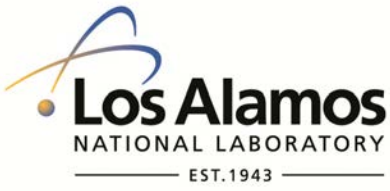
LA-UR-17-24145
June 2017
EP2017-0063

Supplemental Historical Investigation Report for Technical Area 57 Aggregate Area (Fenton Hill)



Prepared by the Associate Directorate for Environmental Management

Los Alamos National Laboratory, operated by Los Alamos National Security, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC52-06NA253 and under DOE Office of Environmental Management Contract No. DE-EM0003528, has prepared this document pursuant to the Compliance Order on Consent, signed March 1, 2005. The Compliance Order on Consent contains requirements for the investigation and cleanup, including corrective action, of contamination at Los Alamos National Laboratory.

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June 2017

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EXECUTIVE SUMMARY

The Technical Area 57 (TA-57) Aggregate Area includes a total of 10 areas of concern (AOCs) located on U.S. Forest Service property west of Los Alamos National Laboratory. Of these 10 sites, 3 have been previously approved for no further action and 2 were investigated during a 2015 investigation of the TA-57 Aggregate Area. The remaining 5 sites require further investigation. These 5 sites were all associated with geothermal exploration activities conducted at TA-57. These sites were previously regulated and administratively closed under a discharge permit issued by the New Mexico Oil Conservation Division and were not included in the previous TA-57 investigation work plan and historical investigation report pending determination of whether they would also be regulated under the Compliance Order on Consent (Consent Order). The 5 sites are included in Appendix A of the 2016 Consent Order and, therefore, will be investigated under the Consent Order as AOCs.

For the remaining five sites requiring investigation, this supplemental historical investigation report provides site descriptions, summarizes previous investigations, and presents analytical results. The background information and previous investigations discussed within this report form the basis for the proposed sampling design necessary to complete site investigations, as discussed in the supplemental TA-57 Aggregate Area investigation work plan.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by Los Alamos National Security, LLC. The Laboratory is located in north-central New Mexico, approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site covers approximately 39 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 to 7800 ft above mean sea level.

The Laboratory is participating in a national effort by DOE to reduce risk to human health and the environment at its facilities. The goal of the Laboratory's effort is to ensure past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, the Laboratory is currently investigating sites potentially contaminated by past Laboratory operations. These sites are designated as either solid waste management units or areas of concern (AOCs).

The Technical Area 57 (TA-57) Aggregate Area is located on Fenton Hill, which lies on the western side of the Jemez Mountains at an elevation of approximately 8700 ft (Figure 1.0-1). TA-57 is located on property owned by the U.S. Forest Service and used by DOE under an Interagency Agreement with the Forest Service. Laboratory operations have been conducted in the aggregate area since 1974.

This supplemental historical investigation report (HIR) describes operational histories, previous investigations, and analytical data for AOCs in TA-57 that are potentially contaminated with hazardous chemicals and radionuclides. The New Mexico Environment Department (NMED), pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 458.1, Administrative Change 3, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management." Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

Corrective actions at the Laboratory are subject to a Compliance Order on Consent (the Consent Order). This supplemental HIR provides supporting information for the work plan activities that will be executed and completed in accordance with the Consent Order.

1.1 Historical Investigation Report Overview

The TA-57 Aggregate Area includes 10 AOCs, 3 of which have previously been approved for no further action (NFA) and 2 of which were previously investigated in 2015. The remaining 5 sites require additional characterization. These 5 sites were all associated with geothermal exploration activities conducted at TA-57. These sites were previously regulated and administratively closed under a discharge permit issued by the New Mexico Oil Conservation Division (NMOCD) and were not included in the TA-57 investigation work plan (LANL 2012, 214550) and HIR (LANL 2012, 214549) pending determination of whether they would also be regulated under the Consent Order. The 5 sites are included in Appendix A of the 2016 Consent Order and, therefore, will be investigated under the Consent Order as AOCs. Table 1.1-1 provides a summary of the 10 sites within the aggregate area and their status. For the NFA sites and sites previously investigated, only a brief description and the reference to the approval document is provided in this supplemental HIR and only in Table 1.1-1.

Section 2 of this supplemental HIR provides descriptions and operational histories, summarizes previous investigations, and presents analytical data for sites under investigation. For each site, the location, historical operations, and current status are described first, followed by descriptions of historical investigations with the dates and activities performed. The results of analytical data obtained from previous investigations are then summarized. Plate 1 shows the locations of the sites under investigation within the TA-57 Aggregate Area. Appendix A includes a list of acronyms and abbreviations, a metric conversion table, and a table for data qualifier definitions.

1.2 Data Overview

Data evaluated in this report include historical data collected in 1994 and 2002 as part of a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) and NMOCD closure, respectively. All data records include a vintage code field denoting how and where samples were submitted for analyses. In the early years, the samples were submitted to the Laboratory's Chemical Science and Technology (CST) Division and were either analyzed at a CST laboratory (on-site) or submitted to one of several off-site contract analytical laboratories. Samples analyzed at a CST laboratory are identified by the vintage code "CST Onsite." Two vintage codes identify samples CST Division submitted to off-site contract analytical laboratories—"CST Offsite" if validation was not performed and "CSTROUT03" if validation was performed.

From late 1995 to the present, samples have been submitted through the Sample Management Office (SMO) to off-site contract analytical laboratories. Two vintage codes identify samples the SMO submitted to off-site contract analytical laboratories: "AN95" if validation was not performed and "SMO" if validation was performed.

All the data collected during the 1994 RFI are screening-level data and are summarized in this supplemental HIR. Inorganic chemical analyses for samples from the 2002 NMOCD closure were performed by an on-site laboratory and are screening-level data. Results of organic chemical analysis for samples from the 2002 NMOCD closure are decision-level data. All valid 2002 organic results were below detection limits and are not presented in tables or figures in this supplemental HIR.

Screening-level data are used to identify areas of contamination and to guide sample collection and analyses proposed in the TA-57 Aggregate Area supplemental investigation work plan (LANL 2017, 602375) but will not be used in defining the nature and extent of contamination or in risk-screening evaluations.

2.0 SITES UNDER INVESTIGATION

TA-57 was established at the Fenton Hill site to support the Laboratory's Hot Dry Rock (HDR) program, an experimental program designed to test the feasibility of extracting heat from deep geologic units near the Valles Caldera. The first site investigated was in Barley Canyon north of the current TA-57 site. This location was abandoned because of poor winter access and topographic limitations after one test well had been drilled. Operations were then moved to the current TA-57 site, which offered a large flat area with easier access. Operations at the TA-57 site began in 1974.

The HDR concept was based on drilling deep (i.e., 10,000 to 15,000 ft) boreholes into the low permeability, hot crystalline rock beneath the site. Hydraulic fracturing was then used to create a permeable fractured zone between the two boreholes. During operation, pressurized water was injected into one well and extracted from the other after flowing through the fractured zone and becoming heated.

Heat exchangers on the surface were used to extract heat from the water, which was then circulated through settling ponds for further cooling before being reinjected.

The first geothermal well drilled at TA-57, well GT-2, was started in 1974 and completed in 1975. Upon completion of hydraulic fracturing of well GT-2, drilling began on well EE-1, which was to be the extraction well used with GT-2. Well EE-1 was completed in 1976 but did not initially intersect the fractured zone from well GT-2. Additional drilling and fracturing was performed and testing of the two-well system began in 1978. Work on a larger Phase II system began in 1979 with drilling of well EE-2, the injection well for the Phase II system. Well EE-2 was completed in 1980 and drilling began on extraction well EE-3, which was completed in 1981. Various fracturing and redrilling activities occurred until good hydraulic connection between the two wells was made in 1985. Testing of the system continued until 1992, when operations were substantially reduced because of funding limitations.

When the extraction wells were drilled, various materials were added to drilling muds to lubricate the drill bit and maintain the borehole. Drilling mud additives used in large quantities included bentonite clay, barium sulfate, sodium hydroxide, ammonium bisulfite, cotton seed hulls, lime, sawdust, and walnut hulls (LANL 1994, 034757, pp. 2–13). Materials used in smaller quantities included para-formaldehyde (a biocide), organic solvents and salts, inorganic and organic acids, isopropyl alcohol, and phosphate descaler. Drilling muds were discharged to mud pits and settling ponds near the drill sites. These sites were regulated by NMOCD and closed in accordance with NMOCD requirements.

As noted above, during geothermal testing, water was injected into injection wells, heated as it flowed through fractures in the hot rock, and extracted into extraction wells. As the fluid was circulated, it dissolved and mobilized residual additives from the wells as well as constituents from the rock. Constituents dissolved and mobilized from rock include arsenic, boron, cadmium, carbonates, chloride, fluoride, lithium, silica, sodium, sulfate, and uranium. Because these chemicals generally have higher solubility at high temperature, they would come out of solution and precipitate as the fluid cooled in the settling ponds.

Chemical and radioactive tracers were also injected into the wells to map temperatures and determine reservoir characteristics. Chemical tracers included sodium fluorescein, sodium bromide, sodium nitrate, and p-toluenesulphonic acid (LANL 1994, 034757, pp. 2–13). Bromide-82 was the radioactive tracer most commonly used, but iodine-131 was also used in early studies.

After the end of the HDR project, the 5-mil.-gal. synthetically lined settling pond [AOC 57-004(b)] was converted to a gamma-ray observatory for a project known as Milagro. The liquid and sludge were removed from the pond, the interior of the pond was cleaned, instruments were placed in the pond, and it was refilled with pure water. A cover was also constructed over the pond.

The TA-57 site is now used to operate a fully automated observatory in support of the Thinking Telescopes project in the Laboratory's Intelligence and Space Research Division. This project combines automated telescope observation, feature extraction from image data, change and anomaly detection, and automated response. An automated measurement program continuously scans the sky to detect optical transients. Transients may be a gamma-ray burst that is of interest to the open science community or a man-made object of interest for space situational awareness.

2.1 AOC 57-001(b), Former Settling Pond

2.1.1 Description and History

AOC 57-001(b) consists of a former settling pond associated with the HDR geothermal energy experiments conducted at the TA-57 Fenton Hill site (Figure 2.1-1). The settling pond was designated GTP-3. Constructed in 1974, Pond GTP-3 was approximately 100 ft × 120 ft × 20 ft deep and was constructed by building a 10-ft-high berm across the head of Burns Swale and excavating into tuff behind the berm. A spillway directed overflow water around the west end of the berm and into the swale. The settling pond was used to settle out particulates from the water used in the drilling and circulating operations for well GT-2 (Plate 1). After the particulates had settled out, the water was either recirculated or discharged from the pond. Discharges to the swale were performed periodically, and the liquid from the pond was sampled and analyzed before discharge. Solids and mud were occasionally removed from the pond during the operation period and were transported to the sludge pit (AOC 57-002). When the pond ceased to be used, all the material in the pond was removed and taken to the sludge pit, and the settling pond was backfilled.

Discharges from the pond were permitted under a National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permit (NM0028576) required monitoring for arsenic, boron, cadmium, fluoride, and lithium each day a discharge occurred. In addition to the NPDES permit, the discharge was also subject to a groundwater discharge permit issued by the State of New Mexico. The groundwater discharge permit required the discharge from the outfall to be controlled so no effluent flow traveled beyond the point where Lake Fork Canyon Road crosses the watercourse receiving the discharge. This point is approximately 1 mi downstream of the outfall.

The site of the former pond is currently vegetated with grasses. The land surface where the pond was located slopes gently to the south to what appears to be the berm that formed the southern boundary of the pond. The topography then steepens to the south. A drainage ditch originates near the southwest corner of the former pond and runs along the west side of the slope below the berm. To the southeast of the pond is a discharge structure that contains a flow-measuring gage and appears to be associated with the former NPDES outfall. A discharge hose is present below the outfall structure.

2.1.2 Previous Investigations

The Laboratory conducted a Phase I RFI at AOC 57-001(b) in 1994 (LANL 1996, 053801). Samples were collected from within pond GTP-3 and below the outfall. Sampling locations are shown in Figure 2.1-1. At pond GTP-3, one borehole was advanced near the center of the pond. Samples were collected at 1-ft intervals from 2 to 18 ft below ground surface (bgs) (tuff bedrock was encountered at 16 ft bgs) and screened in the field for barium using x-ray fluorescence (XRF). The sample with the highest field-screening result for barium (5300 mg/kg at 11 ft to 12 ft bgs) was submitted for laboratory analysis of target analyte list (TAL) metals, total cyanide, uranium, and semivolatile organic compounds (SVOCs). The material sampled at this interval was reported to be “service material” (a sludge-like mixture of drilling mud and additives) (LANL 1996, 053801, p. 27).

Samples were also collected at two locations in Burns Swale below the outfall. One sampling location was just south of the perimeter fence for TA-57 near the inlet of the swale, and the other was approximately 100 ft downgradient. At the upper location, a borehole was advanced to 9.75 ft bgs (tuff bedrock was encountered at 7 ft bgs), and samples were collected at 1-ft intervals from the surface to 8 ft and screened in the field for barium using XRF. The sample from the surface (0 to 1 ft bgs) and the sample with the highest field-screening result for barium (494 mg/kg at 4 ft to 5 ft bgs) were submitted for laboratory analysis of TAL metals, total cyanide, uranium, and SVOCs. At the lower location, a borehole

was advanced to 5 ft bgs (tuff bedrock was encountered at 3.5 ft bgs), and samples were collected at the surface (0 to 1 ft bgs) and from 3 ft to 4 ft and 4 ft to 5 ft bgs. The two deeper samples were screened in the field for barium using XRF. Field-screening results did not show elevated barium. The surface sample (0 to 1 ft bgs) and the sample at the soil/tuff interface (3 ft to 4 ft bgs) were submitted for laboratory analysis of TAL metals, total cyanide, uranium, and SVOCs.

2.1.3 Analytical Results

No decision-level data are available for AOC 57-001(b). Data from the 1994 Phase I RFI are screening level and are not presented in this report but are summarized below.

Inorganic chemicals detected above current background values (BVs) for soil (LANL 1998, 059730) in the sample collected from the borehole at GTP-3W were arsenic (13 times BV), barium (38 times BV), calcium (3.7 times BV), chromium (1.2 times BV), copper (15 times BV), lead (7.5 times BV), magnesium (5.4 times BV), sodium (3.1 times BV), and zinc (4.5 times BV). Antimony, cadmium, cyanide, silver, and thallium were not detected but had detection limits (DLs) above current BVs for soil (LANL 1998, 059730). Arsenic was detected above current residential and industrial soil screening levels (SSLs) (NMED 2017, 602273) (22 times the residential SSL and 4.0 times the industrial SSL). No SVOCs were detected, although DLs were elevated (69 mg/kg to 170 mg/kg) because of dilutions made in the laboratory necessitated by the high organic content of the material sampled.

Inorganic chemicals detected above current BVs for soil (LANL 1998, 059730) in the samples collected in Burns Swale were arsenic (3.7 times BV), barium (1.8 times BV), cadmium (11 times BV), manganese (1.3 times BV), and uranium (1.04 times BV). Antimony was not detected but had DLs above the current BV for soil (LANL 1998, 059730). Arsenic was detected above current residential and industrial SSLs (NMED 2017, 602273) (6.5 times the residential SSL and 1.2 times the industrial SSL). No organic chemicals were detected (DLs ranged from 0.35 mg/kg to 1 mg/kg).

2.2 AOC 57-001(c), Former Settling Pond

2.2.1 Description and History

AOC 57-001(c) consists of a former settling pond associated with the HDR geothermal energy experiments conducted at the TA-57 Fenton Hill site (Figure 2.2-1). The settling pond was designated GTP-2. The pond was constructed in 1976 by excavation into tuff bedrock. The pond had approximate dimensions of 25 ft × 80 ft × 10 ft and was used to contain circulation fluids consisting of water injected into the deep geothermal extraction wells. This water contained tracer compounds and dissolved, naturally occurring minerals leached during contact with hot rock formations. The pond was decommissioned in 1980, cleaned, and filled with clean soil to the level of the original ground surface. A portion of building 57-56, a storage building, is currently located on the footprint of the former pond.

The site of the former pond is currently vegetated with grasses. The land surface where the pond was located slopes gently to the south. A three-sided storage building (building 57-56) is currently located along the southern boundary of the former pond. The building has metal walls and a concrete floor and currently contains two inactive 300-gal. tanks that were used to store gasoline and diesel fuel.

2.2.2 Previous Investigations

The Laboratory conducted a Phase I RFI at AOC 57-001(c) in 1994 (LANL 1996, 053801). One borehole was advanced within the expected footprint of the former pond. A review of historical aerial photographs indicates the location of the RFI sample may not have been within the footprint of the former pond. The 1994 RFI work plan indicated the pond location was no longer evident at the time the work plan was

prepared (LANL 1994, 034757, pp. 5–7). The boundary of the former pond has been updated based on the aerial photographs, and the updated boundary and RFI sampling location are shown in Figure 2.2-1. Samples were collected at 1-ft intervals from 2 ft to 15 ft bgs (tuff bedrock was encountered at 9.5 ft bgs) and screened in the field for barium using XRF. Field-screening results did not show elevated barium. The core sample from 4 ft to 5 ft bgs revealed a slimy, black, clay-like material containing pieces of wood that appeared similar to “service material” (LANL 1996, 053801, p. 41). A sample of this material from 4.5 ft to 5.0 ft bgs was submitted for laboratory analysis of TAL metals, total cyanide, uranium, and SVOCs.

2.2.3 Analytical Results

No decision-level data are available for AOC 57-001(c). Data from the 1994 Phase I RFI are screening level and are not presented in this report.

Cadmium was detected above the current BV for soil (3.2 times BV). Antimony and silver were not detected but had DLs above current BVs for soil (LANL 1998, 059730). No inorganic chemicals were detected above current SSLs (NMED 2017, 602273), and no organic chemicals were detected (DLs ranged from 0.39 mg/kg to 0.95 mg/kg).

2.3 AOC 57-002, Sludge Pit

2.3.1 Description and History

AOC 57-002 is a sludge pit located on U.S. Forest Service property approximately 2 mi west of the TA-57 site (Figure 2.3-1). This pit was used from 1974 to 1990 to dispose of solids removed from the bottom of Fenton Hill settling ponds and drilling mud removed from the Fenton Hill drilling mud pits. The sludge pit is located at the former site of a gravel pit that was used by the State of New Mexico during construction of NM 126. The approximate dimensions of the pit are 100 ft × 200 ft. The pit is divided into two sections. The western section is reported to be 15 ft to 20 ft deep and was used during the early stages of operation at Fenton Hill (LANL 1994, 034757). It was active until about 1985 when disposal started in the eastern section. The eastern section is reported to be 6 ft to 8 ft deep and was used until 1990 when pond GTP-1W [AOC 57-004(a)] was cleaned out.

During operations, sludge from cleanout of the settling ponds and mud pits at TA-57 was trucked to the site and dumped into the north end of the pit. The sludge was then distributed throughout the pit using a bulldozer. If the water in the sludge did not evaporate or infiltrate at a sufficient rate, a berm on the south side of the pit would be breached to allow the water to flow onto a graded area south of the pit where it could evaporate.

The site of the disposal pit is currently sparsely vegetated with grasses and shrubs. The pit is located in a depression that appears to be the former borrow pit. A berm divides the pit into eastern and western sections, and the ground surface of the western section is visibly higher than the eastern.

2.3.2 Previous Investigations

The Laboratory conducted a Phase I RFI at AOC 57-002 in 1994 (LANL 1996, 053801). Two boreholes were advanced—one within the footprint of the eastern pit area and one in the western pit area. Sampling locations are shown in Figure 2.3-1. At the eastern pit location, the borehole was advanced until tuff bedrock was encountered at 7 ft bgs. The core revealed a black, saturated, clay-like material at 4.5 ft bgs that appeared similar to “service material” (LANL 1996, 053801, p. 44). A sample of this material from 4.5 ft to 5.0 ft bgs was submitted for laboratory analysis of TAL metals, total cyanide, uranium, and SVOCs. At the western pit location, the borehole was advanced to 15 ft bgs (tuff bedrock was

encountered at 12.5 ft bgs). The black “service material” was encountered at 9 ft to 10 ft bgs, and a sample from this interval was submitted for laboratory analysis of TAL metals, total cyanide, uranium, and SVOCs.

2.3.3 Analytical Results

No decision-level data are available for AOC 57-002. Data from the 1994 Phase I RFI are screening level and are not presented in this report but are summarized below.

Inorganic chemicals detected above current BVs in the sample collected from the eastern borehole were arsenic (13 times BV), barium (82 times BV), calcium (6.5 times BV), copper (15 times BV), lead (11 times BV), magnesium (2.9 times BV), sodium (4.6 times BV), and zinc (4.5 times BV). Antimony, cadmium, cyanide, mercury, silver, and thallium were not detected but had DLs above current BVs for soil (LANL 1998, 059730). Arsenic was detected above current residential and industrial SSLs (NMED 2017, 602273) (23 times the residential SSL and 4.1 times the industrial SSL), and barium was detected above the current residential SSL (1.5 times the residential SSL). No SVOCs were detected, but DLs were elevated (64 mg/kg to 160 mg/kg) because of dilutions made in the laboratory necessitated by the high organic content of the material.

Inorganic chemicals detected above current BVs in the sample collected from the western borehole were barium (2.3 times BV), calcium (4.7 times BV), copper (2.5 times BV), lead (11 times BV), sodium (1.8 times BV), and zinc (2.0 times BV). Antimony, cadmium, and cyanide were not detected but had DLs above the current BVs for soil (LANL 1998, 059730). No inorganic chemicals detected above BV were detected above current residential and industrial SSLs (NMED 2017, 602273). No organic chemicals were detected but DLs were elevated (4.2 mg/kg to 10 mg/kg) because of dilutions made in the laboratory necessitated by the high organic content of the material sampled.

2.4 AOC 57-004(a), Former Settling Ponds

2.4.1 Description and History

AOC 57-004(a) consists of two former settling ponds (GTP-1E and GTP-1W) located at the north end of TA-57 (Figure 2.1-1). Settling pond GTP-1E was originally excavated in 1975 for use as a disposal pit during the drilling of well EE-1. Pond GTP-1E was enlarged in several stages as operations advanced and also was used for settling circulation fluids from geothermal testing. Pond GTP-1E was constructed by excavating into soil and tuff at the site and was expanded several times during operations. Final dimensions were approximately 40 ft × 310 ft. In 1983 and 1984, pond GTP-1E was decommissioned, cleaned of sludge, and backfilled with clean soil to the original ground level. Pond GTP-1W was then excavated and lined with plastic. The location of this new pond included the eastern portion of pond GTP-1E. Pond GTP-1W had a capacity of 1 million gal. and dimensions of 120 ft × 280 ft. In 1990, pond GTP-1W was relined with a double liner after the original lining deteriorated. In 1997, the pond was cleaned to remove accumulated sludge. From 1997 to 2002, the pond was used to hold geothermal circulation fluid and ion exchange backflush water from the Milagro Project.

When pond GTP-3 [AOC 57-001(b)] was in operation, no discharge occurred from pond GTP-1W to the environment. Instead, fluid would be circulated through pond GTP-1W and then piped to pond GTP-3 where supernatant liquid would be discharged through the NPDES outfall to Burns Swale. After pond GTP-3 was taken out of service in 1984, supernatant liquid from pond GTP-1W was piped directly to the NPDES outfall.

In 2002, the Laboratory closed pond GTP-1W in accordance with a closure plan approved by the NMOCD (LANL 2002, 101220). During closure, the liquid and sludge remaining in the pond were removed and

disposed of off-site (LANL 2002, 101221). The two liners and the fill between the liners were also removed and disposed of off-site. After the liners were removed, the liner bedding material, which consisted of crusher fines, was sampled and found to contain arsenic ranging from 204 mg/kg to 272 mg/kg. Similar concentrations were detected, however, in the bedding material located above the waterline of the pond. The Laboratory concluded that the arsenic was from high background levels in the crusher fines rather than from the leakage of pond fluids. The Laboratory proposed to consolidate the crusher fines in the deepest part of the pond excavation before backfilling (LANL 2003, 101221). This backfill plan was approved by NMOCD, and the pond was backfilled, graded, and reseeded (NMOCD 2003, 101222). Following completion of closure, a final closure report was submitted by the Laboratory to, and approved by, NMOCD (LANL 2003, 101264; NMOCD 2003, 101265).

The site of the former ponds is currently vegetated with grasses. The land surface where the ponds were located slopes gently to the south. No structures were located on the site of the former ponds. A monument is located north of the former ponds at the closed wellhead of geothermal well EE-3.

2.4.2 Previous Investigations

The Laboratory conducted a Phase I RFI at AOC 57-004(a) in 1994 (LANL 1996, 053801). Because former pond GTP-1W was active at that time, sampling was performed east of pond GTP-1W within the footprint of former pond GTP-1E. One borehole was advanced to a depth of 7.33 ft bgs, when drilling ceased because of the hardness of the tuff bedrock, which was encountered at 6 ft. Samples were collected at 1-ft intervals from 2 to 7 ft bgs and screened in the field for barium using XRF. From 5.25 ft to 6 ft bgs, the core material consisted of a black, clay-like material that appeared similar to “service material” (LANL 1996, 053801, p. 50). This material was screened using XRF and found to contain a higher concentration of barium than the other material. A sample of this material and of the underlying tuff from 6 ft to 7 ft bgs were submitted for laboratory analysis of TAL metals, total cyanide, uranium, and SVOCs.

As described above, the area beneath the lower pond liner was sampled during the 2002 closure of pond GTP-1W. Ten samples were collected from five locations in the pond footprint. Four of the five locations are shown in Figure 2.2-1. Samples from the other location were submitted only to an on-site laboratory, and the location was not found in the analytical database. At each location, a sample of the crusher fine bedding material was collected from an interval 0 to 0.5 ft beneath the liner, and a sample of tuff was collected from an interval 1.5 ft to 2 ft beneath the liner, except for one location where the tuff sample was collected from 0.8 ft to 1.3 ft beneath the liner because of the hardness of the tuff. All samples were submitted to an on-site analytical laboratory for analysis of TAL metals plus boron, molybdenum, tin, thorium, and uranium. Two samples were also submitted to an off-site analytical laboratory for analysis of SVOCs.

In response to the detection of elevated levels of arsenic in the crusher fine samples, two additional samples of crusher fines (0 to 0.5 ft below the former liner) were collected from above the pond overflow pipe (i.e., above the high water line of the pond). A surface sample of tuff (0 to 0.5 ft bgs) was also collected outside the footprint of the pond. These samples were submitted to an on-site analytical laboratory for analysis of arsenic. In addition, three of the previous crusher fine samples were submitted to an off-site laboratory for analysis of toxicity characteristic leaching procedure metals.

2.4.3 Analytical Results

Data from the 1994 Phase I RFI are screening level and are not presented in this report but are summarized below.

Inorganic chemicals detected above current BVs (LANL 1998, 059730) in the RFI sample collected at 5.25 ft to 6 ft bgs were barium (2.9 times BV), cadmium (15 times BV), calcium (5.2 times BV), chromium (1.5 times BV), copper (17 times BV), cyanide (1.9 times BV), lead (7.2 times BV), uranium (1.3 times BV), and zinc (26 times BV). Antimony, cobalt, sodium, and silver were not detected in this sample but had DLs above current BVs for soil (LANL 1998, 059730). No inorganic chemicals detected above BV were detected above current SSLs (NMED 2017, 602273). No organic chemicals were detected, but DLs were elevated (98 mg/kg to 240 mg/kg) because of dilutions made in the laboratory necessitated by the high organic content of the material sampled.

No inorganic chemicals were detected above current BVs for tuff (LANL 1998, 059730) in the RFI tuff sample. Antimony was not detected but had a DL above the current BV for tuff (LANL 1998, 059730). No organic chemicals were detected (DLs of 0.33 mg/kg to 0.81 mg/kg).

Inorganic data from the 2002 closure are screening-level data and are not presented in this report but are summarized below.

Aluminum, antimony, arsenic, barium, beryllium, cobalt, magnesium, manganese, mercury, potassium, sodium, thallium, uranium, vanadium, and zinc were detected above current BVs for soil (LANL 1998, 059730) in the crusher fine samples. Aluminum, arsenic, barium, beryllium, chromium, copper, iron, lead, magnesium, manganese, mercury, potassium, sodium, uranium, and zinc were detected above current BVs for Qbt 2,3,4 (LANL 1998, 059730) in the tuff samples. Arsenic was detected above current residential and industrial SSLs (NMED 2017, 602273) in crusher fine and tuff samples.

Organic data from the 2002 closure are decision-level data but are not presented in this report because all results were below DLs.

2.5 AOC 57-004(b), Settling Pond

2.5.1 Description and History

AOC 57-004(b) is a 5-million-gal. plastic-lined settling pond located southwest of the main TA-57 operating area (Figure 2.5-1). The pond was constructed in 1982 and previously contained circulation fluids from geothermal wells. The pond has a synthetic membrane liner with an underdrain system below the liner. In 2002, the pond was modified for use in the Milagro gamma-ray observatory project. The pond was cleaned out, instrumented with over 700 photomultiplier tubes, refilled with purified water, and covered with a lightproof cover consisting of a synthetic membrane. The Milagro project has since ended and the photomultiplier tubes have been removed. The pond liners have been partially removed.

The pond underdrain system was designed to collect any leakage through the pond liner. The underdrain system consisted of a 6-in. layer of granular material that was sloped toward a collection trench located along the center of the pond. The collection trench contained a 6-in. perforated pipe and granular backfill. The pipe was sloped to the west and passed beneath the western pond wall. A 10-in. drain pipe was located beneath the underdrain system and ran parallel to the underdrain pipe. The underdrain pipe, drain pipe, and an overflow pipe all flowed to the west of the pond to a common discharge structure. The discharge structure consists of a collection sump and discharge pump as well as an emergency overflow. Water collecting in the sump would be pumped from the sump and discharged to the ground. In the event of an emergency, the sump would overflow onto the ground surface.

No records of any discharge of leakage or overflow during operation of the pond are available. During decommissioning of the Milagro Project, the pond was pumped down to allow the photomultiplier tubes to be removed. In 2015, discharge from the outfall was discovered, apparently caused by valve leakage from the drainpipe, and repairs were made to stop the leak.

2.5.2 Previous Investigations

No previous investigations have been conducted at AOC 57-004(b).

2.5.3 Analytical Results

No analytical data are available for AOC 57-004(b).

3.0 REFERENCES AND MAP DATA SOURCES

3.1 References

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID or ESHID. This information is also included in text citations. ERIDs were assigned by the Associate Directorate for Environmental Management's (ADEM's) Records Processing Facility (IDs through 599999), and ESHIDs are assigned by the Environment, Safety, and Health Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and ADEM maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

EPA (U.S. Environmental Protection Agency), January 21, 2005. "EPA's Prior Decisions on SWMU/AOC Sites at Los Alamos National Laboratory (LANL)," U.S. Environmental Protection Agency letter to J. Bearzi (NMED-HRMB) from L.F. King (EPA Federal Facilities Section Chief), Dallas, Texas. (EPA 2005, 088464)

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LANL (Los Alamos National Laboratory), April 1996. "RFI Report for Potential Release Sites at TA-57, 57-001(b), 57-001(c), 57-002, 57-004(a), 57-006, 57-007 (located in former Operable Unit 1154)," Los Alamos National Laboratory document LA-UR-96-1062, Los Alamos, New Mexico. (LANL 1996, 053801)

LANL (Los Alamos National Laboratory), September 22, 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-98-4847, Los Alamos, New Mexico. (LANL 1998, 059730)

LANL (Los Alamos National Laboratory), February 7, 2003. "Progress Report and Proposed Backfill Plan, 1-MG Service Pond, Fenton Hill Geothermal Facility," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2002, 101221)

LANL (Los Alamos National Laboratory), August 2002. "Closure Plan for Fenton Hill Geothermal 1-MG Service Pond and EE-2A Production Well," Los Alamos National Laboratory document LA-UR-02-5009, Los Alamos, New Mexico. (LANL 2002, 101220)

LANL (Los Alamos National Laboratory), August 13, 2003. "Final Closure Report, 1-MG Service Pond and EE-2A Wellhead, Fenton Hill Geothermal Facility," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2003, 101264)

LANL (Los Alamos National Laboratory), April 2012. "Investigation Work Plan for Technical Area 57 Aggregate Area (Fenton Hill)," Los Alamos National Laboratory document LA-UR-12-20545, Los Alamos, New Mexico. (LANL 2012, 214550)

LANL (Los Alamos National Laboratory), April 2012. "Historical Investigation Report for Technical Area 57 Aggregate Area (Fenton Hill)," Los Alamos National Laboratory document LA-UR-12-20544, Los Alamos, New Mexico. (LANL 2012, 214549)

LANL (Los Alamos National Laboratory), December 2015. "Investigation Report for Technical Area 57 Aggregate Area (Fenton Hill), Revision 1," Los Alamos National Laboratory document LA-UR-15-29322, Los Alamos, New Mexico. (LANL 2015, 601045)

LANL (Los Alamos National Laboratory), May 2017. "Supplemental Investigation Work Plan for Technical Area 57 Aggregate Area (Fenton Hill)," Los Alamos National Laboratory document LA-UR-17-24144, Los Alamos, New Mexico. (LANL 2017, 602375)

NMED (New Mexico Environment Department), March 2017. "Risk Assessment Guidance for Site Investigations and Remediation, Volume 1, Soil Screening Guidance for Human Health Risk Assessments," Hazardous Waste Bureau and Ground Water Quality Bureau, Santa Fe, New Mexico. (NMED 2017, 602273)

NMOCD (New Mexico Oil Conservation Division), February 14, 2003. "Discharge Plan GW-031 1-MG Service Pond Closure Plan, Fenton Hill Geothermal Facility," New Mexico Oil Conservation Division letter to B. Beers (LANL) from W. Price (NMOCD), Santa Fe, New Mexico. (NMOCD 2003, 101222)

NMOCD (New Mexico Oil Conservation Division), August 29, 2003. "Termination of Discharge Plan GW-031, Fenton Hill Geothermal Facility," New Mexico Oil Conservation Division letter to B. Beers (LANL) from W. Price (NMOCD), Santa Fe, New Mexico. (NMOCD 2003, 101265)

3.2 Map Data Sources

Data sources used in original figures created for this report are described below and identified by legend title.

Legend Item	Data Source
LANL Technical Areas	Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 04 December 2008.
Paved roads	Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Dirt roads	Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Drainages	WQH Drainage Arcs; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; 1:24,000 Scale Data; 03 June 2003.
LANL AOC boundaries	Areas of Concern; Los Alamos National Laboratory, Waste and Environmental Services Division, Environmental Data and Analysis Group, EP2009-0137; 1:2,500 Scale Data; 25 January 2010.
LANL structures	Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Legend Item	Data Source
LANL fence lines	Security and Industrial Fences and Gates; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL communications lines	Communication Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 08 August 2002; as published 28 May 2009.
LANL electric lines	Primary Electric Grid; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL gas lines	Primary Gas Distribution Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL sewer lines	Sewer Line System; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL water lines	Water Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Contours	Hypsography, 2, 10, 20, and 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

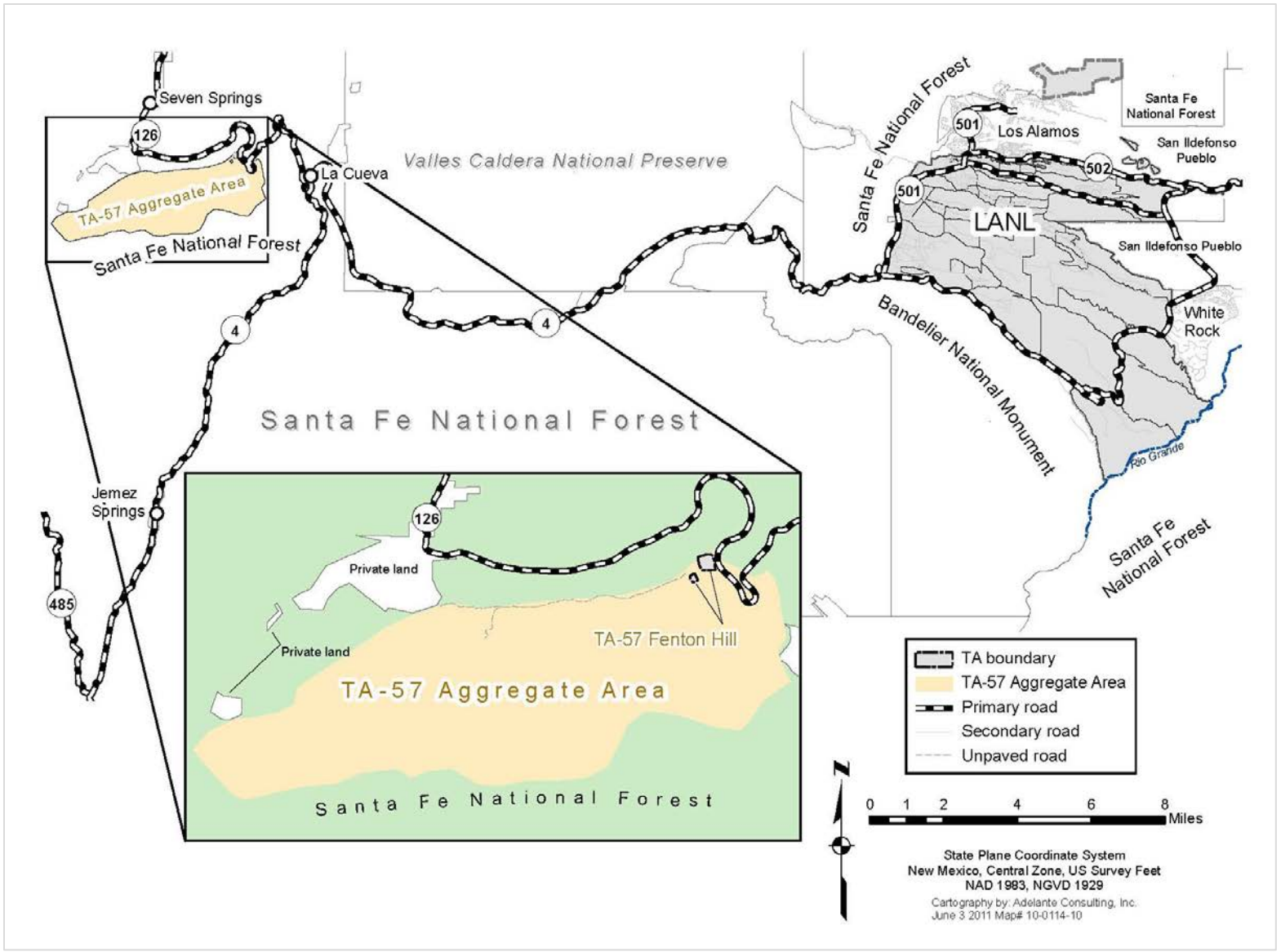

Figure 1.0-1 Location of TA-57 Aggregate Area

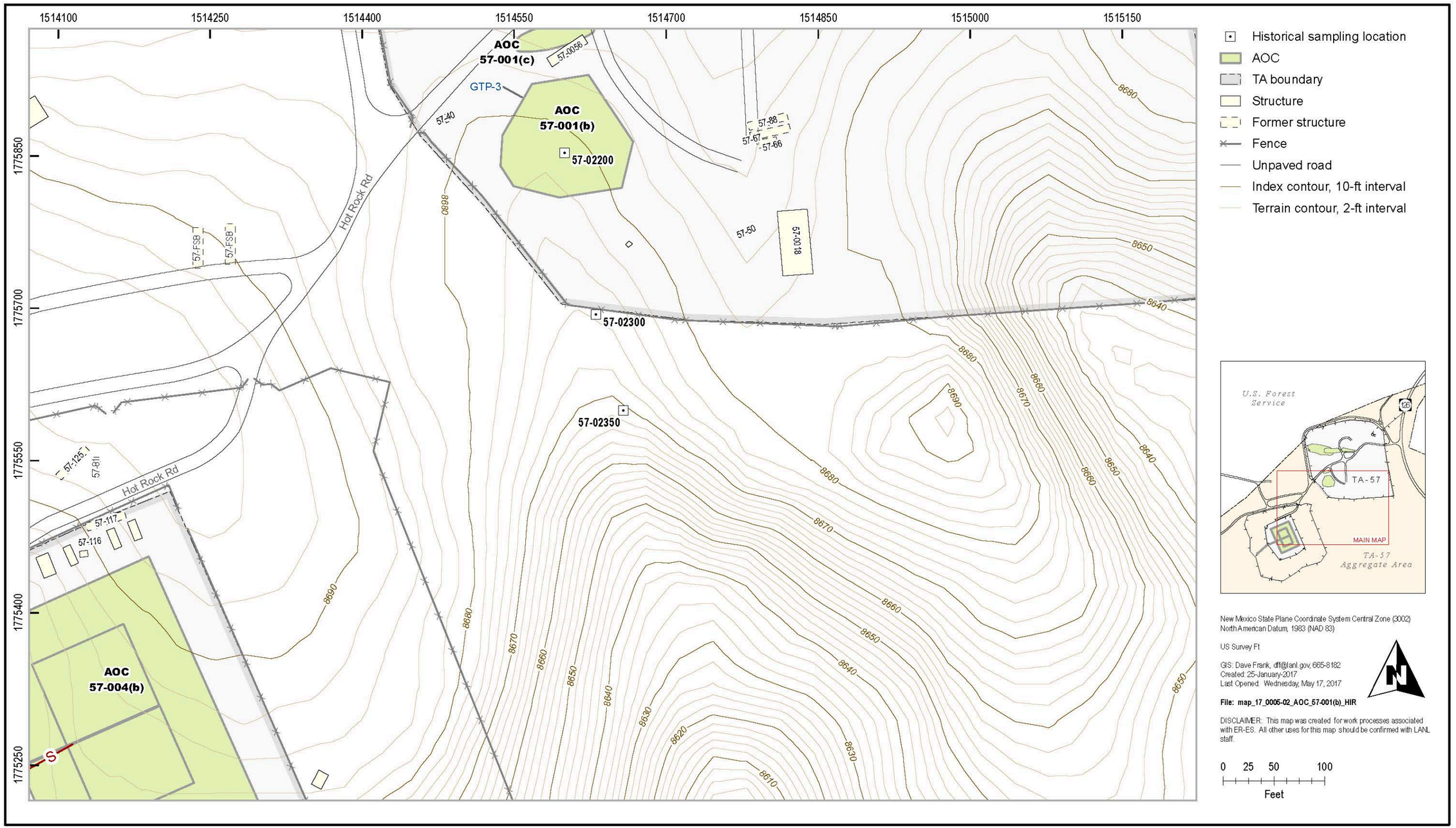

Figure 2.1-1 Site features and historical sampling locations for AOC 57-001(b)

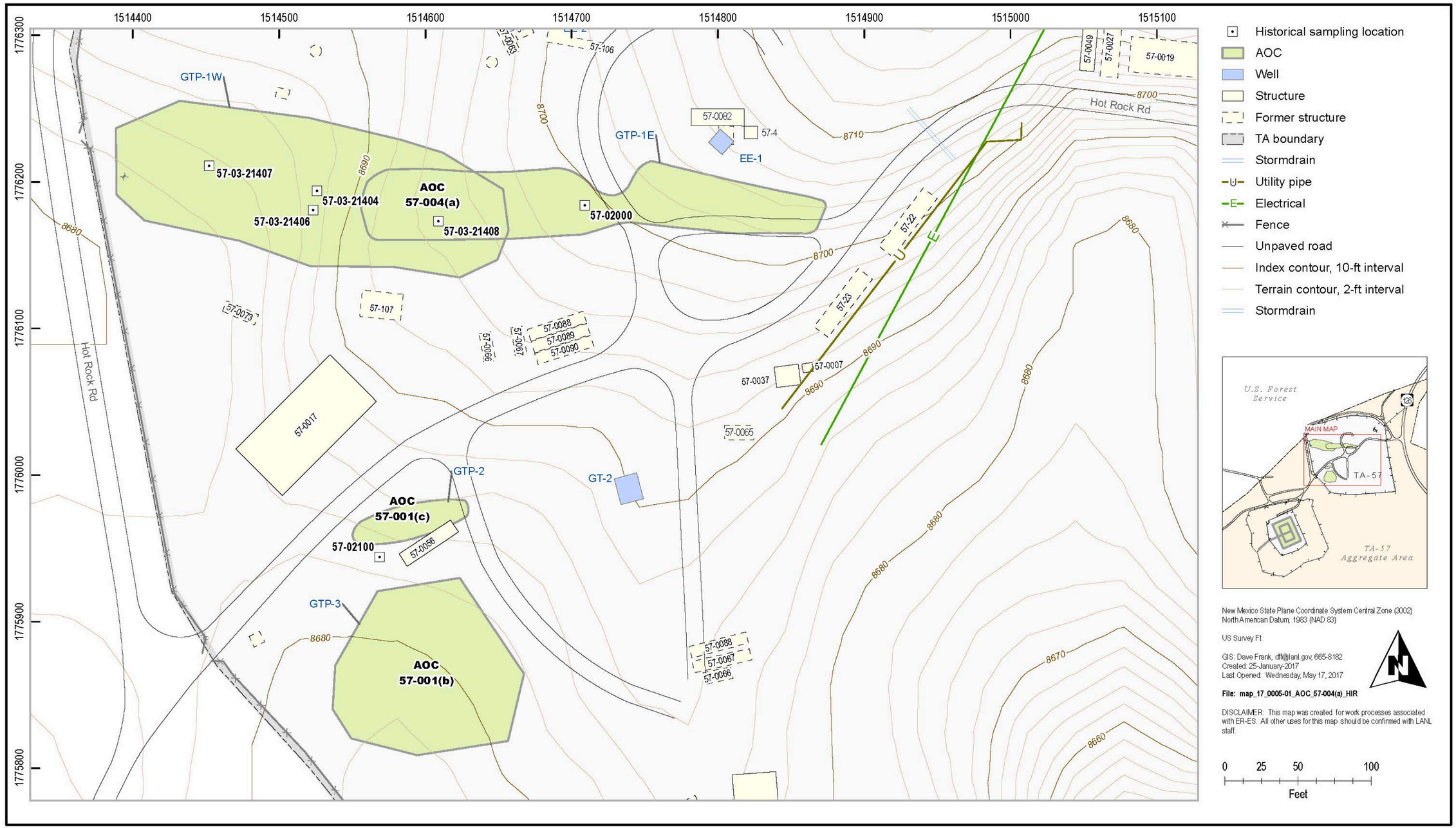

Figure 2.2-1 Site features and historical sampling locations for AOCs 57-001(c) and 57-004(a)

Figure 2.3-1 Site features and historical sampling locations for AOC 57-002

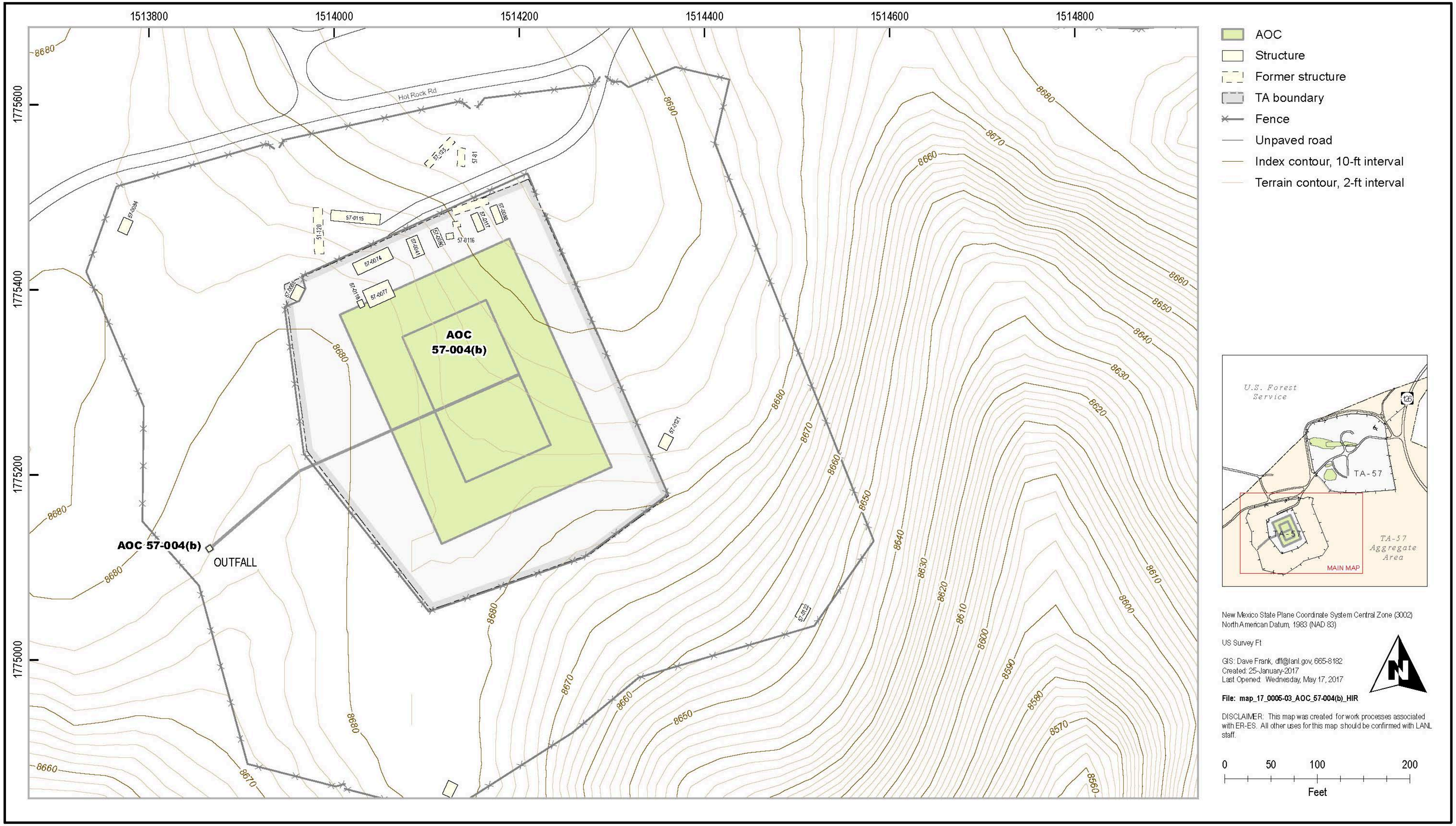

Figure 2.5-1 Site features for AOC 57-004(b)

Table 1.1-1
Status of AOCs in TA-57 Aggregate Area

Site ID	Brief Description	Site Status	Reference
AOC 57-001(a)	Drilling mud pits	NFA Approved, 01/21/05	EPA 2005, 088464
AOC 57-001(b)	Former settling ponds	Under Investigation	Section 4.1
AOC 57-001(c)	Former settling pond	Under Investigation	Section 4.2
AOC 57-002	Sludge pit	Under Investigation	Section 4.3
AOC 57-003	Container storage facility	NFA Approved, 01/21/05	EPA 2005, 088464
AOC 57-004(a)	Former settling ponds	Under Investigation	Section 4.4
AOC 57-004(b)	Settling pond	Under Investigation	Section 4.5
AOC 57-005	Pond filtration unit	NFA Approved, 01/21/05	EPA 2005, 088464
AOC 57-006	Former drum and contents	Investigation Complete	LANL 2015, 601045
AOC 57-007	Leach field	Investigation Complete	LANL 2015, 601045

Note: Shading denotes NFA approved.

Appendix A

Acronyms and Abbreviations and
Metric Conversion Table

A-1.0 ACRONYMS AND ABBREVIATIONS

ADEM	Associate Directorate for Environmental Management
AOC	area of concern
bgs	below ground surface
BV	background value
Consent Order	Compliance Order on Consent
CST	Chemical Science and Technology Division
DL	detection limit
DOE	Department of Energy (U.S.)
EPA	Environmental Protection Agency (U.S.)
HDR	Hot Dry Rock (Laboratory program)
HIR	historical investigation report
IWP	investigation work plan
Laboratory	Los Alamos National Laboratory
LANL	Los Alamos National Laboratory
NFA	no further action
NMED	New Mexico Environment Department
NMOCD	New Mexico Oil Conservation Division
NPDES	National Pollutant Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
RFI	Resource Conservation and Recovery Act facility investigation
SMO	Sample Management Office
SSL	soil screening level
SVOC	semivolatile organic compound
TA	technical area
TAL	target analyte list (EPA)
XRF	x-ray fluorescence

A-2.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain U.S. Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

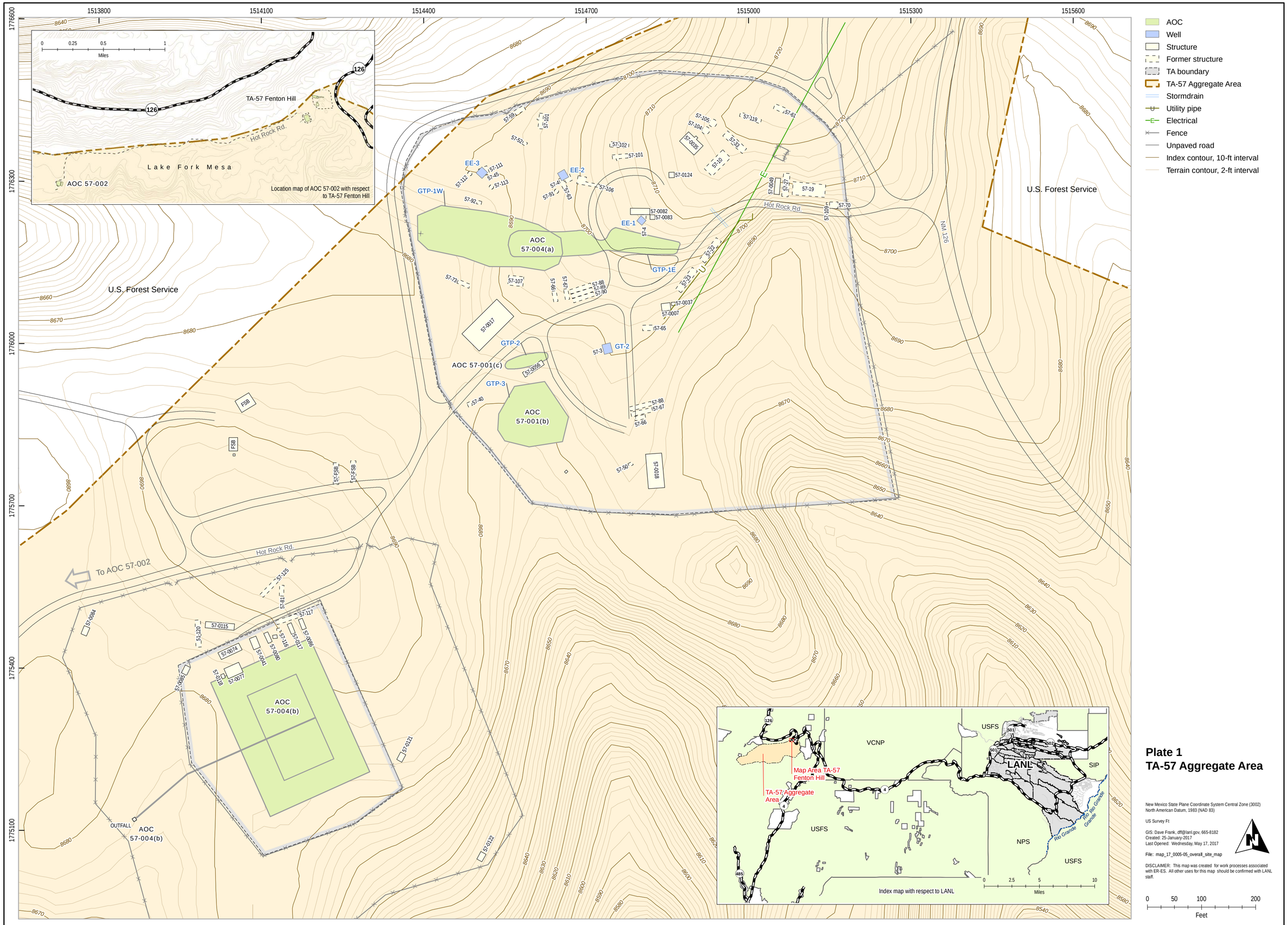

Plate 1
TA-57 Aggregate Area

New Mexico State Plane Coordinate System Central Zone (3002)
North American Datum, 1983 (NAD 83)

US Survey Ft

GIS: Dave Frank, dff@lanl.gov, 665-8182
Created: 25-January-2017
Last Opened: Wednesday, May 17, 2017

File: map_17_0005-05_overall_site_map