitoring data MAY NOT be disclosed to anyone without a right to know or without written consent for the monitored individual.

6.4.3.1 External Gamma Radiation

Occupational Radiation Workers who are approved for unescorted access to demarcated and posted work zones controlled for radiological purposes (e.g. RMAs) will be monitored for external gamma radiation exposure by a personal radiation dosimeter when performing tasks where a dosimeter is required. Results from the measurement of external gamma radiation dose will be recorded in units of mrem and attributed to the individual(s) dose of record. Visitors, or others requiring limited and infrequent access to the areas, are not required to have a personal radiation dosimeter provided that:

- they are escorted by site personnel who have completed Project-specific RWT (Section 4.2).
- the escort wears a personal radiation dosimeter.
- the external gamma exposure rate in the work area is less than 2 mrem/hr (i.e., they are not expected to receive more than 100 mrem in 1 year from exposures in this area).

Personal radiation dosimeters, when issued, shall be worn at all times when workers enter areas demarcated and posted for radiological purposes. Personal radiation dosimeters shall not be worn off site. When a personal radiation dosimeter is not in use, it shall be stored in the designated location on the project site. The designated storage location shall be equipped with a “control” dosimeter. Control dosimeters are used to subtract background radiation from total dose in order to generate the occupational dose of workers. Control dosimeters are not to

leave their designated location until they are collected for analysis. Best practice is to order at least two control dosimeters should a worker need to have their dosimeter analyzed off-cycle from the remaining dosimeters.

If there is reason to believe that any site personnel or member of the public may have exceeded the project ALARA goals (section 5.2.5), immediately notify the PRSO and project management. At a minimum, this exceedance should be discussed during the annual program audit and any other program reviews to attempt to determine the root cause and if corrective action is necessary.

If there is reason to believe that any site personnel or member of the public may have exceeded regulatory dose limits (section 5.2) a report should be filed to the NRC according to 10 CFR parts 20.2202 and 20.2203. The PRSO and project management should be immediately notified of any such exposures.

6.4.3.2 Inhalation Dose Monitoring

Work zone air sampling will be performed in accordance with Section 6.4.1.

The results from work zone air samples will be used to assess individual workers' exposures to radiation doses from the inhalation of airborne radioactive particulates. These samples will be counted using the alpha/beta sample counters identified in (Section 7.5.1). Results from the measurement of radioactivity on work zone samples will be recorded in units of DAC-hours and attributed to the individual(s) dose of record.

It is worth noting that, in practice, interferences from radon progeny may be present and may be evaluated using subsequent counts of the same samples. Air samples may be allowed to decay for up to three days before counting.

If there is reason to believe that any site personnel or member of the public may have exceeded the project ALARA goals (section 5.2.5), immediately notify the PRSO and project management. At a minimum, this exceedance should be discussed during the annual program audit and any other program reviews to attempt to determine the root cause and if corrective action is necessary.

If there is reason to believe that any site personnel or member of the public may have exceeded regulatory dose limits (section 5.2) a report should be filed to the NRC according to 10 CFR parts 20.2202 and 20.2203. The PRSO and project management should be immediately notified of any such exposures.

6.4.4 Environmental Monitoring

The object of environmental monitoring for this project will be to ensure that radioactive particles which could contaminate areas outside of the project or expose the public to doses above 100 mrem/yr are not exceeding the effluent limits at site boundaries. Low volume air samplers (Section 7.5.1) will be set up around the site boundary and ran at a rate and duration at which the MDC for air sample counting will achieve 10% of the effluent limit. Air samples will be collected on a weekly basis and allowed to decay for up to 1 week before counting to eliminate Radon progeny. At a minimum, four low volume air samplers should set up, one on each side of the project boundary and be running at all times when the site is active. If, for any reason, less than four environmental air samplers are running at one time, all intrusive work that could liberate radioactive particles must cease until the air samplers are restored to working order.

If there is reason to believe that effluent radioactivity limits have exceeded the values in Section 5.2.2, a report should be filed to the NRC according to 10 CFR part 20.2203.

7.0 RADIOLOGICAL INSTRUMENTATION

The selection of instrumentation to be used for making radiological measurements in support of radiation protection are described below. The intent is not to specify make and model of instrument or sampling device, but rather the identify the class and capability/characteristics of a class of instrument that is necessary to achieve the measurement objectives and detection sensitivities desired for the project. Where a make and model of instrument is identified in the sections that follow, it should be understood to be “or functionally equivalent” in kind and capability.

7.1 External Gamma Exposure Rate

External gamma exposure rate measurements will be made with portable radiation survey instruments designed to be sensitive gamma radiation levels in the range of typical background radiation levels (~5-10 micro µR/hr).

7.1.1 Instrument Types

For this project, external gamma exposure rate measurements will be collected using an instrument comparable to:

- Thermo Fisher Scientific, FH40 G-L
- Thermo Scientific (Bicron), MicroRem
- Ludlum Model 19

7.1.2 Calibration and Performance Testing

Portable radiation survey instruments designed to measure external gamma exposure rate levels will be calibrated annually. Calibration will be performed in accordance with ANSI N323 (ANSI 2014) and using National Institute of Standards and Technology (NIST) traceable standards, or equivalent. A calibration label shall be affixed to the instrument which clearly indicates the calibration date or due date. Certificates of calibration shall be made part of the project records file and a copy of the certificate maintained on the project site.

Performance tests of radiological instruments will be conducted on a daily basis. Daily performance tests are not required on instruments that are not used that day. Performance test results are deemed satisfactory if the instrument’s response is shown to be within ±20% of the expected response. Instruments that do not meet performance test criteria, are found to be out of calibration, or are defective, will be removed from service until repaired and/or calibrated. The results of these checks will be recorded in a daily source check log by the instrument operator and will be maintained on site.

7.1.3 Detection Sensitivity

The published detection sensitivity for the Thermo Fisher FH40 G-L and Ludlum Model 19 is 1 µR/hr.

The published detection sensitivity for the Thermo Scientific (Bicron) is also ~1 µrem/hr.

7.2 Cumulative External Gamma Exposure/Dose

Cumulative external gamma exposure/dose measurements will be made with a NVLAP-certified dosimetry device/service provider.

7.2.1 Instrument Types

For this project, cumulative external gamma exposure/dose measurements will be collected using a dosimeter comparable to:

- Mirion TLD
- Mirion InstaDose

7.2.2 Calibration

Not applicable.

7.2.3 Detection Sensitivity

The published detection sensitivity for the Mirion TLD radiation dosimeters is 1 mrem.

The published detection sensitivity for the Mirion InstaDose radiation dosimeters is 3 mrem.

7.3 Ground Level Gamma Scans

Ground level gamma scan measurements provide for a qualitative means to detect variances, either in space or over time, in gamma emission rates from the surface of a soil being measured. The degree of variability is qualitatively interpreted by the HPT as an indicator of the potential variance in the concentration of radioactivity concentration in the soil. Other factors also contribute to potential variability including the geometry of the measurement. Nonetheless, this measurement serves as an early qualitative indicator of the potential presence of unexpected concentrations of radioactivity in soil and are used as a sentinel for the PRSO to assess and evaluate the control measures in place. Ground level gamma scan trigger levels are discussed in detail in the Project Excavation Plan.

7.3.1 Instrument Types

For this project, ground level gamma scan measurements will be collected using an instrument comparable to:

- Ludlum Model 44-10

7.3.2 Calibration

Portable radiation survey instruments designed to measure gamma count rate levels will be calibrated annually. Calibration will be performed in accordance with ANSI N323 and using NIST traceable standards, or equivalent. A calibration label shall be affixed to the instrument which clearly indicates the calibration date or due date. Certificates of calibration shall be made part of the project records file and a copy of the certificate maintained on the project site.

Performance tests of radiological instruments will be conducted on a daily basis. Daily performance tests are not required on instruments that are not used that day. Performance test results are deemed satisfactory if the instrument’s response is shown to be within ±20% of the expected response. Instruments that do not meet performance test criteria, are found to be out of calibration, or are defective, will be removed from service until repaired and/or calibrated. The results of these checks will be recorded in a daily source check log by the instrument operator and will be maintained on-site.

7.3.3 Detection Sensitivity

The published detection sensitivity for the Ludlum 44-10 detector is 900 counts per minute (cpm) per µR/h.

7.4 Contamination

Contamination can be measured in one of two ways. Total surface radioactivity is measured with direct reading instrumentation. The removable portion of surface deposited activity can be measured via a wipe sampling technique. Wipe samples are then measured using a wipe/air sample counter. This section describes instruments used to make direct measurements of “total” contamination for purposes of assessing potentially contaminated surfaces, and for screening of personnel and equipment for surface contamination upon exit from work zones demarcated and posted for radiological purposes, and “removable” surface deposited activity for purposes of assessing the amount of removable radioactivity deposited on a surface.

7.4.1 Instrument Type(s)

7.4.1.1 Instrument Types(s) – Direct Measurements

For this project, total surface deposited radioactivity measurements will be collected using direct reading instruments comparable to:

- Ludlum Model 2224 w/ Ludlum 43-93
- Ludlum Model 12 w/ Ludlum 44-9
- Thermo Scientific FH40 w/ FHZ 382

7.4.1.2 Instrument Type(s) – Removable Measurements/Air Samples

For this project, removable surface deposited radioactivity measurements will be collected using 47 millimeters (mm) diameter, Whatman, Grade 42 (or equivalent) wipe sample media. The surface wiped is nominally 100 cm^2. After sample collection, the wipe sample is “counted” for its radioactivity using a scaler-based measurement system equipped to measure both alpha and beta activity. Air sample media will be counted in the same instruments. For this project, the radioactivity measurement of the wipe sample will be made using a scaler instrument comparable to:

- Ludlum Model 2929 w/ Ludlum 43-10-1 detector
- Ludlum Model 3030

7.4.2 Calibration and Performance Testing

Portable radiation survey instruments designed to measure surface deposited radioactivity will be calibrated annually. Calibration will be performed in accordance with ANSI N323 and using NIST traceable standards, or equivalent. A calibration label shall be affixed to the instrument which clearly indicates the calibration date or due date. Conventional instruments, such as the Ludlum Model 12 w/44-9 detector, are calibrated as a pair and must remain associated with one another throughout the calibration period. Modern “smart” instruments, such as the Thermo Scientific FH40 GL w/FHZ 382 are designed such that the instrument and detector can be interchanged without voiding the calibration. Where smart instruments are used, the calibration of the instrument and detector must be verified individually. Certificates of calibration shall be made part of the project records file and a copy of the certificate maintained on the project site.

Performance tests of radiological instruments will be conducted on a daily basis. Daily performance tests are not required on instruments that are not used that day. Performance test results are deemed satisfactory if the instrument’s response is shown to be within ±20% of the expected response. Instruments that do not meet performance test criteria, are found to be out of calibration, or are defective, will be removed from service until

repaired and/or calibrated. The results of these checks will be recorded in a daily source check log by the instrument operator and will be maintained on-site.

The evaluations below are provided to show the instrumentation selected for surface deposited radioactivity surveys have an appropriate detection limit for use in decision-making for radiation protection purposes. The scope of work being performed under this RPP is limited to the collection of data for radiological protection and does not address final status surveys.

The radiological release of equipment brought into a work zone controlled for radiological purposes will be based on scans, static counts, and wipe samples. Portable instruments used for releasing equipment will have an *a priori* MDC no greater than 50% of the applicable surface clearance limits provided in Section 7.5.1. In practical terms, the goal to have MDC that is not more than 50% of the decision limit is to ensure that the inherent measurement uncertainties encountered in the field, most of which cannot be controlled or quantified, do not render the measurements questionable for radiation protection decision making.

7.4.2.1 Detection Sensitivity – Direct Measurements

To assess the detection sensitivity, the static MDC equation from NUREG-1507 is used (Equation 3-11 of NUREG-1507).

$$MDC = \frac{3 + 3.29\sqrt{(R_b)(T_{s+b})\left(1 + \frac{T_{s+b}}{T_b}\right)}}{(K)(T_{s+b})}$$

where:

b R_b is the background count rate (cpm),

c T_{s+b} is the sample counting time (minutes),

d T_b is the background counting time (minutes),

e K is the proportionality constant. K is the product of the following factors:

- K_1 is the instrument counting efficiency,
- K_2 is the source efficiency,
- K_3 is the surface efficiency, and
- K_4 is the probe geometry correction factor.

7.4.2.2 Detection Sensitivity – Removable Activity Measurements

To assess the *a priori* detection sensitivity for measurements of removable surface radioactivity, the static MDC equation from NUREG-1507 is used (Equation 3-11 of NUREG-1507). Again, a set of reasonable, yet conservative values will be used for each of the factors in the equation for measurements of wipe samples for removable surface radioactivity:

$$MDC = \frac{3 + 3.29\sqrt{(R_b)(T_{s+b})\left(1 + \frac{T_{s+b}}{T_b}\right)}}{(K)(T_{s+b})}$$

where:

- R_b is the background count rate (counts per minute [cpm]),
- T_{s+b} is the sample counting time (minutes),
- T_b is the background counting time (minutes),

- K is the proportionality constant. K is the product of the following factors:
  - K_1 is the instrument counting efficiency,
  - K_2 is the source efficiency,
  - K_3 is the surface efficiency, and
  - K_4 is the probe geometry correction factor.
- K is the proportionality constant which includes instrument counting efficiency, source efficiency, surface efficiency, and a probe geometry correction factor. K is the product of each of these efficiency elements.

7.5 Area Air Sampling

When loose or unsealed radioactive material is handled, there is a potential for workers to receive internal exposures from inhalation of loose airborne radioactive material. Airborne radioactivity in air in the general work area is measured by collecting a sample of the suspended airborne particulates from a specified volume of air from the work area on a particulate filter and then measuring the amount of particulate radioactivity collected on the sample filter medium.

7.5.1 Instrument Type(s)

Area air sampling will be performed using one of two air sampling pumps, depending on the sampling objective. Time-weighted average air sampling designed to characterize environmental air quality will be collected with a low-volume sampler such as the LV-1 sample pump housed in “bird cage” or other protective housing. Work Zone air sampling designed to measure radioactivity concentration in a specified work area will be collected using a Nuvia Tech EGS or equivalent. Air samples will be collected on membrane filters with 5-micron pore size (comparable to the Millipore AW-19 filter) to improve the alpha signal degradation associated with filter “burial losses.”

After sample collection, the sample filter media is “counted” for its radioactivity using a scaler-based measurement system equipped to measure both alpha and beta activity. For this project, the radioactivity measurement of the air sample filter will be made using a scaler instrument comparable to:

- Ludlum Model 2929 w/ Ludlum 43-10-1 detector
- Ludlum Model 3030

7.5.2 Calibration and Performance Testing

Air samplers will be calibrated annually. Calibration will be performed in accordance with ANSI N323 and using NIST traceable standards, or equivalent.

7.5.3 Detection Sensitivity

Air sample counting sensitivity is based off a variety of factors, the largest of which are counting efficiency, background count rate, and total air volume sampled, however air sampling counting instruments should be capable of low detection limit in order to reduce counting time.

7.6 Radioactive Sources

The following types are sealed source are permitted solely for the purpose of response checking instruments on the project and are described on Table 5. Sources are not to be used for any other purpose.

Table 10: Source Activity Limits

Isotope	β/γ	Maximum Activity (µCi)
Tc-99	β	10
Cs-137	β / γ	10

8.0 WASTE MANAGEMENT

It is critical that non-impacted material is not comingled with wastes containing greater than 584pCi/g U-nat.

8.1 Non-Impacted Waste

No specific radiological controls are required for wastes that do not have radiological concerns.

8.2 Source Material Waste

Material which has been identified as having the potential to cause exposure of greater than 100 mrem/yr to personnel shall be controlled as RAM and stored inside an RMA until it is processed for disposal. Material which meets this classification should be containerized to avoid the possibility of spreading and exposing site personnel.

Although there are no regulatory requirements for disposing of this material in a certain time frame, stockpiling of materials could potentially cause increased exposure rates at the level where workers could be exposed to over 100 mrem/yr. Materials should be disposed of before this threshold is met. The exposure rate at the boundary of RMA's should not exceed 50 µR/hr over background. If exposure rates are higher than 50 µR/hr above background, material should be disposed of, or the RMA boundary should be expanded until dose rates drop below 50 µR/hr above background. Equipment which was not able to be surveyed below the release limits (Section 6.4.2) shall be controlled as RAM and stored inside an RMA until it is decontaminated or processed for disposal.

Soil samples confirmed to be over 584 pCi/g U-nat will be disposed of as RAM if they are returned to the project.

Materials which have been identified as having the potential to cause exposures over 100mrem/yr to site workers shall not be knowingly mixed with materials containing less than 584 pCi/g U-nat.

9.0 EMERGENCY RESPONSE

Project emergency response procedures are contained in the Health and Safety Plan. The radiological hazards/risks at this project are very low. An emergency response for any life or safety hazard that may arise should never be delayed or foregone because of a radiological work control. For example, should an emergency situation arise that requires a person to immediately evacuate a Work Zone that is controlled for radiological purposes, the indicated emergency response action should take precedent over a radiological control requirement that would ordinarily require that personnel frisk upon exit. The evacuation order overrides the radiological control requirement.

If radiological controls are overridden in an emergency response situation, the PRSO should be notified immediately. The PRSO should determine the reasonable and appropriate recovery measures to be implemented for radiological controls and radiation protection purposes. The recovery measures should be documented and summarized before the return to normal site operations is approved.

Under no circumstance should life-saving or critical medical response be delayed or hindered to enforce radiological control measures.

10.0 RECORDS

Records resulting from implementation of this RPP will document radiological protection activities and conditions. Field measurements and count rate data will be recorded electronically and/or on paper. Records of field-generated data will be reviewed for completeness, consistency, and accuracy, by the PRSO, or a designee knowledgeable in the measurement method.

Changes or corrections to project documentation will be made by crossing out the erroneous item with a single line, initialing (by the person performing the correction), and dating the correction. The new information will be written above the crossed-out item. Corrections will be written clearly and legibly.

Records will be retrievable and maintained onsite for their prescribed retention time, typically for up to 3 years past performance of activities. Certain records, such as dose records and RPP audits, will be maintained for the life of the associated radioactive material license (if applicable).

11.0 QUALITY

The project manager and PRSO are responsible for the management of radiological quality through the use of approved procedures, observation of radiological work practices, and review of radiological data collected.

11.1 Surveillance and Inspections

Throughout the course of project work where radiological controls are being implemented, the project radiation protection staff will perform and document the performance of surveillances and inspections of the implementation of the requirements of this RPP.

Where corrective actions are identified, they will be administered and dispositioned using the project's corrective action process.

11.2 Audits

Annual internal audits of the implementation of the RPP will be conducted by a person selected by the project manager during the execution of the project. These audits will be performed as quality measures to verify that the radiological operations are being conducted in accordance with the RPP and applicable procedures.

Records of audits and findings will be maintained for the life of the project or radioactive materials license (as applicable).

12.0 REFERENCES

Haley & Aldrich, Inc. 2020. Technical Memorandum. April 30, 2020.

Stantec. 2020. Site Radiation Survey. March 9, 2020

US EPA. 2018. Navajo Nation Aerial Radiological Surveys.

APPENDIX A

Example RWP

RADIAITON WORK PERMIT (EXAMPLE)

☐ General ☐ Job Specific RWP No.:_____

Start Date: _____
End Date: _____

Location: Painted Desert Solar Project _____

Description of Work:
Personnel in the area of excavation control performed in areas with known elevated gamma levels

RADIOLOGICAL CONDITIONS

* Indicates an estimated value

Radiological Source(s)

☒ Alpha Emitting
☒ Beta/Gamma Emitting
☐ Other: _____

Airborne Radioactivity

Source (b/g or alpha) Concentration

_____ _____ µCi/ml
_____ _____ µCi/ml

☒ N/A

Surface Contamination

☐ N/A ☐ None Detectable ☒ Unknown Levels
Fixed: _____dpm/____cm^2 Alpha
Fixed: _____dpm/____cm^2 Beta/Gamma
Removable: _____dpm/____cm^2 Alpha
Removable: _____dpm/____cm^2 Beta/Gamma
Radionuclide(s): U-nat, Th-nat ☐ See Latest Survey

Radiation Levels

General Area: _____
Contact: _____
Other: _____

Pre-Job Survey Information

Detailed survey information contained in the following:

RADIOLOGICAL PROTECTION REQUIREMENTS

Protective Clothing

☐ None Required
☐ Lab Coat _____
☒ Surgeon-Style Gloves
☐ Coveralls/Tyvek _____
☐ Shoe Covers _____
☐ Plastic Suit _____
☒ Plastic Shoe Covers _____
☐ Rubber Boots _____
☐ Hood _____
☐ Work Gloves _____
☐ Other: _____

Respiratory Protection

☒ None Required
☐ Full Face Air Purifying (APR)
☐ SCBA
☐ Airline (Supplied Air)
☐ Other: _____

Dosimetry

☐ None Required
☒ Whole Body TLD
☐ Additional TLD(s): _____
☐ Extremity: _____
☐ Self-Reading Dosimeter
☐ Lapel Air Sampling
☐ Bioassay:
☐ Pre-job ☐ Post-job
☐ Frequency: _____
☐ Other: _____

Training

☐ GERT
☒ Radiation Worker (RWT)
☐ Respiratory Protection
☐ Confined Space Safety
☐ Other: _____

Monitoring

☐ Notify HPT at Job Start
☐ Intermittent
☒ Continuous
☐ Notify HPT at Job Completion
☐ HPT required at Control Point
☐ Undress by HPT
☐ Portable CAM
☒ Portable Air Sampling During Job
☐ Other: _____

RADIOLOGICAL HOLD POINTS and SPECIAL INSTRUCTIONS	
Material which is found to 2x background levels or greater shall be segregated and clearly marked. Personnel who enter the excavation or handle removed material shall have a whole body frisk performed before leaving the area to ensure <1000dpm α removable/ 5000 dpm α fixed contamination. All equipment which contacted material shall be surveyed to ensure <1000dpm α removable/ 5000 dpm α fixed contamination before moving outside the work area. Work Zone air sampling required. Use RWP Continuation Sheet (if necessary) ☐ Continuation Sheet(s) Attached	
RWP Sign-In/Out ☐ Initial Entry ☒ Daily ☐ Each Entry ☐ Other: _____ (List other sheet if used for access control)	**Personnel Contamination Frisk** ☐ None ☐ On Exiting Area ☒ Hands & Feet ☐ Whole Body ☐ Other: _____
REVIEW/APPROVAL SIGNATURES	
Prepared by:	Date:
Approved by (RSO):	Date:
TERMINATION SIGNATURE	
RWP Termination By:	Date:

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