LMS/AMC/43806

Post-Closure Monitoring and Inspection Plan for Mud Pit Sites at the Amchitka, Alaska, Site

May 2023

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

3H:1V	3 horizontal to 1 vertical
AEC	U.S. Atomic Energy Commission
Alaska DEC	Alaska Department of Environmental Conservation
AWG	Amchitka Working Group
DOE	U.S. Department of Energy
ft	feet
LM	Office of Legacy Management
LMS	Legacy Management Support
LTSP	Long-Term Surveillance Plan
NNSA	National Nuclear Security Administration
USFWS	U.S. Fish and Wildlife Service

1.0 Introduction

In 2001, the U.S. Department of Energy (DOE) remediated several areas of surface disturbance associated with historical underground nuclear tests on Amchitka Island, Alaska. Remediation was conducted by the DOE National Nuclear Security Administration (NNSA). Responsibility for the long-term monitoring was transferred to the DOE Office of Legacy Management (LM) on October 1, 2006. This post-closure monitoring and inspection plan for the Amchitka, Alaska, Site outlines monitoring and inspections related to surface disturbances and chemical contamination associated mainly with drilling activities (drilling muds) for the nuclear tests. This plan does not address radioactive contamination; environmental monitoring related to radioactivity is described in a separate environmental sampling plan (DOE 2023).

The Amchitka site is under the long-term care of LM. To ensure the integrity and effectiveness of the surface remedial action, LM conducts periodic inspections of the mud pit caps, or cover systems, at seven remediated areas where contaminated materials have been encapsulated. These seven areas are referred to as mud pit sites. LM conducts inspections in accordance with the *Long-Term Surveillance Plan for the Amchitka, Alaska, Site* (LMS/AMC/S01980), called the Long-Term Surveillance Plan (LTSP). The 2014 LTSP refers to a post-closure monitoring and inspection plan to ensure the integrity and effectiveness of the remedial action and provide guidance on the inspection of the seven mud pit caps every 5 years. This document is an update to the 2016 post-closure monitoring and inspection plan and describes the work planned for 2023.

1.1 Regulatory Framework

Activities at the Amchitka site will be performed in accordance with all applicable regulatory requirements, including those related to radiation protection, health and safety, real property and asset management, institutional controls, environmental compliance, and others. The most significant environmental laws applicable to surface remediation at the Amchitka site are listed in the site's LTSP. Applicable or relevant and appropriate requirements pertaining to remediation are listed in the site's Record of Decision (DOE 2008a).

The 2001 remedial activities were conducted under the State of Alaska's Contaminated Sites Program (Title 18 *Alaska Administrative Code* Section 75 [18 AAC 75], "Oil and Hazardous Substances Pollution Control"). In 2004, the Alaska Department of Environmental Conservation (Alaska DEC) accepted the surface remedial action as complete. Under 18 AAC 75(d)(1), Alaska DEC may require additional action if new information is discovered that leads Alaska DEC to determine that the remedial action is not protective of human health, safety, and welfare, or the environment (DOE 2008a).

LM has a Memorandum of Understanding with the U.S. Fish and Wildlife Service (USFWS) that established roles and responsibilities of both agencies for site access, long-term care activities, and the exercise of institutional controls (USFWS 2010). DOE also has an Agreement in Principle with Alaska DEC (DOE 1999) to ensure oversight of DOE's activities on and near Amchitka Island.

1.2 Background

Amchitka Island is near the far western end of the Aleutian Islands, approximately 1340 miles west-southwest of Anchorage, Alaska. It is within the Alaska Maritime National Wildlife Refuge, which is managed by USFWS. Access to the island is restricted. Although Amchitka is now uninhabited, it is an ancestral home of the Unangaŝ people whose nearest community is now on Adak Island, about 170 miles to the east.

The U.S. military began using Amchitka Island during World War II, and it has since been used by multiple U.S. government agencies for a variety of military and research activities. These activities include three underground nuclear tests. The U.S. Department of Defense and U.S. Atomic Energy Commission (AEC) conducted the Long Shot and Milrow tests in 1965 and 1969, respectively, and the Cannikin test was conducted in 1971. DOE, as one of the successor agencies to AEC, accepted responsibility for seven locations on Amchitka Island that were associated with AEC activities. Three were drilling locations, three were drilling and nuclear test locations, and one was a former asphalt plant. NNSA remediated contamination at all seven locations in accordance with a Record of Decision for surface closure (DOE 2008a). The former asphalt plant received closure complete from the State of Alaska and requires no further action. The remaining remediated locations are now collectively called the Amchitka, Alaska, Site, where LM is responsible for long-term stewardship. Although LM is not responsible for other parts of the island, it relies on access roads for vehicle travel to the seven locations. LM maintains these roads as needed, including Infantry Road, which runs from southeast to northwest across the eastern part of the island.

Historic activities at the site resulted in the creation of 12 drilling mud pits containing a mixture of bentonite, diesel fuel, and other compounds. During drilling, this mixture controlled the fluids' viscosity and mitigated the loss of drilling mud in the large-diameter boreholes. The composition of the drilling mud was 91%–93% water, 6%–8% oil (chiefly diesel fuel), and other additives including cement, bentonite, paper, chrome lignosulfonate, chrome lignite, and sodium bicarbonate (DOE 2008a). The drilling mud was held in large, bermed drilling mud pits that were open to the environment until they were remediated by NNSA.

During remediation, each mud pit was stabilized by removing standing water and mixing soils with the drilling mud to solidify the materials. The 12 mud pits were consolidated into 7, and an engineered cap was installed over each pit according to requirements in the *Remedial Action Work Plan Amchitka Island Mud Pit Closures* (NNSA 2001). The mud pit caps are constructed of a 30-mil (0.030-inch-thick) geomembrane and soil layers that were revegetated with a USFWS-approved seed-infused erosion control fabric. Each cap was constructed with drainage ditches and energy dissipators to control runoff. The caps, in order of their location along Infantry Road, are Rifle Range (containing materials from the Milrow test site), Long Shot, Cannikin South (also called Cannikin Post Shot in other documents), Cannikin Ground Zero (also called Cannikin North in other documents), Drill Site D, Drill Site F, and Drill Site E. Table 1 provides a summary of the seven mud pit sites, and Figure 1 shows their locations. As-built drawings for the mud pit caps in the *Amchitka Island Surface Closure Report* (NNSA 2003) provide baseline reference conditions for the mud pit cap inspections.

Table 1. Summary of Amchitka Mud Pit Sites and Mud Pit Caps

Mud Pit Site	Mile on Infantry Road	Acreage of Mud Pit Site/ Mud Pit Cap	Mud Pits Remediated	Mud Pit Caps Installed	Energy Dissipators Installed
Rifle Range (Milrow)	2.4	1.2/0.8	1	1 (at Rifle Range)	2
Long Shot	4.6	1.6/1.5	2 (east and west)	1	1
Cannikin South[a]	10.4	0.7/0.4	2 (north and south)	1	1
Cannikin Ground Zero[b]	10.4	0.7/0.7	1	1	2
Drill Site D	16.1	7.5/6.2	3 (south, northwest, northeast)	2 (northwest and northeast combined)	2
Drill Site F	18.8	0.6/0.5	1	1	1
Drill Site E	20.3	0.3/0.1	2 (north and south)	1 (South only; no further action at north)	1

Notes:
[a] The Cannikin South mud pit site is also called the Cannikin Post Shot site.
[b] The Cannikin Ground Zero mud pit site is also called the Cannikin North site.

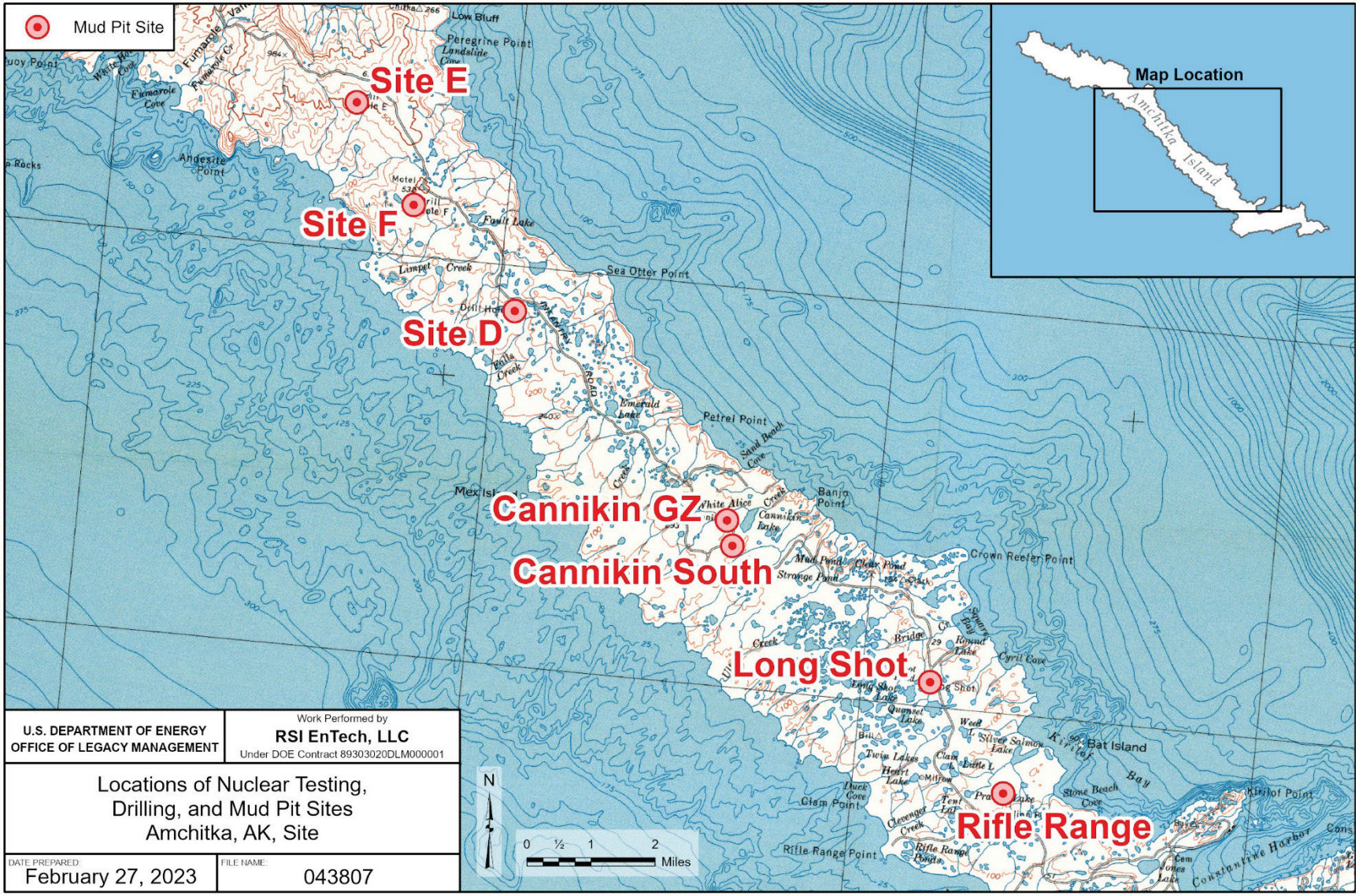

Figure 1. Locations of Nuclear Testing, Drilling, and Mud Pit Sites

The last full post-closure monitoring and inspection of the mud pit sites was conducted in 2016 in accordance with the 2016 monitoring and inspection plan (DOE 2016c), and results were reported in the *Amchitka Mud Pit Caps 2016 Post-Closure Monitoring and Inspection Report Amchitka Island, Alaska* (DOE 2016b). Additional site visits were performed in 2017, 2018, and 2019 due to a 2014 earthquake that occurred 11 miles north of Amchitka Island. No significant changes were identified during the 2017–2019 site visits.

In 2022, LM investigated the mud pit caps to collect data to support the design of potential future corrective actions and performed repairs to areas damaged during the 2014 earthquake (RSI 2022a). Geotechnical samples were collected, and a topographical survey was performed. The work also involved road repairs for access. The 2023 inspections will be conducted in the context of the 2022 investigations.

1.3 Scope and Objectives

The scope of the activities planned for 2023 is to conduct integrity inspections at each of the mud pit caps (Section 2.1), complete vegetation monitoring on each mud pit cap (Section 2.2), and prepare a summary report (Section 2.3) for LM and stakeholders including USFWS, Alaska DEC, and others.

The objectives of the 2023 monitoring are to evaluate structural and vegetative components of the caps to determine whether the geosynthetic caps are performing as designed, subsiding, or eroding; the drainage ditches and energy dissipators are performing as designed, have been damaged, or are eroding; the vegetation is establishing and ecologically stable; and administrative controls are functioning as designed.

1.4 Special Considerations for the Amchitka Site

Special considerations related to the Amchitka site are summarized in this subsection.

1.4.1 Access to the Alaska Maritime National Wildlife Refuge

Amchitka Island is part of the Alaska Maritime National Wildlife Refuge, managed by USFWS. Access to the island is restricted by USFWS. LM has obtained a special use permit from USFWS to access the island and conduct monitoring and inspections. LM, the Legacy Management Support (LMS) contractor, and subcontractors must comply with the conditions of the special use permit.

1.4.2 Project Personnel

LMS contractor personnel will conduct the post-closure monitoring and inspections. Personnel from LM, USFWS, or Alaska DEC may also participate. Key project personnel proposed to conduct the cap integrity inspections will include an environmental scientist, geologist, an engineer, or other staff with experience conducting landfill cover inspections similar to those described in this plan. Key project personnel proposed to conduct the vegetation monitoring for the 2023 trip will include two ecologists.

1.5 Mud Pit Site Descriptions

1.5.1 Rifle Range (Milrow)

The Rifle Range site is east of Infantry Road between mile markers 2 and 3 (Figure 2). The mud pit cap ranges in height from about 2 to 4 feet (ft) above grade with 3 horizontal to 1 vertical (3H:1V) side slopes. The total surface area of the cap is approximately 0.8 acre. Minor damage was reported on this cap following the 2014 earthquake. The damage did not require repair during the 2022 mud pit investigation and repair trip.

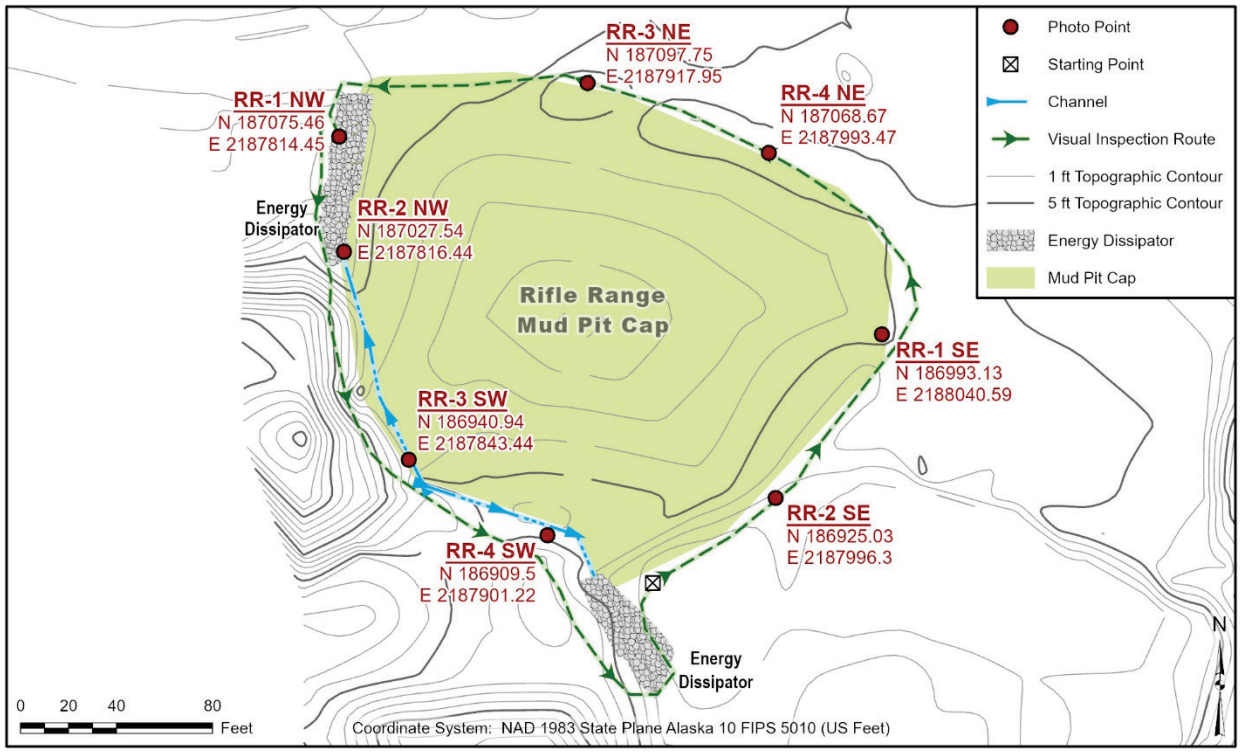

Figure 2. Rifle Range Mud Pit Site

1.5.2 Long Shot

The Long Shot mud pit site is on the west side of Infantry Road between mile markers 4 and 5 (Figure 3). The mud pit cap ranges in height from approximately 9 to 11 ft and covers approximately 1.5 acres at the surface. Slopes on the north, south, and east sides are approximately 2H:1V to 3H:1V. Slopes on the west side are about 3H:1V. At the toe of the cap's slope is a drainage channel. Minor damage was reported on this cap following the 2014 earthquake. The damage did not require repair during the 2022 mud pit investigation and repair trip.

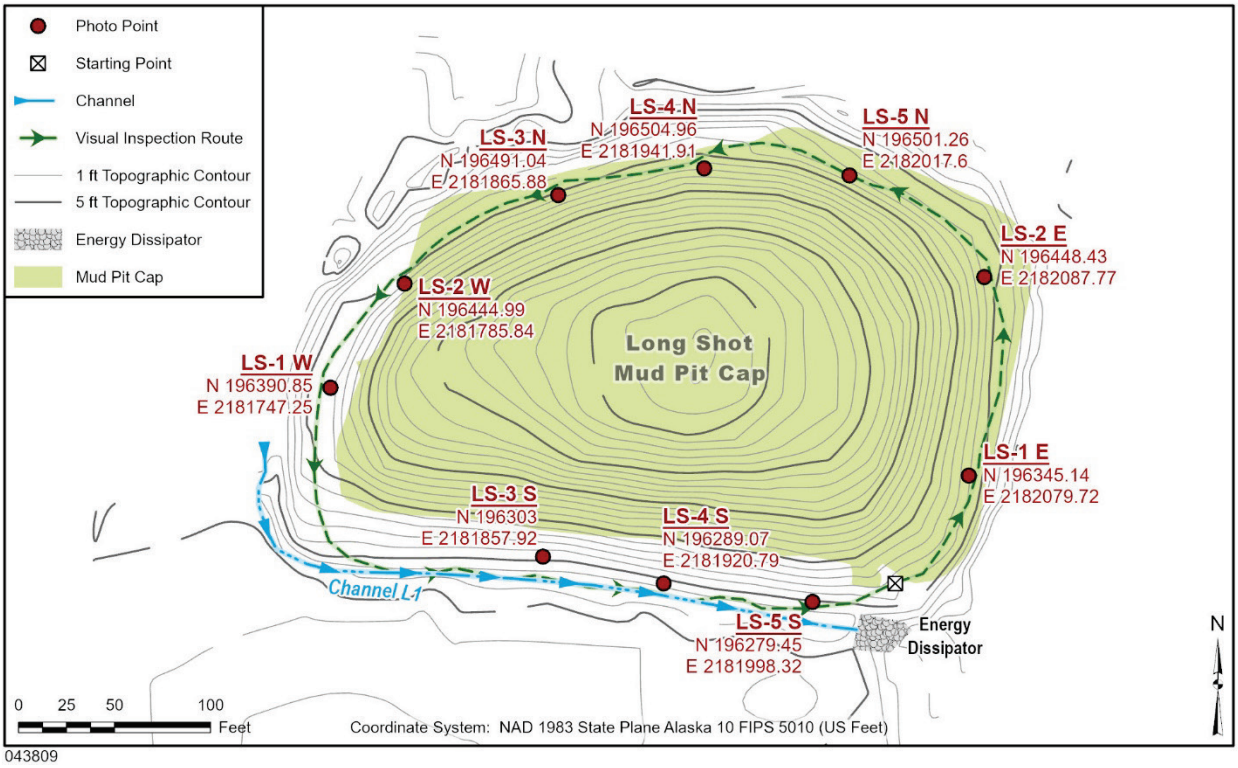

Figure 3. Long Shot Mud Pit Site

1.5.3 Cannikin South

The Cannikin South mud pit site is off a spur road between mile markers 10 and 11 of Infantry Road (Figure 4). The mud pit cap is approximately 0.4 acre on the surface within the 0.7-acre site. All side slopes are approximately 3H:1V. Surface drainage is to the southeast. No sign of damage was noted following the 2014 earthquake.

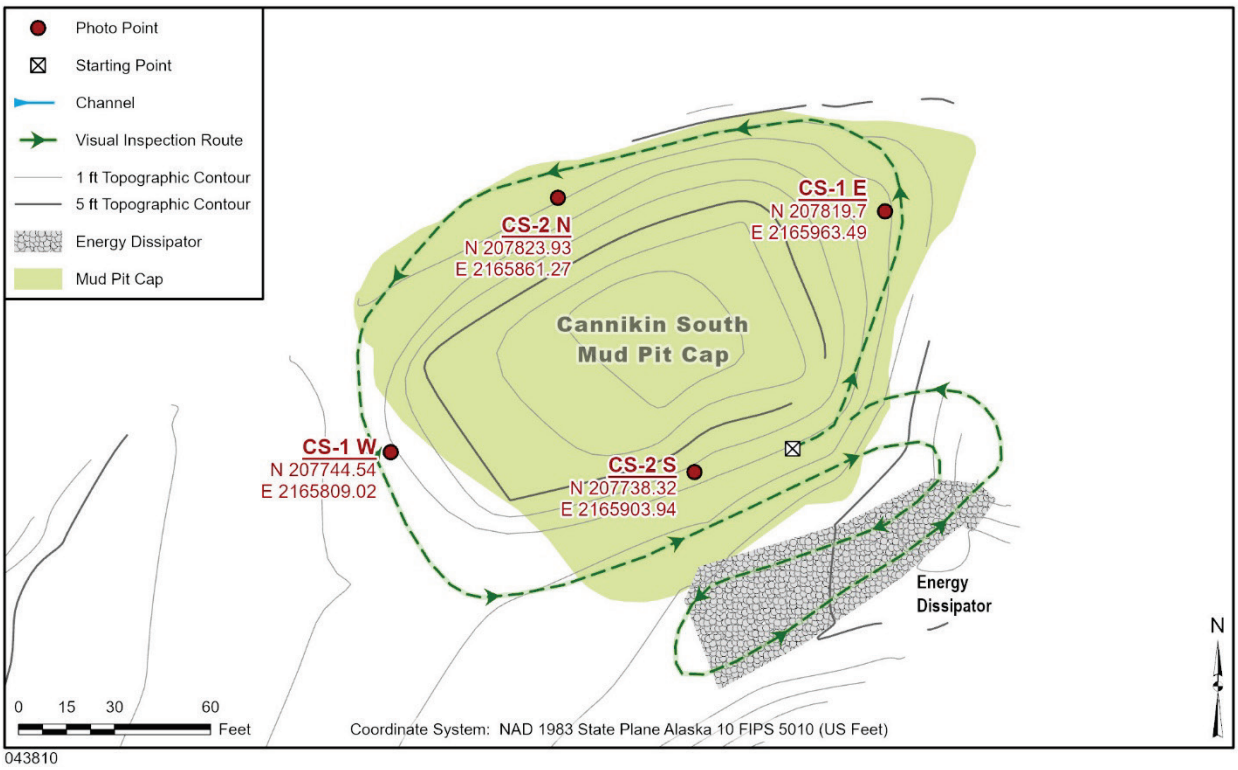

Figure 4. Cannikin South Mud Pit Site

1.5.4 Cannikin Ground Zero

The Cannikin Ground Zero mud pit site (Figure 5) is about 300 ft from the Cannikin South mud pit site (Figure 5). The cap is approximately 0.7 acre in size. Side slopes range from 2H:1V to 3H:1V. Water can collect in the toe drainage, and the site slopes slightly to the south. Like the Cannikin South mud pit cap, no sign of damage was apparent following the 2014 earthquake.

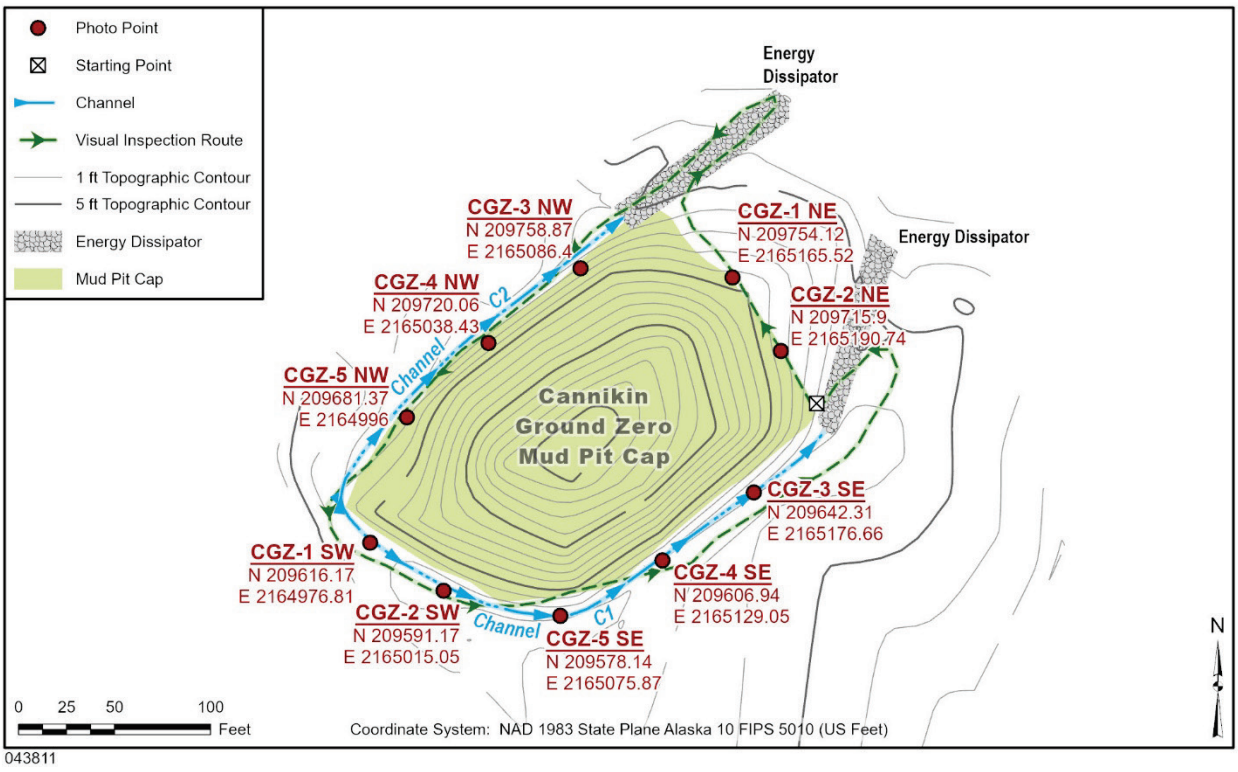

Figure 5. Cannikin Ground Zero Mud Pit Site

1.5.5 Drill Site D

The Drill Site D mud pit site is an approximately 7.5-acre site near mile marker 16 of Infantry Road, and it contains a 6.2-acre mud pit cap on the surface (Figure 6). The cap's north and east slopes are approximately 2H:1V to 3H:1V; the slopes on the south, southeast, and southwest sides are about 1.5H:1V to 2H:1V. At the toe of the cap along the south side is a lake, and the slope appears to bulge at the lake's edge. The site drains toward the lake. A slight swale exists between the east and west sides of the cap. Moderate damage from the 2014 earthquake was noted, including slumping of the soil cover from the side of the cap, exposing a small section of the geomembrane where it attaches in the anchor trench. A maintenance repair was conducted in 2022 to replace cover material where the geomembrane was exposed.

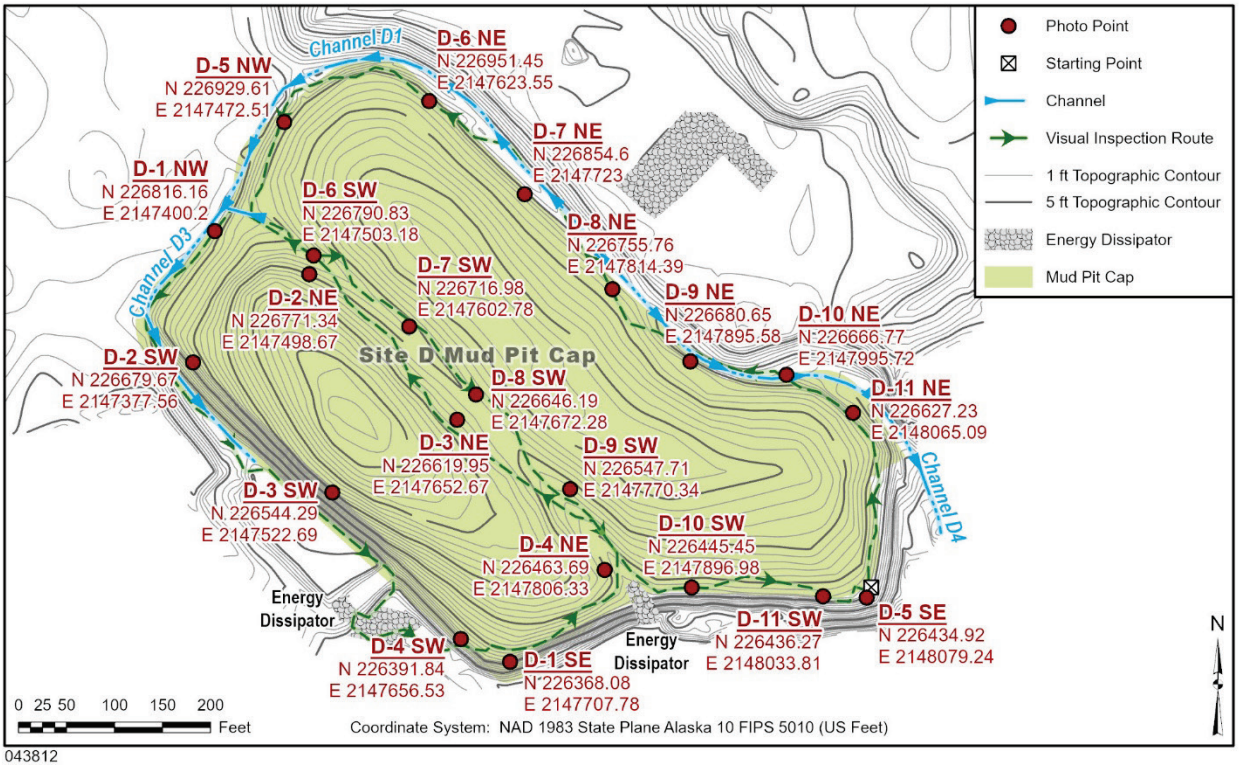

Figure 6. Drill Site D Mud Pit Site

1.5.6 Drill Site F

The Drill Site F mud pit site is between mile markers 18 and 19 of Infantry Road and is approximately 0.6 acre in size (Figure 7). The mud pit cap on the site covers approximately 0.5 acre on the surface. Slopes are about 1.5H:1V on the south side of the cap; slopes on the north side are approximately 4H:1V, and slopes on the east and west sides are approximately 3H:1V to 4H:1V. Minor damage from the 2014 earthquake was noted. The damage did not require repair during the 2022 mud pit investigation and repair trip.

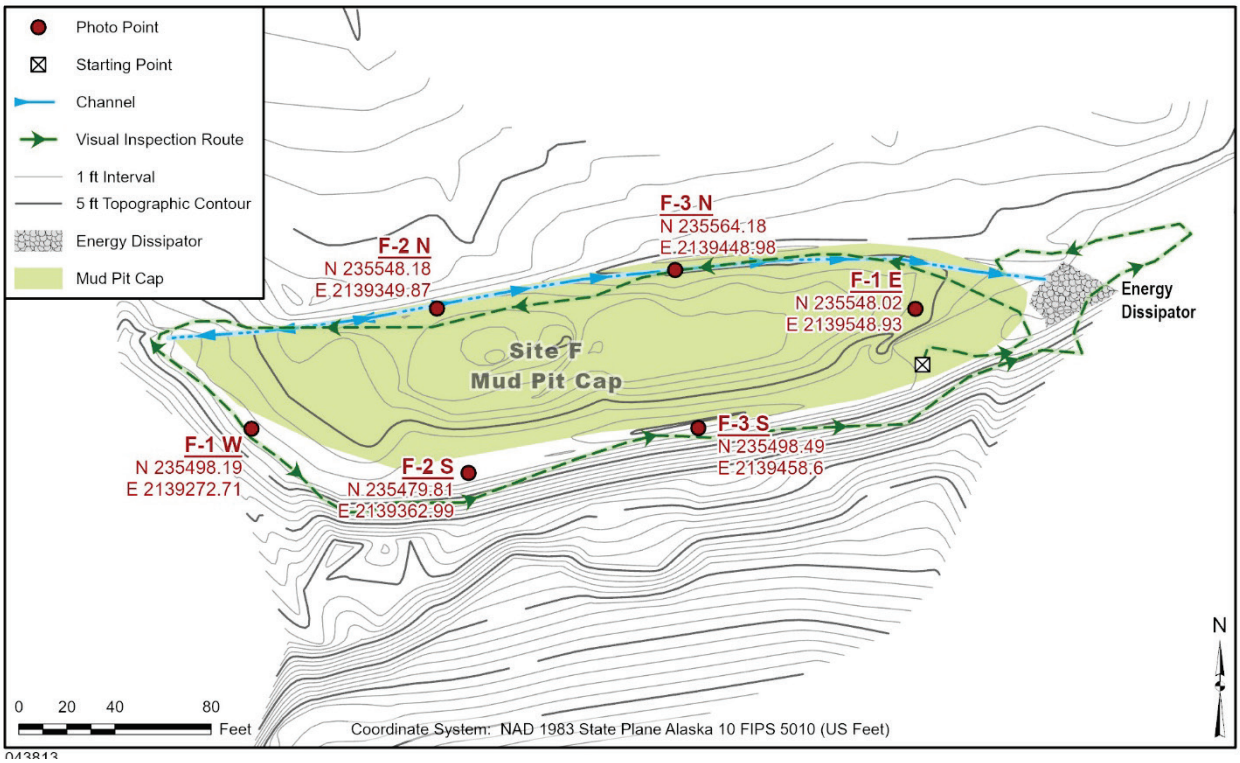

Figure 7. Drill Site F Mud Pit Site

1.5.7 Drill Site E

The Drill Site E mud pit cap covers approximately 0.1 acre on the surface within the 0.3-acre site (Figure 8). The cap has gentle side slopes estimated at 3H:1V, except the south slope, which is about 2H:1V or steeper. Drill Site E is past mile marker 20 of Infantry Road and is the farthest north of the mud pit sites. The site slopes to the south. Moderate damage from the 2014 earthquake was noted outside the footprint of the cap including significant cracks along the uphill side of the mud pit cap and land surface downgradient of the cap had slumped away. There were no observations of exposed liner at Drill Site E.

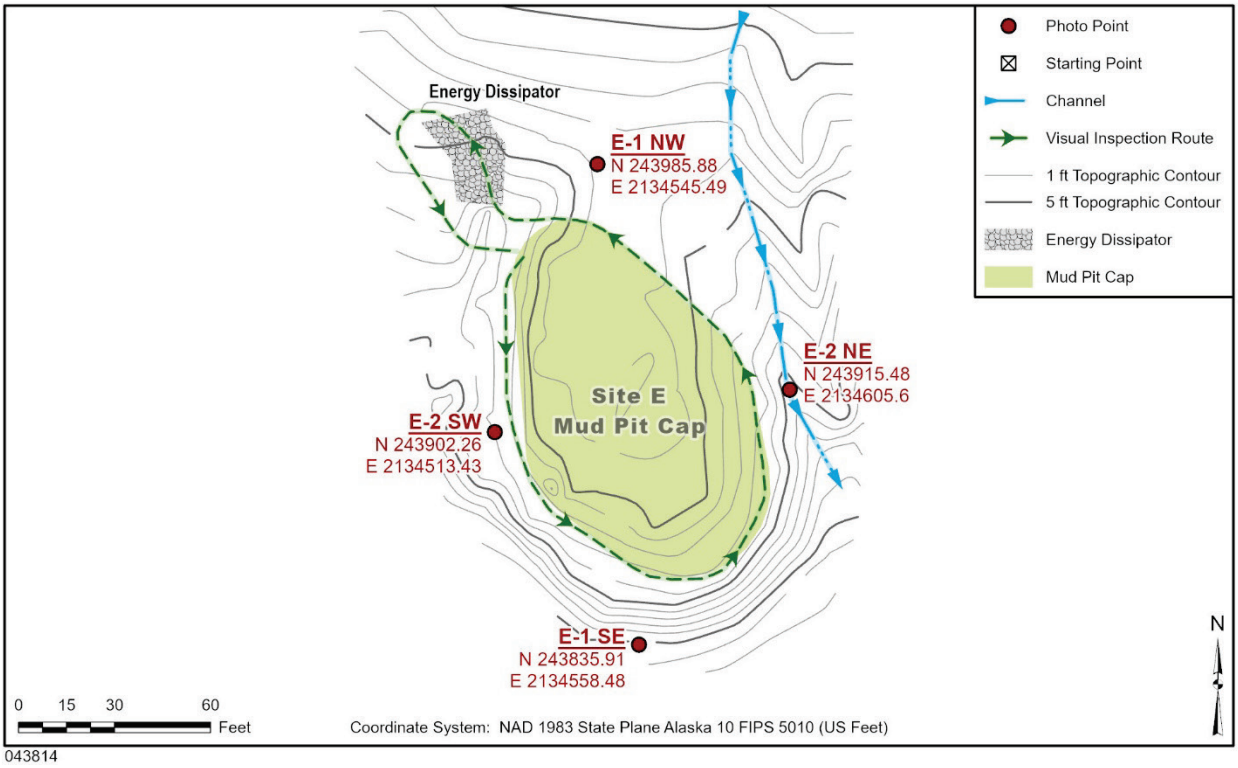

Figure 8. Drill Site E Mud Pit Site

2.0 Post-Closure Monitoring and Inspection Requirements

This section describes requirements for conducting the post-closure monitoring and inspection activities in 2023. Actual field conditions may require minor modifications to the protocol. If deviations are warranted, personnel will document them in field notes. Monitoring and inspection results will be recorded in field notes and reported on a post-closure monitoring checklist (Appendix A).

2.1 Cap Integrity Inspection

A physical inspection of each mud pit cap will be conducted by the LMS contractor team. The inspections will consist of visual observations and photo documentation of the caps and areas adjacent to the caps.

2.1.1 Inspection for Damage or Degradation

Each mud pit cap and the surrounding area will be inspected for evidence of the following:

- Subsidence, settling, or slumping
- Exposed geomembrane or evidence of damage to geomembrane
- Cracks or scarps
- Erosion channels, rills, or gullies
- Ponding water
- Human intrusion or vandalism
- Animal burrows
- Sedimentation
- Integrity of drainage ditches and energy dissipators

The inspectors will document the location(s) and describe their observations. Measurements will be taken as needed to document the observations.

2.1.2 Inspection Protocol

Inspectors will walk the perimeter of each mud pit cap, and the caps will be inspected by walking transects.[1] To ensure consistency with previous inspections, starting points and general guidelines are provided in Table 2. Mud pit cap inspections will begin at the designated starting point, proceed in the direction indicated in Table 2, and continue along 20-ft parallel transects until the entire cap is inspected. The 20-ft spacing between transect lines is recommended but spacing can be adjusted to ensure full visual coverage. A compass or GPS unit may be used to help inspectors stay on a straight course along each transect. Figure 9 shows a general diagram of a mud pit cap inspection pattern. Locations where stakes are recommended are shown on this figure, but stakes are not mandatory.

[1] These transects apply to the cap inspections and are not the same as the line transects used in vegetation monitoring (Section 2.2).

Table 2. Proposed Cap Inspection Guidelines

Mud Pit Site	Starting Point	Cap Inspection Pattern	Photo Points
Rifle Range	South end of cap (on north side of energy dissipator)	• Proceed northeast from the starting point to the opposite side of the cap • Complete the inspection with 20 ft parallel transects	8
Long Shot	Southeast corner of cap (just north of energy dissipator)	• Proceed north from the starting point to the opposite side of the cap • Complete the inspection with 20 ft parallel transects	10
Cannikin South	Southeast corner of cap (just north of energy dissipator)	• Proceed north from the starting point to the opposite side of the cap • Complete the inspection with 20 ft parallel transects	4
Cannikin Ground Zero	Easternmost corner of cap (at south end of energy dissipator)	• Proceed northwest from the starting point to the opposite side of the cap • Complete the inspection with 20 ft parallel transects	10
Drill Site D	Southeast corner of cap	• This cap will be inspected in two parts: The northeast portion and the southwest portion • Proceed north from the starting point to the opposite side of the northeast portion of the cap • Continue the inspection with 20 ft parallel transects until the bend in the cap is reached, then proceed in a northeast-southwest transect pattern • Move to the southernmost edge of the cap • Proceed northeast to the opposite side of the southwest portion of the cap • Complete the inspection with 20 ft parallel transects	22
Drill Site F	Far east side of cap	• Proceed north from the starting point to the opposite side of the cap • Complete the inspection with 20 ft parallel transects	6
Drill Site E	Far northwest corner of cap	• Proceed east from the starting point to the opposite side of the cap • Complete the inspection with 20 ft parallel transects	4

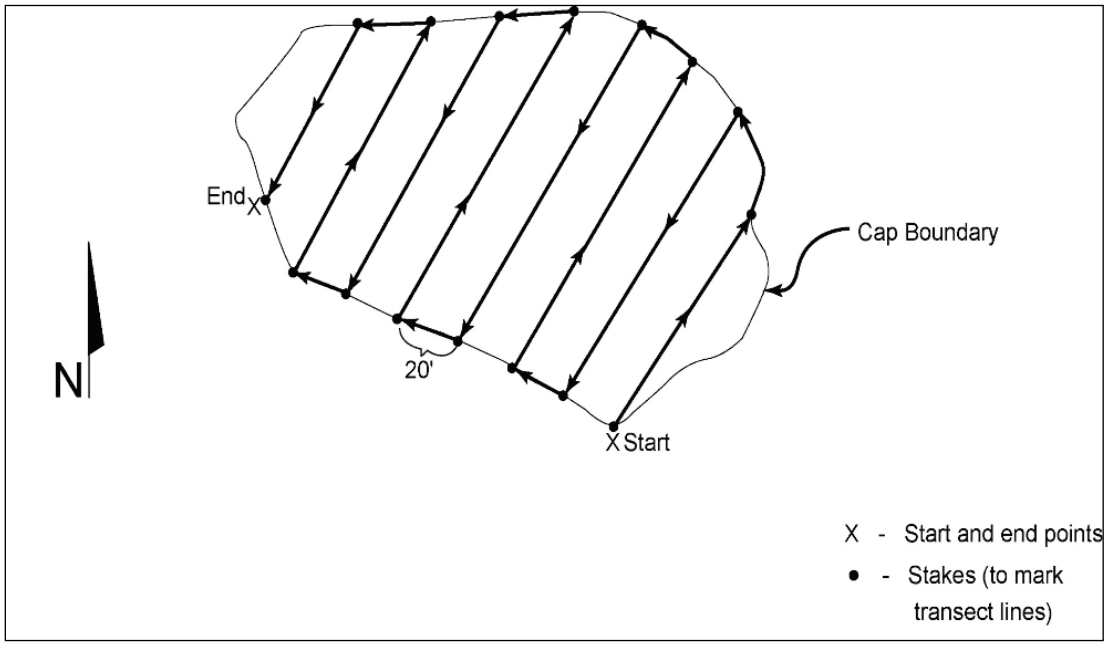

Figure 9. Example of Cap Inspection Pattern on 20-ft Transects

2.1.3 Photo Documentation

Photo documentation is performed to compare photographs from the same locations (photo monitoring points) over time. Photo monitoring points and their coordinates were established during previous cover inspections. Table 2 shows the minimum number of photo monitoring points for each mud pit cap. Inspectors may add additional points as warranted. Figure 2–Figure 8 show the location and coordinates of the photo monitoring points. Inspectors will locate each photo monitoring point using GPS and take a photograph at each point. Specific observations of damage or degradation (Section 2.1.1) will be photographed as necessary. The content of the additional photos will be at the discretion of the inspectors, who will ensure that the features can be accurately viewed and sufficiently documented from the photos.

A digital camera meeting LM and LMS specifications for image quality will be used. All photographs taken will be logged on a photograph log (Appendix C) and retained as LM records. A subset of pertinent photographs will be included as appropriate in the 2023 inspection and monitoring report (Section 2.3).

2.2 Vegetation Monitoring

The purpose of the vegetation monitoring is to document the abundance and composition of plants on the mud pit caps and the presence of any weeds, damage, disease, pests, or other areas of concern. Vegetation, when established and self-sustaining, protects mud pit caps from erosion. Over time, healthy vegetation cover will integrate into the surrounding ecosystems and provide wildlife habitat. LM monitors vegetation at the mud pit sites, especially on the mud pit caps, to measure vegetative cover and changes. While past vegetation monitoring at the mud pit sites used point-intercept sampling along established transects, a more efficient sampling method—the line-transect method—has been approved by USFWS and Alaska DEC for use in 2023 (Alaska DEC 2023). The line-transect method, described in detail in Section 2.2.4, will provide high quality data while reducing labor and time.

2.2.1 Revegetation of Mud Pit Caps

The mud pit caps were seeded in 2001 with two grass species, Bering hairgrass (*Deschampsia behringensis*) and red fescue (*Festuca rubra*), using a seed mat product called North American Green SC150, which consisted of erosion control fabric embedded with seed (DOE 2003). The fabric was constructed of straw and coconut fiber placed between two natural-fiber nets. The three caps at the highest elevation (Drill Sites D, E, and F) were reseeded in 2008 with the same two species of grass at a rate of 500 pounds per acre; fertilizer consisting of 20% nitrogen, 20% phosphoric acid, and 10% potash was also applied to these caps (DOE 2008b).

2.2.2 Ecology of Amchitka Island

A summary of Amchitka Island's ecology is provided to help familiarize ecologists with the site's unique characteristics before they conduct monitoring. Vegetation communities on Amchitka Island are maritime tundra communities characterized by bryophytes, lichens, and low-growing vascular plant species. Low temperatures result in a low-energy environment, although no permafrost is present. On the island, plant communities tend to intergrade, with many of the same species appearing in multiple communities in different proportions. Most of

the species on the island are native to Alaska, and no invasive weeds are known to be present. In the late 1960s, Hansford T. Shacklette and others characterized vegetation on Amchitka Island for the U.S. Geological Survey (Shacklette et al. 1969), and C.C. Amundsen described the plant ecology of the island for AEC (Amundsen 1972).

Amundsen described three "topoenvironmental units" on the island. Two of these units, lowland tundra and upland tundra, surround the mud pit sites. Lowland and upland tundra are distinguished not by elevation but by degree of drainage; upland tundra is well-drained, and lowland tundra tends to retain moisture. Plant community types within the upland and lowland tundra surrounding the mud pit sites include (1) crowberry meadow (crowberry-sedge-grass and crowberry-grass-sedge types), (2) crowberry-grass stripe, (3) secondary succession, and (4) wet tundra (ephemeral pools, "breakaway tundra," and sedge-lichen meadow). Crowberry meadows are ecologically mature communities dominated by Pacific reedgrass (*Calamagrostis nutkaensis*), sedges, and crowberry (*Empetrum nigrum*). Crowberry-grass stripe describes communities where crowberry meadow alternates in "stripes" with grass meadow or bare patches. This community is believed to be formed by wind erosion and patterns of plant succession; it is found at elevations over 400 ft. Secondary succession communities are areas that were extensively disturbed by historical military occupation. These communities contain many of the same species as the surrounding heath, but at different densities; for example, Nootka lupine (*Lupinus nootkatensis*) is much more common and vigorous in secondary succession communities than in crowberry meadows. Wet tundra communities exist along lakes, ephemeral pools, and streams as well as low-lying areas with poorly drained soils. "Breakaway tundra" is dominated by sedges and lichens; because of past disturbances, it contains few well-rooted plants.

Ecological succession is complex on Amchitka Island. Early and secondary successional communities are present in places disturbed by military operations, underground nuclear testing, and remediation. However, these successional communities do not progress toward a single "climax" community. Rather, mature plant communities on the island constantly change due to peat accumulation and movement, which causes drying and swamping patterns over space and time. Solifluction, the process of downslope soil movement related to saturation and freeze-thaw cycles, also causes constant changes in plant cover. Although ecological changes are constant, they progress slowly because of the low-energy environment of maritime tundra communities.

2.2.3 Field Observation Protocol

At each mud pit cap, ecologists will note any patches on the cap that are devoid of vegetation and describe the general condition of the erosion control fabric. Erosion control fabric was applied when the caps were reseeded, and it is slow to break down in the cold climate of the Aleutian Islands. Vegetation is also slow to grow, and vegetation communities are slow to develop. The erosion control fabric continues to provide erosion protection until a self-sustaining vegetation community can become established.

Before conducting numerical sampling with line transects, ecologists will walk each mud pit cap and record all species of plants growing on the cap. An effort will be made to identify every species on the cap because this information is useful in assessing ecological diversity, and a comprehensive list of plants for each cap will aid the ecologists in identifying species encountered on the line transects. Species will be identified using a technical flora of the

Aleutian Islands (Hultén 1968 or equivalent), and nomenclature will follow the USDA PLANTS Database (USDA 2023). Bryophytes will be identified to genus, and lichens will be identified by form (crustose, foliose, or fruticose).

Ecologists will record additional field notes as needed to document the overall health and diversity of vegetation at each cap, to describe observed changes, to describe evidence of animal grazing or burrowing, or to record any other pertinent ecological information. The line-transect method will be used to record vegetation cover data for comparison to past monitoring events. Application of the line-transect method for the 2023 mud pit cap monitoring is described in the following section.

2.2.4 Line Transect Monitoring Protocol

Line transects collect point-intercept data at regular intervals along a measuring tape that is secured with pins in a straight line along the ground. A starting point for each line transect will be randomly generated and loaded into a GPS unit; the unit will be used to locate each point, and at each point, a random azimuth will be established using a random numbers table and compass. A 25-meter tape (line transect) will be pinned at each starting point, and the randomly generated azimuth will be adjusted as necessary to ensure that each transect is entirely within the boundaries of the cell. At 0.5-meter intervals along each transect, the live or dead plant species or other cover class (e.g., bare ground, erosion control fabric, rock, leaf litter) will be recorded (as illustrated in Figure 10).

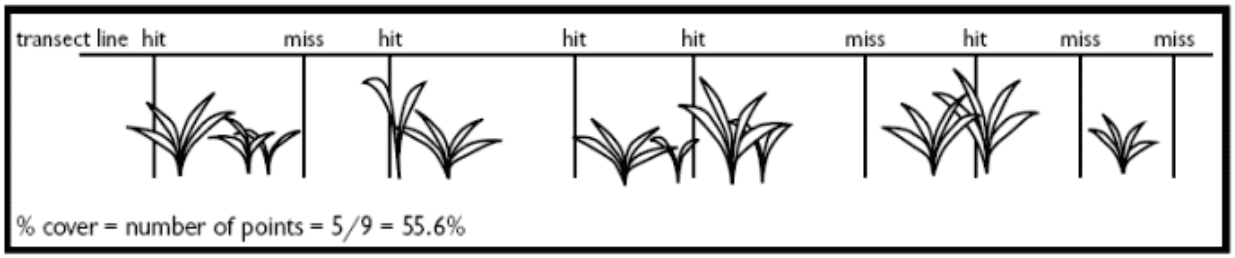

Figure 10. Illustration of Point-Intercept Data to be Collected Along Line Transects

Ecologists will record the data on paper or electronically. Observations will be summarized and added to a post-closure monitoring checklist (Appendix A). After fieldwork is complete, data will be compiled, statistically analyzed, and reported in the summary report (Section 2.3).

Previous monitoring data were analyzed to determine the minimum number of samples for the 2023 monitoring. Table 3 shows the ecological context of the caps and provides these sample numbers.

Table 3. Ecological Information and Sample Numbers for 2023 Vegetation Monitoring

Mud Pit Site	Ecological Community	Approximate Elevation (ft)	Number of Transects (Total of 83)
Rifle Range	Crowberry meadow	56	15
Long Shot	Crowberry meadow and wet tundra	165	20

Table 3. Ecological Information and Sample Numbers for 2023 Vegetation Monitoring (continued)

Mud Pit Site	Ecological Community	Approximate Elevation (ft)	Number of Transects (Total of 83)
Cannikin South	Crowberry meadow	237	5
Cannikin Ground Zero	Crowberry meadow	215	10
Drill Site D	Crowberry meadow	310	18
Drill Site F	Crowberry meadow	475	8
Drill Site E	Crowberry-grass stripe	475	7

2.3 Site Maintenance and Repair

Existing conditions and repair efforts of the mud pit caps have been documented in previous reports (DOE 2008b, DOE 2014, DOE 2016b, RSI 2022b). Any deficient site conditions that remain or have developed since 2022 will be documented and categorized as maintenance or structural deficiencies.

Maintenance deficiencies result from normal weather, ecological succession, animal activity, and other typical site influences. These deficiencies are minor in nature and will be corrected during the inspection as time, materials, and staffing allow. Deficiencies that are not corrected at the time of the inspection will be documented and reported and appropriate actions will be planned with the USFWS, Alaska DEC, and the AWG as needed.

Structural deficiencies result from atypical site conditions, including earthquakes, severe weather, flooding, vegetation mortality, encroachment of invasive species, large-scale animal activity, and human activities such as vandalism. These conditions are considered significant and cannot be corrected during the inspection. Structural repairs might involve actions such as regrading an area to modify drainage and reduce runoff or erosion problems. All repair work would attempt to preserve the original cover and intent of the engineering design; however, permanent modification might be required to prevent detrimental site conditions from recurring. If permanent modifications were made, the area would be resurveyed after repair to establish new baseline conditions. If warranted, structural repairs could also involve nature-based actions to establish self-sustaining, desirable ecological communities on the mud pit caps over the long term. Structural repairs would be developed in collaboration with the USFWS, Alaska DEC, and AWG as needed.

Table 4 provides examples of conditions that could require maintenance or structural repairs, potential associated actions, schedules, and notification plans.

Table 4. Examples of Deficiencies Requiring Maintenance or Structural Repair

Deficient Condition	Repair Action	Repair Schedule	Notification
Maintenance Repairs			
Cracks, subsidence, erosion rills, or animal burrows generally <15 centimeters (cm) (6 inches) deep or <1 meter (m) (3 ft) long	Backfill with soil and compact to reestablish grade	Repair by hand during inspection as time allows, or during a subsequent visit	Document observations, repairs, and future repair needs in the inspection and monitoring report
Live, absolute foliar plant and bryophyte cover of less than 50% across a mud pit cap	Develop and implement a nature-based revegetation plan designed to establish self-sustaining, desirable ecological communities on the mud pit caps over the long term	Schedule will be determined when developing a revegetation plan	Document vegetation cover data in the inspection and monitoring report Develop a revegetation plan in collaboration with USFWS, Alaska DEC, and AWG members Use of off-island materials would be subject to approval by USFWS
Infestations of invasive plants on mud pit caps	Develop and implement an invasive species control plan to be implemented as possible during future site visits	Schedule will be determined when developing an invasive species control plan	Document invasive species in the inspection and monitoring report Develop an invasive species control plan in collaboration with USFWS, Alaska DEC, and AWG members Use of off-island materials would be subject to approval by USFWS
Structural Repairs			
Cracks, subsidence, erosion rills, or animal burrows generally >15 cm (6 inches) deep or >1 m (3 ft) long on mud pit cap	Repair by backfilling soil and compacting to reestablish grade Use local materials whenever possible Development of a corrective action plan or resurveying grade(s) may be required if the impact extends into the geomembrane layer, energy dissipators, or drainage ditches or if excavation and regrading is required	Evaluate and repair by hand during site inspection visit as time, materials, staffing, and site conditions allow Schedule for work to be performed during subsequent site visit The schedule will be determined when developing a corrective action plan	Document deficiencies in the inspection and monitoring report Develop a corrective action plan in collaboration with USFWS, Alaska DEC, and AWG members Use of off-island materials would be subject to approval by USFWS
Damage to mud pit cap from storms, floods, earthquakes, animals, or humans that removes significant cover materials or exposes the cap geomembrane			
Damage to the site from storms, floods, animals, or humans that threatens the integrity of energy dissipators, drainage ditches, or other integral mud pit features			

2.4 Recordkeeping and Reporting

2.4.1 Permanent Record

LM maintains a permanent record of the mud pit site inspection reports and other supporting documentation for the long-term surveillance activities. Documents associated with the 2023 post-closure inspection and monitoring will be included in the permanent record. The record includes:

- Documentation of inspection results (e.g., checklists, drawings, survey results, photographs).
- Supporting information to help forecast future site surveillance and monitoring needs.
- Reports to stakeholders regarding mud pit cap integrity, performance, and deficiencies.

The permanent record will be maintained in accordance with DOE Orders to ensure their proper handling, maintenance, and disposition, and with Title 36 *Code of Federal Regulations* Chapter 12 (36 CFR 12), Subchapter B. The permanent record is available for public review.

2.4.2 Summary Report

The purpose of the summary report is to convey observations and monitoring results to stakeholders. In accordance with the LTSP, evidence of mud cap failure will determine the need for follow-up actions at the site. Follow-up actions will be developed with Alaska DEC and other stakeholders and specified in separate documentation from the summary report.

The mud pit cap inspection and monitoring activities and observations will be documented using inspection checklists, site drawings, photographs, photo logs, vegetative cover data files, and field notes. LM will prepare an inspection and monitoring report following completion of fieldwork for 2023. The report will contain sections for cover inspections, vegetation monitoring results, and conclusions. The vegetation monitoring section will show the location and azimuth of each line transect. LM will submit the report to USFWS and Alaska DEC within 120 days of completion of the inspection for information and review.

3.0 References

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RSI (RSI EnTech, LLC), 2022b. *Final Trip Report for Mud Pit Cap Repair Investigation, Amchitka Island, Alaska*, prepared by Geosyntec Consultants, Project Number PNG0962, November.

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Appendix A

Amchitka Mud Pit Sites
Post-Closure Monitoring Checklist

AMCHITKA MUD PIT SITES POST-CLOSURE MONITORING CHECKLIST

Mud Pit Site:	Date of Inspection:
Responsible Agency:	Project Manager:
Inspector (name, title, organization):	

A. General Instructions

1. All checklist items must be completed and detailed comments made to document the results of the site inspection.
2. The completed checklist is part of the field record of the inspection. Additional pages should be used as necessary to ensure that a complete record is made. Number and attach the additional pages upon completion of the inspection.
3. Any checklist line item marked by an inspector in a SHADED BOX must be fully explained or an appropriate reference to previous reports provided. The explanation should include the inspector's rationale for conclusions and recommendations, if appropriate. Explanations are to be placed on additional attachments and cross-referenced appropriately, and may take the form of sketches, measurements, and/or annotated site maps.
4. The site inspection is a walking inspection of the entire site, including the perimeter and sufficient transects to be able to inspect the entire surface and all features specifically described in this checklist. Attach a drawing indicating the starting and ending points and the direction and pattern of the inspection.
5. A standard set of color 35 mm photographs (or equivalent) is required. In addition, all anomalous features or new features (such as changes in adjacent area land use) are to be photographed. A photo log entry will be made for each photograph taken.

B. Preparation (to be completed prior to site visit)	YES	NO	EXPLANATION
1. Site as-built plans and site base map reviewed			
2. Previous inspection reports reviewed			
a. Were anomalies or trends detected on previous inspections?			
b. Was maintenance performed on areas with anomalies?			
3. Site maintenance and repair records reviewed			
a. Has site repair resulted in a change from as-built conditions?			
b. Are revised as-builts available that reflect repair changes?			

C. Site Inspection (to be completed during inspection)	YES	NO	EXPLANATION
1. Adjacent offsite features within mud pit site area			
a. Changes in use of adjacent area?			
b. Any new roads or trails?			
c. Change in the position of nearby washes?			
d. Erosion/deposition of nearby washes?			
e. New drainage channels?			
f. Change in surrounding vegetation?			
2. Security markers; signs			
a. Displacement of site markers, boundary markers, or monuments?			
b. Signs damaged or removed?			
3. Cap			
a. Evidence of subsidence?			
b. Evidence of cracking?			
c. Evidence of erosion (wind or water)?			
d. Evidence of animal burrowing?			
e. Are site markers disturbed? By man?_____ By natural processes?_____			
f. Do natural processes threaten the integrity of cap or site marker?			

AMCHITKA MUD PIT SITES POST-CLOSURE MONITORING CHECKLIST (continued)

Mud Pit Site:	Date of Inspection:

C. Site inspection (continued)	YES	NO	EXPLANATION
4. Vegetative cover			
a. Is plant cover adequate to prevent erosion?			
b. Are weedy annual plants present? Do they require removal?			
c. Evidence of animals on cap?			
d. Evidence of excessive plant mortality?			
e. Has a vegetative cover log been completed?			
5. Photo Documentation			
a. Has a photo log been prepared?			
b. How many photos were taken? _____			

D. Field Conclusions			
1. Imminent hazard to integrity of cap? (If yes, immediate report required. Note the person or agency the report will be made to.)			
2. Are more frequent inspections required?			
3. Are existing maintenance actions satisfactory?			
4. Are existing repair actions satisfactory?			
5. Is other maintenance/repair necessary?			
6. Rationale for field conclusions:			
7. Factors contributing to or impacting inspection:			

E. Certification

I certify that I have conducted an inspection of the _____ Mud Pit Site cap in accordance with the Monitoring and Inspection Plan for the Amchitka Mud Pit Release Sites, Rev. ___, dated _____, as recorded on this checklist, attached sheets, field notes, vegetative cover log, photo logs, and photographs.

Inspector Printed Name:	Inspector Signature:
Title:	Date:

Appendix B

Photograph Log

PHOTOGRAPH LOG

Mud Pit Site:				
Date	**Photo #**	**GPS Location***	**Direction of Photo**	**DESCRIPTION (Note if photopoint)**

*GPS location datum AK State Plane 1983