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# NNSS Soils Monitoring: Plutonium Valley (CAU 366)

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## LIST OF ACRONYMS

| | |
|---|---|
| Am-241 | Americium-241 |
| CA | Contamination Area |
| CAS | Corrective Action Site |
| CAU | Corrective Action Unit |
| DRI | Desert Research Institute |
| DOE | Department of Energy |
| GOES | Geostationary Operational Environmental Satellite |
| NNSS | Nevada National Security Site |
| RCT | Radiological Control Technician |
| WRCC | Western Regional Climate Center |

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## INTRODUCTION

The U.S. Department of Energy (DOE) National Nuclear Security Administration (NNSA), Nevada Site Office (NSO), Environmental Restoration Soils Activity has authorized the Desert Research Institute (DRI) to conduct field assessments of potential sediment transport of contaminated soil from Corrective Action Unit (CAU) 366, Area 11 Plutonium Valley Dispersion Sites Contamination Area (CA) during precipitation runoff events.

Field measurements at the T-4 Atmospheric Test Site (CAU 370) suggest that radionuclide-contaminated soils may have migrated along a shallow ephemeral drainage that traverses the site (NNSA/NSO, 2009). (It is not entirely clear how contaminated soils got into their present location at the T-4 Site, but flow to the channel has been redirected and the contamination does not appear to be migrating at present.) Aerial surveys in selected portions of the Nevada National Security Site (NNSS) also suggest that radionuclide-contaminated soils may be migrating along ephemeral channels in Areas 3, 8, 11, 18, and 25 (Colton, 1999). In Area 11, several low-level airborne surveys of the Plutonium Valley Dispersion Sites (CAU 366) show plumes of Americium 241 (Am-241) extending along ephemeral channels (Figure 1, marker numbers 5 and 6) below Corrective Action Site (CAS) 11-23-03 (marker number 3) and CAS 11-23-04 (marker number 4) (Colton, 1999).

Plutonium Valley in Area 11 of the NNSS was selected for the study because of the aerial survey evidence suggesting downstream transport of radionuclide-contaminated soil. The aerial survey (Figure 1) shows a well defined finger of elevated radioactivity (marker number 5) extending to the southwest from the southernmost detonation site (marker number 4). This finger of contamination overlies a drainage channel mapped on the topographic base map used for presentation of the survey data suggesting surface runoff as a likely cause of the contaminated area. Additionally, instrumenting sites strongly suspected of conveying soil from areas of surface contamination offers the most efficient means to confirm that surface runoff may transport radioactive contamination as a result of ambient precipitation/runoff events.

Closure plans being developed for the CAUs on the NNSS may include post-closure monitoring for possible release of radioactive contaminants. Determining the potential for transport of radionuclide-contaminated soils under ambient meteorological conditions will facilitate an appropriate closure design and post-closure monitoring program.

## BACKGROUND

Plutonium Valley is located east of Yucca Flat dry lake in Area 11 of the NNSS in southeastern Nye County, Nevada. Project 56, which consisted of a series of four nuclear device safety tests, was conducted in the valley in 1955 and 1956. The safety tests were performed at test beds 11a through 11d (Figure 1, marker numbers 1 through 4) which are aligned north to south in the valley; these test beds have been designated CASs 11-23-01, 11-23-02, 11-23-03, and 11-23-04, respectively, within CAU 366. In addition, two contaminated waste disposal sites, CAS 11-08-01 and 11-08-02, are also included within CAU 366. The test conducted at test bed 11d, (Figure 1, number 4) (CAS 11-23-04), the southernmost test bed, resulted in extensive alpha contamination on the ground surface (B. Bailey, written communication; Oct 12, 2010) surrounding the ground zero. Aerial surveys (Colton, 1999) detected high concentrations of Americium-241 (Am-241) around the three southern test beds (Figure 1, marker numbers 2 through 4) and a significant plume of Am-241 distributed in a north-northeast direction from the

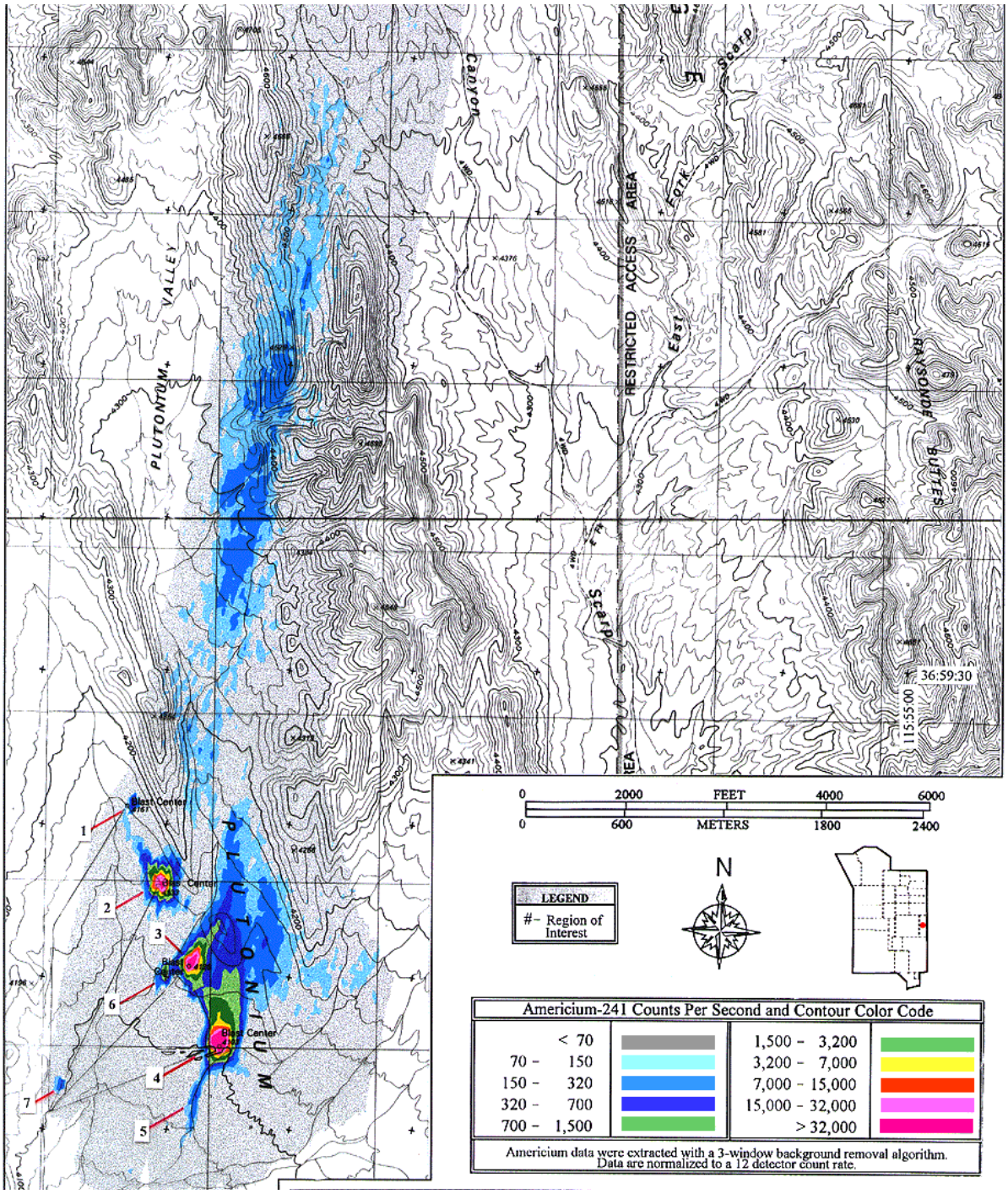


Figure 1. Americium-241 detections in Plutonium Valley suggest migration of radionuclide-contaminated soils along channels conveying runoff away from the Corrective Action Sites. Markers numbered 1 through 4 identify the four Project 56 ground zero sites; items 5 and 6 identify plums in channels draining the ground zero areas; and item 7 designates an isolated low activity spot (after Colton [1999] Figure 5).

southernmost two test locations (Figure 1, marker numbers 3 and 4). These surveys also showed Am-241 concentrations above background in a channel that conveys runoff from the southernmost test bed (CAS 11-23-04) out of the valley to Yucca Flat dry lake (Figure 1, number 5).

## RESEARCH APPROACH

The presence of radionuclide-contaminated soils in a channel that traverses the southernmost CAS in the Plutonium Valley CA suggests that radionuclide-contaminated soil has been transported in the past during runoff events. Various studies (Colton, 1999; Shinn *et al*., 1993) also have indicated that radionuclide-contaminated soils have migrated by surface water transport in the past, suggesting additional surface movement of contaminated soils is possible in the future.

Desert Research Institute proposed to perform a field scale assessment of meteorological and hydrologic conditions that would potentially lead to transport of radionuclide-contaminated soil from the Plutonium Valley CA. The research plan includes measurement of local meteorological parameters and collection of suspended sediment contained within the flow, as well as sediment transported as bedload along the channel bed during runoff events. The precipitation and runoff data will be used to establish threshold conditions that would likely lead to transport of soil particles, including radionuclide-contaminated soils. Such thresholds will aid establishment of conditions that cause monitoring of drainage channel transport pathways to be implemented under a future closure plan.

Two meteorological stations, instrumented to measure temperature, relative humidity, wind speed, wind direction, soil volumetric-water content, soil temperature, solar radiation, barometric pressure, precipitation, and particulate matter suspended in air, were installed in uncontaminated areas north and south of the Plutonium Valley CA on August 24 and 25, 2011. Figure 2 shows the locations of instrument stations relative to the ground zero sites in Plutonium Valley and Figure 3 shows photographs of the two meteorological stations. Location coordinates for the two meteorological stations are provided in Table 1. The meteorological stations were installed to determine the variation in climatic conditions in predominate seasonal wind directions. Both meteorological stations include Geostationary Operational Environmental Satellite (GOES) data transmission equipment which is used to transmit accumulated meteorological data to the Western Regional Climate Center (WRCC) at the DRI offices in Reno at regularly scheduled intervals. At the WRCC the data will be uploaded to a restricted access internet web page available to project personnel.

An ISCO sampler was installed inside the Plutonium Valley CA (Figure 4) on August 24, 2011 in conjunction with two bedload traps to collect samples of suspended sediment and bedload sediment transported under ambient precipitation runoff events. Coordinates of the ISCO installation are given in Table 1. This location is approximately 0.4 miles (0.64 km) downstream of the southernmost test ground zero (CAS 11-08-04) and approximately 0.6 miles (0.96 km) upstream of the detention basin at the southwest corner of the CA. The ISCO installation includes an ultrasonic depth sensor used to detect the presence and depth of water in the channel, a pressure transducer used to estimate the depth of flow in the channel, the ISCO sampler that pumps water from the channel into collection bottles, and a datalogger that interfaces between these instruments and the south meteorological station. When water is

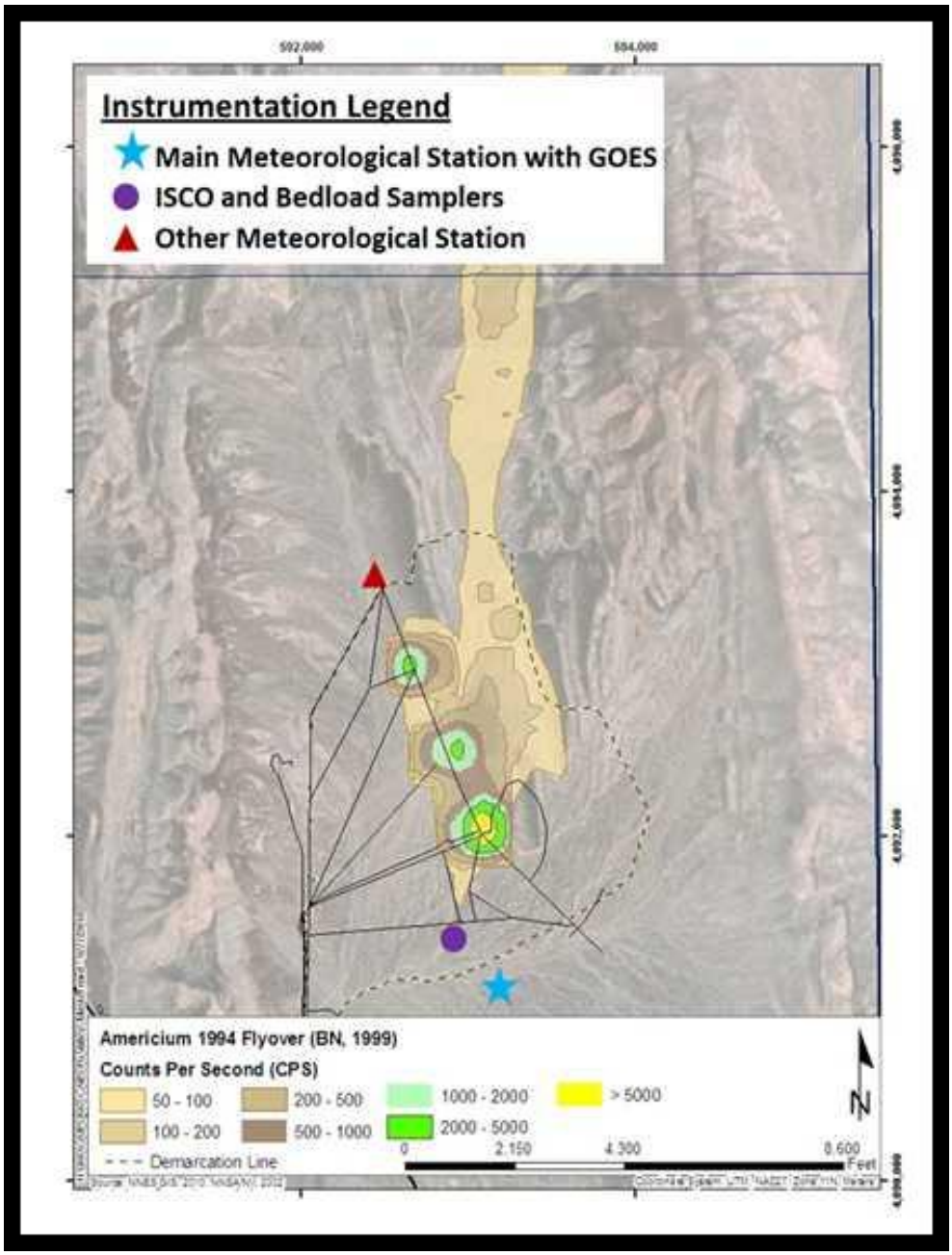


Figure 2. Approximate locations of the meteorological stations and ISCO installation in Plutonium Valley, Nevada.

detected in the channel, the datalogger instructs the ISCO to begin pumping water into the sample bottles. Water is pumped from the channel for a specified period of time and automatically collected in sample bottles inside the ISCO sampler; the bottles rotate through the sampler at specified time intervals to allow samples to be collected from different time periods during the flow event. The sample bottles will be collected and submitted for analysis to determine the suspended soil particle sizes transported in the runoff and the associated radionuclide-contamination.

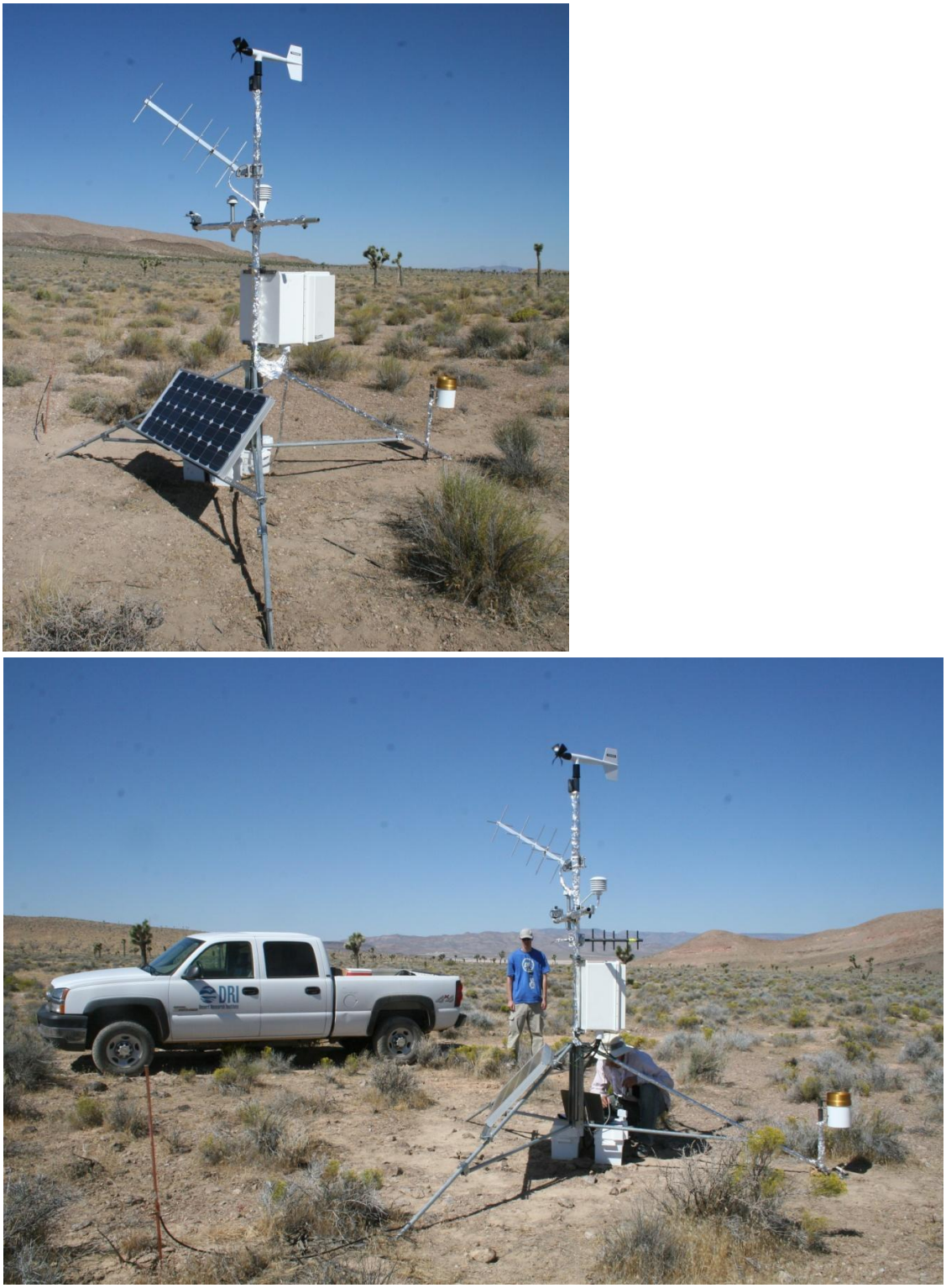


Figure 3. The meteorological stations in Plutonium Valley were installed to measure precipitation, wind, and other meteorological parameters downwind of the Contmination Area during the dominant south wind in summer (top) and dominant north wind in winter (bottom).

Table 1. Universal Transverse Mercator (Zone 11 South) coordinates for equipment installed for the Plutonium Valley runoff transport study.

| Instrumentation | Easting | Northing |
|---|---|---|
| North Meteorological Station | 592375 | 4093665 |
| South Meteorological Station | 592739 | 4090724 |
| ISCO Sampler | 592751 | 4091555 |


Figure 4. The ISCO sampler (inside the orange job box) is triggered when the pressure transducer (yellow cable in the stilling well) detects runoff. The ultrasonic depth sensor (on the left, hanging from the pole) measures flow depth. Detection of runoff and flow depth data are relayed by radio signal to the south meteorological station and then by GOES satellite to the Western Regional Climate Center.

Every 10 minutes the datalogger at the ISCO station transmits current conditions to the south meteorological station via radio frequency. The signal indicating flow at the ISCO sampler will then be transmitted to the WRCC in the next GOES satellite transmission alerting project personnel to the flow event. Initial meteorological and ISCO data transmissions from the Plutonium Valley sites were received by WRCC August 29, 2011. To date, there have been no reported flow events in the instrumented channel.

Bedload samples will be collected using passive sediment traps. Two bedload traps were set in the channel at appropriate locations and will be left until a flow event has occurred. The traps consist of a nylon net attached to an aluminum frame anchored in the channel bed. Bedload material is collected in the net during a flow event and manually transferred to a sample container after the flow event has passed. Retrieval of the suspended and bedload samples will require Radiological Control Technician (RTC) support because entry into the Plutonium Valley CA is required.

## FUTURE WORK

Data transmitted from the Plutonium Valley site instrumentation will be reviewed monthly by project personnel to identify precipitation events that exceed the specified rainfall threshold (~0.2 inches [0.5 cm]) and to assess proper operation of the instrumentation and remote communication equipment. Field inspections will be scheduled to service instrumentation only if necessary, given budget limitations.

In response to a runoff event that triggers the ISCO sampler, project personnel will recover the collected water and bedload samples. These samples will be submitted to a specified laboratory for determination of particle size distribution and radionuclide concentrations. These data will help establish relationships between the sediment eroded and transported during runoff events and the significance of channel runoff as a pathway for migration of radionuclides from the CAU.

In addition, meteorological data collected leading up to and during the runoff event will be analyzed to characterize the meteorological conditions that produced the runoff. This analysis will help delineate threshold conditions that are likely to result in sediment transport and migration of radionuclides in conjunction with the sediment. Establishment of these thresholds will aid identification of meteorological conditions that will trigger monitoring and sampling of channel runoff migration pathways. Requirements for monitoring meteorological conditions and for sampling runoff pathways can then be appropriately incorporated in closure plans.

Note that sample collection and service work on the ISCO sampling equipment will require RCT support because the equipment is located inside the CA; this work will be scheduled as needed.

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