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Sampling and Analysis Plan for Supplemental Environmental Project: Aquatic Life Surveys

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Acronyms and Terms

AWQC	ambient water-quality criteria
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
ETOH	ethanol solution
LANL	Los Alamos National Laboratory (Laboratory)
NMED	New Mexico Environment Department
SEP	supplemental environmental project
SSDs	species sensitivity distributions
WWTP	waste water treatment plant

1.0 Background and Overview

As part of a settlement agreement for nuclear waste incidents in 2014, several supplemental environment projects (SEPs) were initiated at Los Alamos National Laboratory (LANL or the Laboratory) between the U.S. Department of Energy and the state of New Mexico.

One SEP from this agreement consists of performing aquatic life surveys and will be used to assess the applicability of using generic ambient water-quality criteria (AWQC) for aquatic life. AWQC are generic criteria developed by the U.S. Environmental Protection Agency (EPA) to cover a broad range of aquatic species and are not unique to a specific region or state. AWQC are established by a composition of toxicity data, called species sensitivity distributions (SSDs), and are determined by LC_{50} (lethal concentration of 50% of the organisms studied) acute toxicity experiments for chemicals of interest. It is of interest to determine whether aquatic species inhabiting waters on the Pajarito Plateau are adequately protected using the current generic AWQC.

The focus of this study will determine which aquatic species are present in ephemeral, intermittent, and perennial waters within LANL boundaries and from reference waters adjacent to LANL. If the species identified from these waters do not generally represent species used in the SSDs, then SSDs may need to be modified and AWQC may need to be updated.

This sampling and analysis plan details the sampling methodology, surveillance locations, temporal scheduling, and analytical approaches that will be used to complete aquatic life surveys. A significant portion of this sampling and analysis plan was formalized by referring to Appendix E: SEP Aquatic Life Surveys DQO (Data Quality Objectives).

2.0 Objectives

The study goals are as follows:

- Determine what aquatic life species are present in reference and the Laboratory waters of the Pajarito Plateau (ephemeral, intermittent, and perennial waters)
- Provide Windward Environmental LLC with the results so that they can:
    - Determine if the species found in the reference and the Laboratory waters differ from the species represented in the SSDs for New Mexico AWQC (and EPA AWQC that may not yet have been fully adopted in New Mexico).
    - Determine if data exist for other representative taxa that can be used as surrogates for the species not represented in SSDs.
    - Determine if it is necessary for additional acute toxicity testing to be performed for a future update to the SSDs, using either standard laboratory water or natural water from which aquatic life species were collected (resident species approach).

3.0 Site Locations

Sampling locations were identified in the Aquatic Life Survey DQO (summarized in Table 1). Sample locations include three perennial streams, two are off-site and one is on Laboratory property, and three off-site ephemeral and intermittent streams. Sampling of the perennial streams is targeted during the fall (late September/early October) of 2017 and 2018, which corresponds with the highest growth potential of benthic macroinvertebrates, for a total of two sampling events. The ephemeral and intermittent streams will be sampled during spring 2018 after snowmelt and again during the summer 2018 monsoon season, for a total of two sampling events. If a perennial stream cannot be sampled during the fall of 2017, the project manager will select a contingent location. The contingent location will be sampled during spring 2018 after snowmelt and again during the summer 2018 monsoon season, for a total of two sampling events.

3.1 Reaches and Replicates

3.1.1 Perennial Stream Sampling

Table 1 lists the number of survey reach targets for perennial streams. As per the New Mexico Environment Department (NMED 2014) Standard Operating Procedure 5.0 *Physical Habitat Measurements*, a reach is defined "for streams with an average wetted width less than or equal to 3.5 m, a representative reach is 160 meters." Each reach represents a sample, and a sample is a composite of nine subsamples. The reach will be divided into nine equidistant transects, a benthic macroinvertebrate and a meiofauna samples will be collected at each, and then will be composited independently. Survey start locations for sample location are found in Figures 1–9; samples will be collected in a downstream-to-upstream fashion.

3.1.2 Ephemeral and Intermittent Stream Sampling

Table 1 lists ephemeral and intermittent reaches to be sampled. An ephemeral and intermittent stream reach is defined as 40 times the width of the stream, with a range of length between 9 m and 900 m (AZDEQ 2016). Each sample will be a composite of a number of subsamples that will be determined by the sampling crew. Several habitat types will be sampled within each reach, such as pools, riffles, and isolated pools remaining after cessation of flowing waters in ephemeral and intermittent waters. A blend of collection techniques (i.e., dry sediment collection and/or collection of benthic macroinvertebrates and meiofauna from water) will be used to ensure that the extent of the habitat diversity is sampled. Survey start locations for sample locations are shown in Figures 1–9; samples will be collected in a downstream-to-upstream fashion. Sampling efforts for the ephemeral and intermittent reaches will coincide with the local precipitation patterns as much as possible in an effort to maximize the possibility of collecting a sample from water, which will typically coincide with the falling limb of hydrographs or after significant rainfall has ceased but recessional flows are still present. Laboratory resources such as the Weather Machine, the gage station network, and the rain gage network should be used to aid in planning and timing of sampling efforts.

Table 1 Survey Locations, Water Type, and Targeted Number of Sample Reaches[a]

Watershed Name/Area	Water Type	Number of Watersheds	Number of Assessment Units[b]	Number of Survey Reaches[c,d]	Figure Number
San Juan Mesa – off-site	Ephemeral	4	NA	8 (2 per watershed)	1
Bandelier – off-site	Ephemeral	4	NA	8 (2 per watershed)	2
Calaveras and Rio Cebolla – off-site	Perennial	1	2	4 (2 per assessment unit)	3
Sandia (Upper) – on-site	Perennial – effluent	1	1 (upper Sandia LANL Outfall 001 to Sigma Canyon)	2 (2 per watershed)	4
Upper Pueblo (above WWTP) – on-site	Ephemeral intermittent	1	6	6 (1 per assessment unit)	5
Lower Pueblo (below WWTP) – on-site	Ephemeral intermittent - effluent	1	Part of lower Pueblo assessment unit	2 (2 per watershed)	5
Contingent Locations					
Potrillo Canyon– on-site (above Water Canyon) – on-site	Ephemeral intermittent	1	1	1	6
Ancho Canyon – on-site (Rio Grande to North Fork Ancho) – on-site	Ephemeral intermittent	1	1	1	7
Chaquehui Canyon (within LANL) – on-site	Ephemeral intermittent	1	1	1	8
Sandia (within LANL below Sigma) – on-site	Ephemeral intermittent	1	1	1	4
Three-mile Canyon (Pajarito to headwaters) – on-site	Ephemeral intermittent	1	1	1	9

[a] Table is modified from DQO Table E-5.2-1.

[b] Assessment units are defined in existing NMED 305(b)/303(d) assessments.

[c] Survey reaches will be determined by field reconnaissance.

[d] Two survey reaches are assumed for each mainstream watercourse in reference watersheds and for each assessment unit in the watersheds of interest where assessment units have been designated. The spatial habitat diversity may indicate only a single survey reach is appropriate.

4.0 Methodology

4.1 Macroinvertebrate Communities Sampling

Surveys will use standard sampling protocols (NMED 2013; AZDEQ 2016) and samples will be taxonomically identified to develop an inventory of resident macroinvertebrate species (in conjunction with data from prior surveys). Specifically, D kick-net samplers (with a 500-µm mesh net) will be used to collect invertebrates and debris. To the extent possible, inorganic material in the collected sample will be minimized. One subsample will be collected along each of nine equidistant transects per reach in perennial streams, and all subsamples will be composited within the reach per the 2013 NMED standard protocol. Subsamples will be collected at alternating positions (left, center, and right bank or 25%, 50%, and 75% bankfull width) beginning at the farthest downstream transect and ending at the uppermost transect. If a sample cannot be taken at the predetermined position (e.g., substrate is too coarse), a new position will be randomly selected along the same transect.

Per the 2013 NMED standard protocol, personnel will collect the kick-net samples by placing the D-shaped net firmly and evenly against the sediment approximately 3 ft in front of them, visually demarcating a 1-ft by 1-ft square quadrat in the upstream direction of the net, and then slowly shuffling their feet toward the net within the visually marked square for 30 seconds. This process suspends debris and animals that are caught in the net. Before the shuffling step, large cobbles in the square will be gently scraped with a gloved hand or brush to loosen macroinvertebrates clinging to the rocks. Similarly, large invertebrates such as mussels, snails, or crayfish will be moved manually into the net before shuffling. Alternatively, large invertebrates may be placed into a separate container half full of site water to limit interaction with (e.g., predation of) smaller individuals in the kick net and composite bucket.

Kick nets will be lifted out of the water and inverted while they are submerged into a plastic bucket half full of site water, allowing for the collection of invertebrate subsamples. All subsamples will be placed into this bucket. Composites will then be poured onto a 500-µm sieve and rinsed with more site water to remove fine sediment and debris from the sample. Everything left on the sieve after rinsing will be gently transferred into a 1-L container. Preservative (e.g., 95% ethanol solution) will be added to containers to cover material and preserve biological tissues, per the 2013 NMED standard protocol. Sample containers will be labeled with the location name and date and stored in appropriate containers in the field and during shipment to the taxonomy laboratory.

The benthic macroinvertebrate sampling method may need to be adjusted for certain contingencies, such as substantial vegetation in the targeted sampling area or insufficient water to collect a kick-net sample.

These contingencies will be addressed according to the 2013 NMED sampling protocol. However, if the stream channel is mostly dry at the time of the sampling event, then dry sediments will be collected (method described below). Personnel will note conditions in field log books such as the presence and quantity of water (e.g., remnant puddles, wetted sediment, or lack of visible moisture) and any evidence of macroinvertebrates (e.g., visible individuals, mollusk shells, or caddisfly cases). When water is present, abiotic factors will be collected, such as

temperature, pH, and dissolved oxygen. Samples will be placed in 1-L containers and preserved with 95% ethanol. Samples will then be packaged and shipped to qualified laboratories for sorting and identification; the analysis will be conducted using a targeted count (i.e., 500 organisms) followed by a large and rare survey.

4.2 Meiofauna Invertebrates Sampling

This method will be used in conjunction with the macroinvertebrate communities sampling method when applicable. The methods used will be based on methods used by Burdett et al. (2015) and King (2004). Sampling will be conducted at suitable areas with conducive habitat (fine silt, clay, or sand substrate) and will vary in number along selected reaches. Meiofauna sampling will also occur during the same site visit for macroinvertebrate sampling, with care being taken not to disturb sampling locations for both methods. The field crew will identify sampling locations (areas within the channel with fine silt, clay, or sand substrate) on-site. A water column sample of approximately 11 cm and 1 cm of sediment will be collected using a clear acrylic poly vinyl chloride cylinder (2.8 to 4.4 cm diameter by 12 cm height). Samples will be placed in a bucket and each sample will be composed of three subsamples and will then be sifted through two sieves stacked on top of each other, one 500 µm (top) and one 47 to 64 µm (bottom). Organisms retained by the smaller sieve will be placed into sample containers, preserved with 95% ETOH (ethanol solution), then packaged and shipped to qualified laboratories for sorting and identification. Again, when water is present, abiotic factors will be collected, such as temperature, pH, and dissolved oxygen.

4.3 Invertebrate Sampling in Dry Sediments of Ephemeral and Intermittent Streams

Benthic macroinvertebrates and meiofauna samples will be collected using a dry sediment technique in the event that no standing or flowing water is present; likely to only occur in the ephemeral and intermittent streams. Sample collection will follow methods described in Storey and Quinn (2013). Dry sediments will be collected from multiple habitats within the streambed by removing the top 5 cm of streambed sediment from a 0.25-m^2 area using a stainless steel trowel. The next 5 cm of subsurface sediment will be collected within the 0.25-m^2 area, placed into a plastic bag, and transported back to the processing laboratory at LANL. Dry sediments will be placed into a plastic tub roughly 18 L in volume and 50 × 30 × 14 cm, then inundated with dechlorinated tap water or from stream water that has been sieved (47 to 64 µm). Air bubblers will be used to maintain dissolved oxygen levels. After approximately a week of submersion, meiofauna will be collected by the methods described above followed by benthic macroinvertebrate collection as described above.

In addition to dry sediment collection, leaf packs and riparian vegetation will be examined in the field and any invertebrates present will be collected using forceps and preserved in 95% ethanol.

4.4 Vertebrate Communities Sampling

Aquatic vertebrate species will be surveyed in 2018 by one of two methods. 1) Electrofishing is a technique widely used by fisheries researchers to temporarily stun fish for capture using electrical current (Reynolds and Kolz 2012). If conditions exist (perennial water, applicable water chemistry, etc.) where backpack fishing can be employed, then a single pass survey will be conducted using a three-person crew. Stunned aquatic species will be netted, placed into a bucket

of freshwater, and held until the end of the pass. All vertebrates captured will be identified to genus and species level, recorded, and returned to the stream. NMED personnel will be requested to assist in this survey and will provide and operate the backpack electrofisher. All crewmembers participating in this work must adhere to the integrated work document approved for electrofishing. 2) Net and seine sampling is used in reaches where it is not possible to use an electrofisher (i.e., areas that do not have flowing water). In larger pools, technicians will extend a seine net across the pool and walk from one side to the other. For smaller pools, technicians may use dip or pond nets to collect vertebrate taxa. If vertebrates are discovered, they will be transferred to a bucket with fresh water until sampling is finished. All vertebrates captured will be identified to genus and species level, recorded, and returned to the stream. Abiotic factors will be collected from water, such as temperature, pH, and dissolved oxygen.

5.0 Quality Assurance

5.1 Order of Sampling and Decontamination Considerations

Lower reaches are sampled first, eventually working up to the upper reaches, in order to avoid biasing sampling from agitation of stream reaches above and thereby altering sample results below. Additionally, sampling will be conducted in order of least disruptive (meiofauna epibenthic coring) to most disruptive (electrofishing, seine netting). All equipment that comes into contact with waters of a particular watershed will be decontaminated to avoid the spread of potentially harmful biota between areas. Decontamination will be done using sprayers or pre-diluted Virkon (disinfectant and virucide) solution or immersion in bleach solutions.

5.2 Data Quality Objectives

Field surveys will adhere to the following criteria. Samples will be collected and processed precisely according to method; modifications made in the field should be adequately documented. Sampling will occur within a representative survey reach identified in the field and will be adequately documented. Location and timing of sampling events should be appropriate; the presence of water will be documented. The loss of vertebrates before cataloging (i.e., during electrofishing) and the condition of vertebrate species during sampling (e.g., alive, desiccated) will be documented. Field notes will be detailed and appropriate to understand and verify sampling methods.

6.0 References

AZDEQ 2016 Arizona Department of Environmental Quality – Standard Operating Procedures Intermittent Streams, November 30, 2016.

Burdett A.S., J.S. Fenci, and T. Turner 2015. “Evaluation of Freshwater Invertebrate Sampling Methods in a Shallow Aridland River (Rio Grande, New Mexico),” *Aquatic Biology*, Vol. 23, pp. 139–146.

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Storey, R.G. and J.M. Quinn 2013. "Survival of Aquatic Invertebrates in Dry Bed Sediments of Intermittent Streams: Temperature Tolerances," *Freshwater Science*, Vol. 32, No. 1, pp. 250–266.

Reynolds, J.B. and A.L. Kolz 2012. "Electrofishing" in *Fisheries Techniques Third Edition*, A.V. Zale, D.L. Parrish, and T.M. Sutton, Eds. pp. 305–361 American Fisheries Society, 2012.

NMED 2013 New Mexico Environment Department – Surface Water Quality Bureau Standard Operating Procedure "Benthic Macroinvertebrate Sampling" No. 11.1, Rev.0, May 1, 2013.

NMED 2014 New Mexico Environment Department – Surface Water Quality Bureau Standard Operating Procedure "Physical Habitat Measurements" No. 5.0, Rev. 3, August 21, 2014.

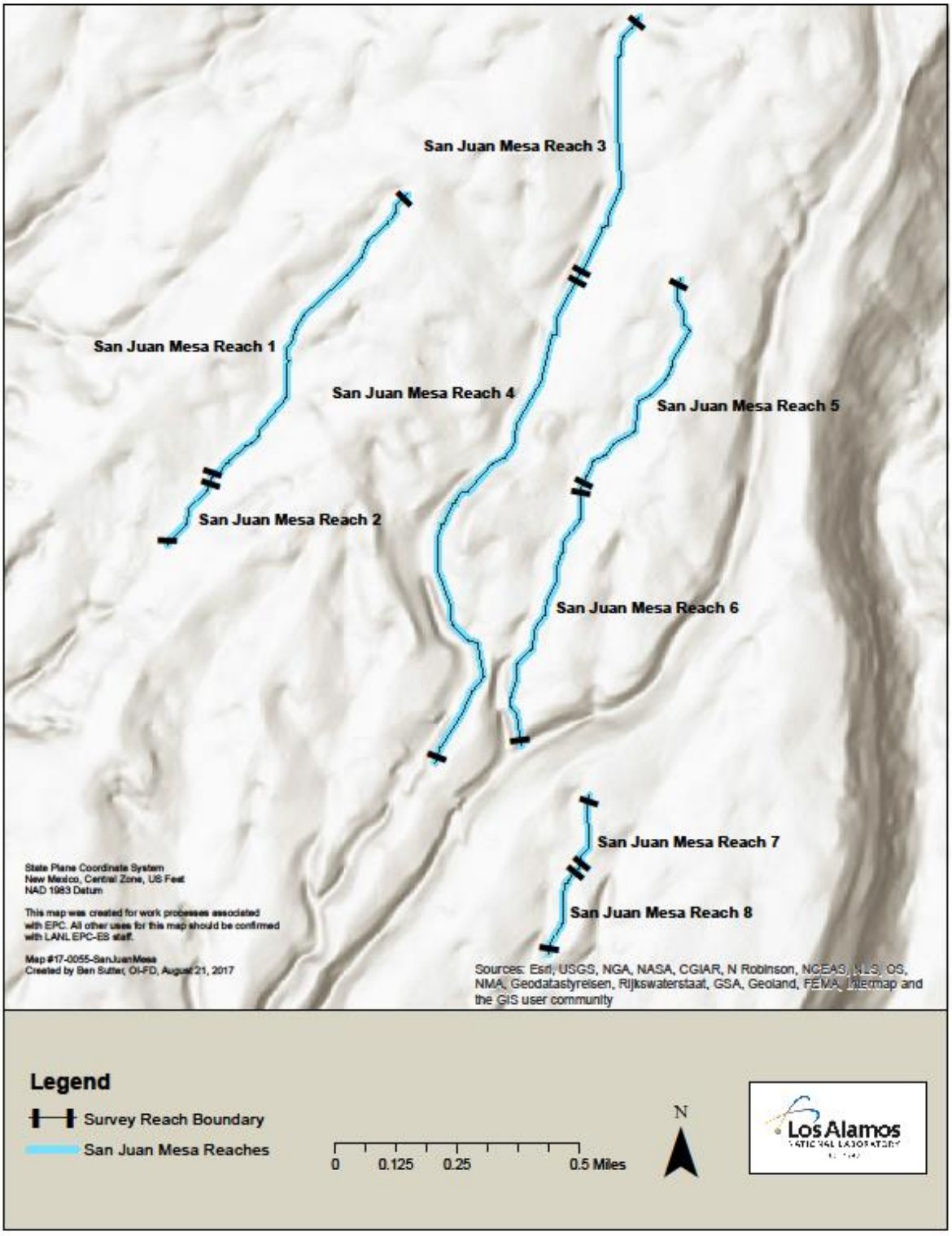

Figure 1. San Juan Mesa watershed

Note: these ephemeral and intermittent segments are scheduled to be sampled for aquatic life after snow melt during the spring of 2018 and again during the monsoon summer season of 2018.

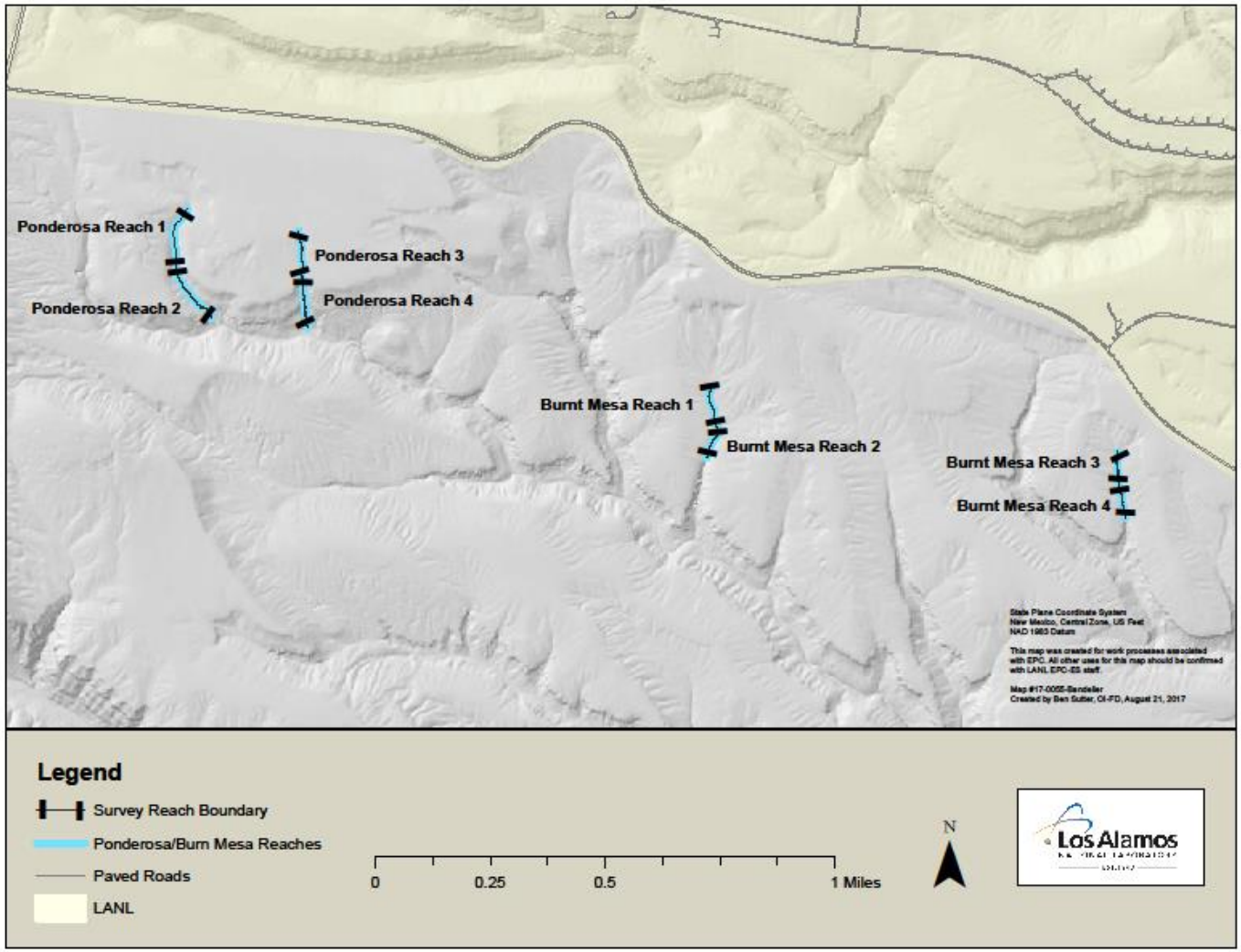

Figure 2. Bandelier watershed

Note: These ephemeral and intermittent segments are scheduled to be sampled for aquatic life after snow melt during the spring of 2018 and again during the monsoon summer season of 2018.

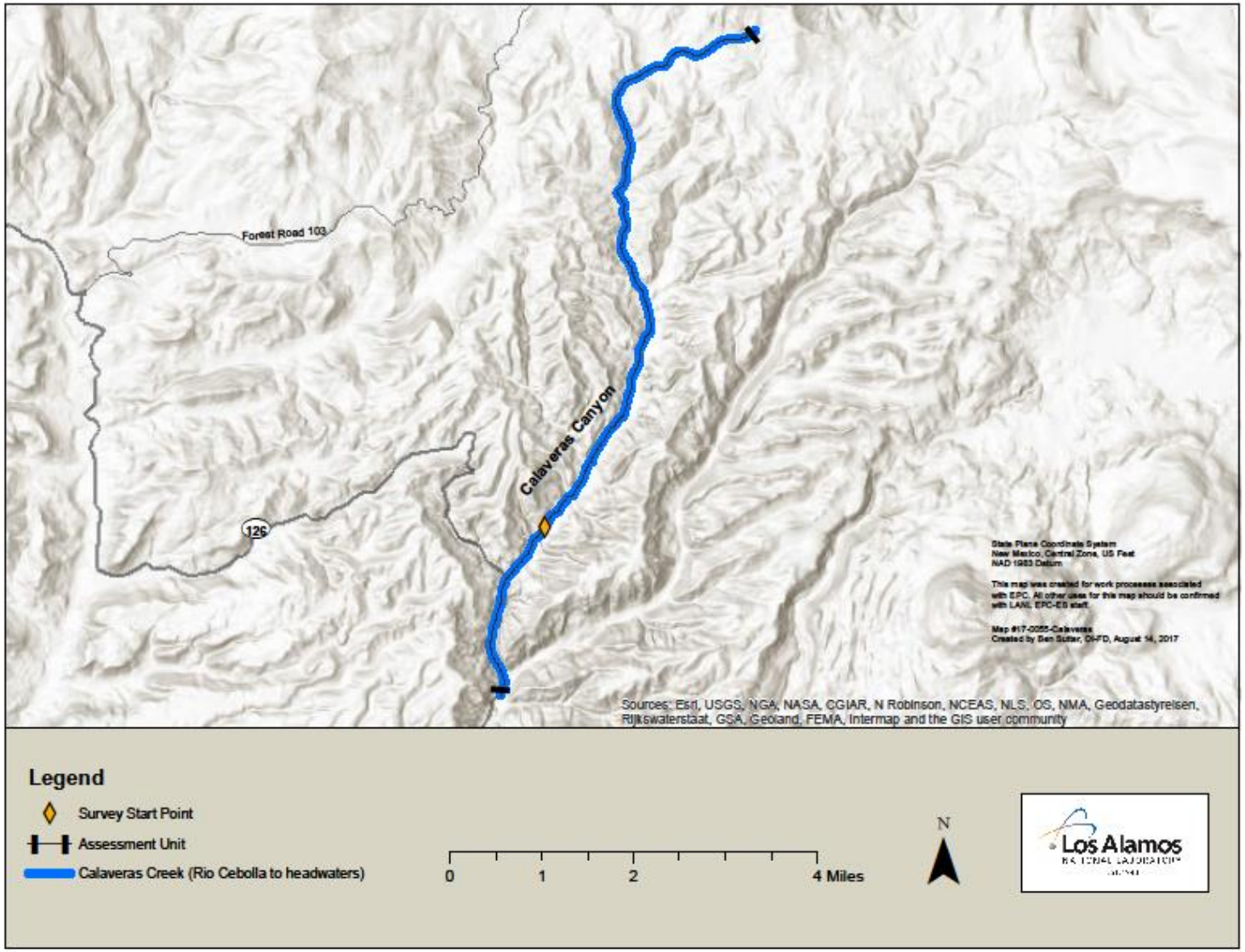

Figure 3. Assessment units of Calaveras and Rio Cebolla to be sampled for aquatic life

Note: This perennial segment is scheduled be sampled fall of 2017 and again during the fall of 2018.

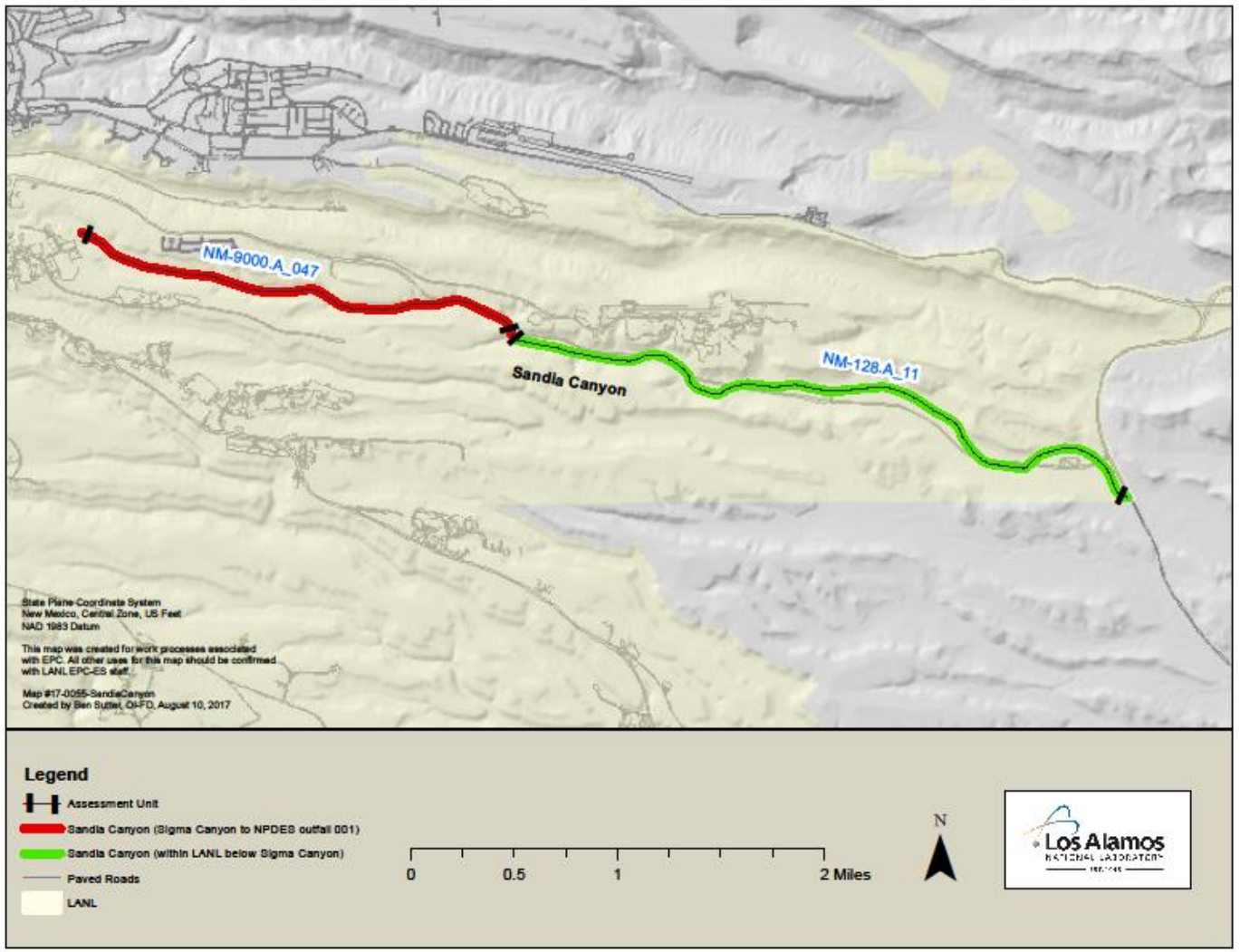

Figure 4. Assessment units of Sandia Canyon to be sampled for aquatic life

Note: The perennial segment of upper Sandia Canyon (Assessment Unit NM-9000.A_047) is scheduled to be sampled in the fall of 2017 and again during the fall of 2018. The ephemeral and intermittent segment of lower Sandia Canyon (Assessment Unit NM-128.A_11) is a contingent location and will be sampled for aquatic life in the spring and summer of 2018 if needed.

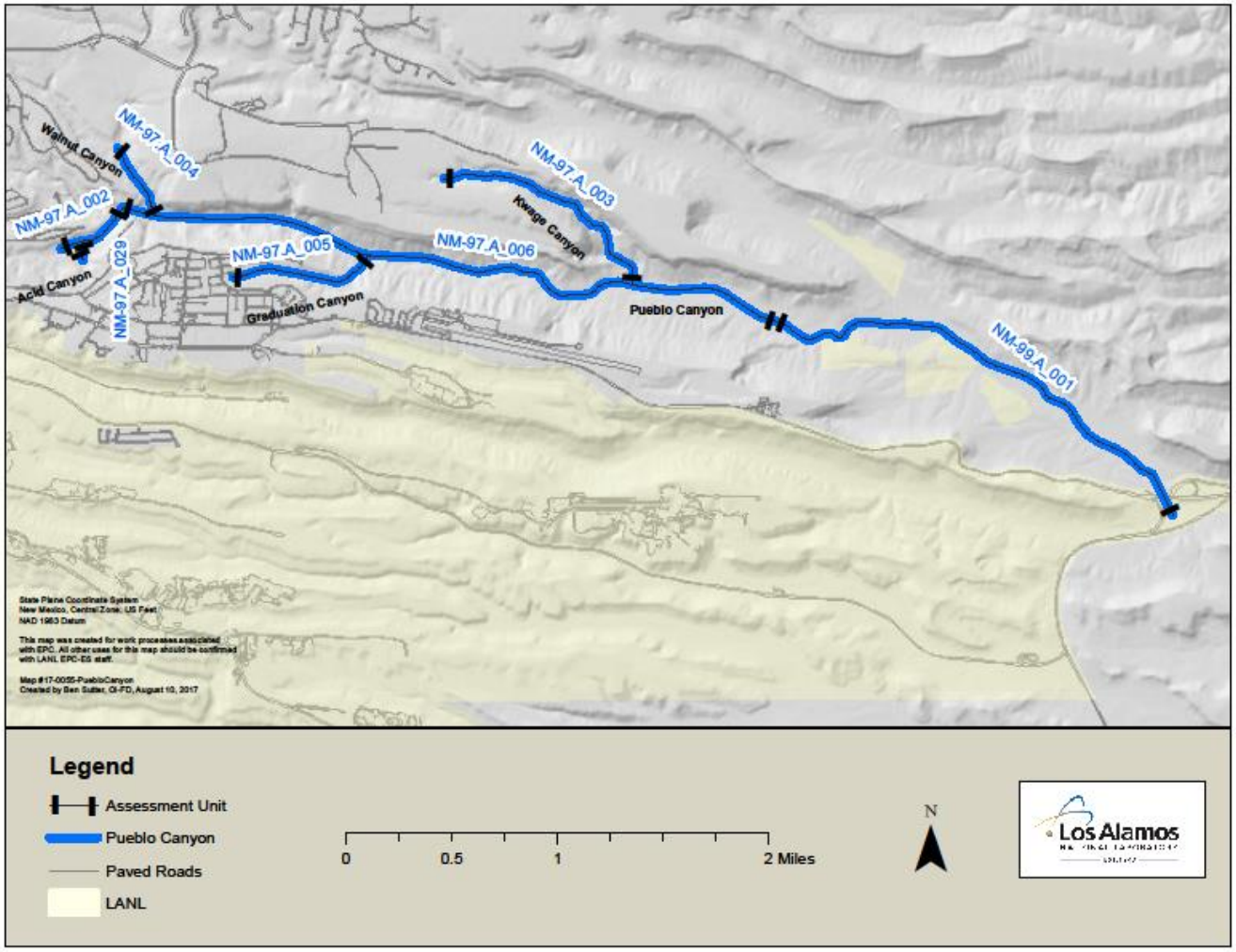

Figure 5. Assessment units of Pueblo Canyon to be sampled for aquatic life

Note: The perennial segment of lower Pueblo Canyon (Assessment Unit NM-99.A_001) is scheduled to be sampled in the fall of 2017 and again during the fall of 2018. The six ephemeral and intermittent segments of upper Pueblo Canyon (Assessment Units: NM-97.A_004, NM-97.A_002, NM-97.A_029, NM-97.A_005, NM-97.A_006, and NM-97.A_003) are scheduled to be sampled for aquatic life after snow melt during the spring of 2018 and during the monsoon summer season of 2018.

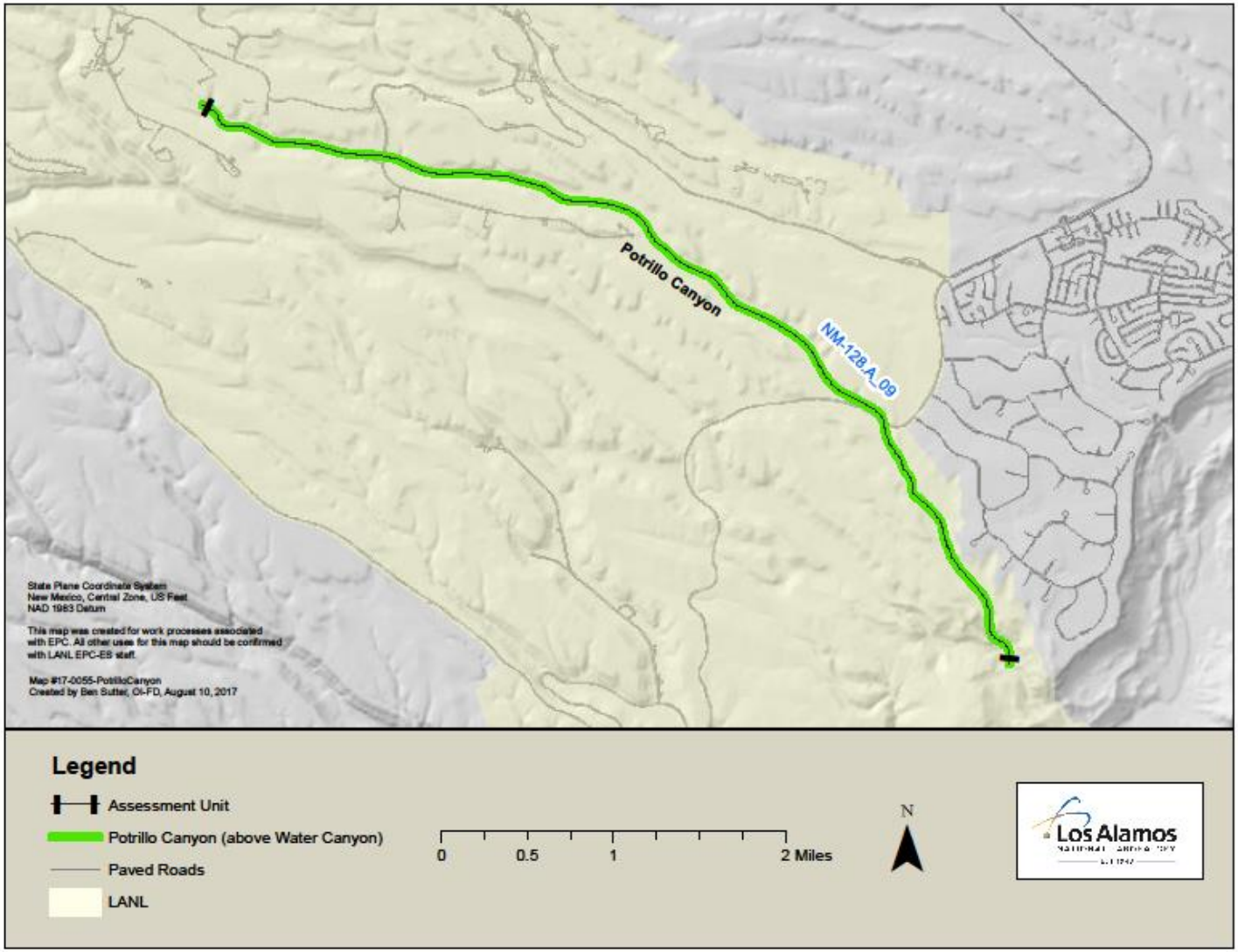

Figure 6. Contingent assessment unit in Portillo Canyon to be sampled for aquatic life

Note: This ephemeral and intermittent segment (Assessment Unit NM-128.A_09) will be sampled for aquatic life in the spring and summer of 2018 if needed.

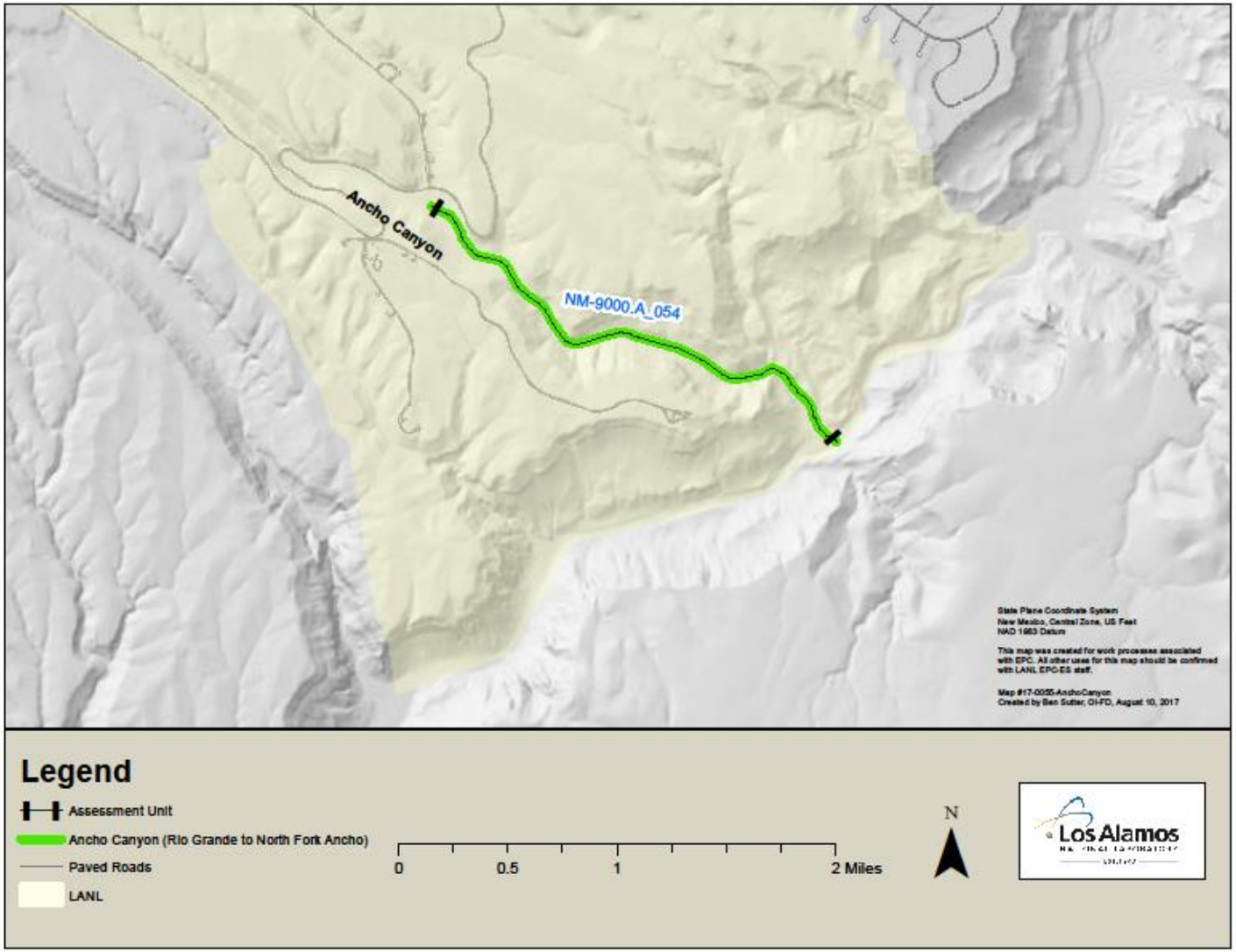

Figure 7. Contingent assessment unit in Ancho Canyon to be sampled for aquatic life

Note: This ephemeral and intermittent segment (Assessment Unit NM-9000.A_54) will be sampled for aquatic life in the spring and summer of 2018 if needed.

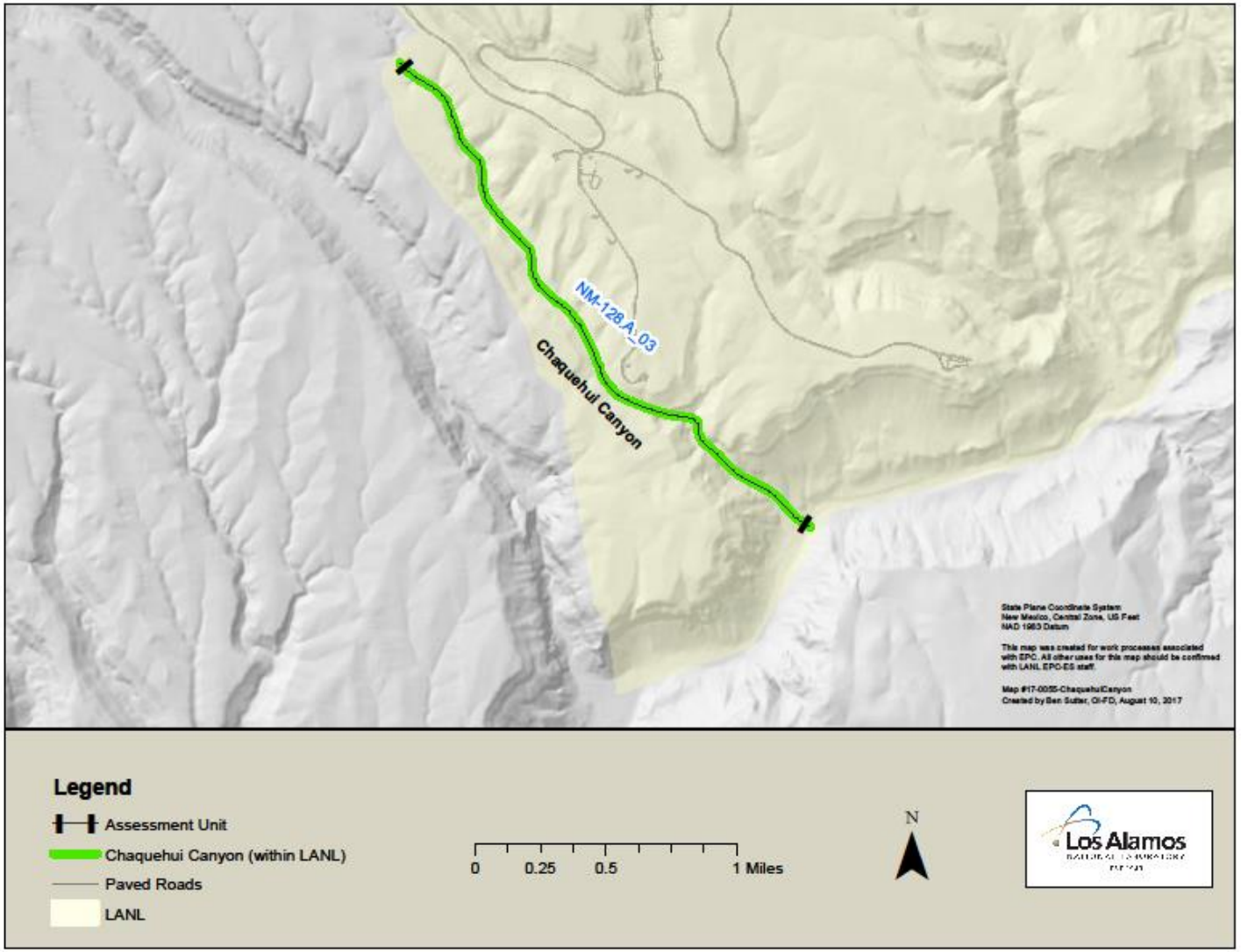

Figure 8. Contingent assessment unit in Chaquehui Canyon to be sampled for aquatic life

Note: This ephemeral and intermittent segment (Assessment Unit NM-128.A_03) will be sampled for aquatic life in the spring and summer of 2018 if needed.

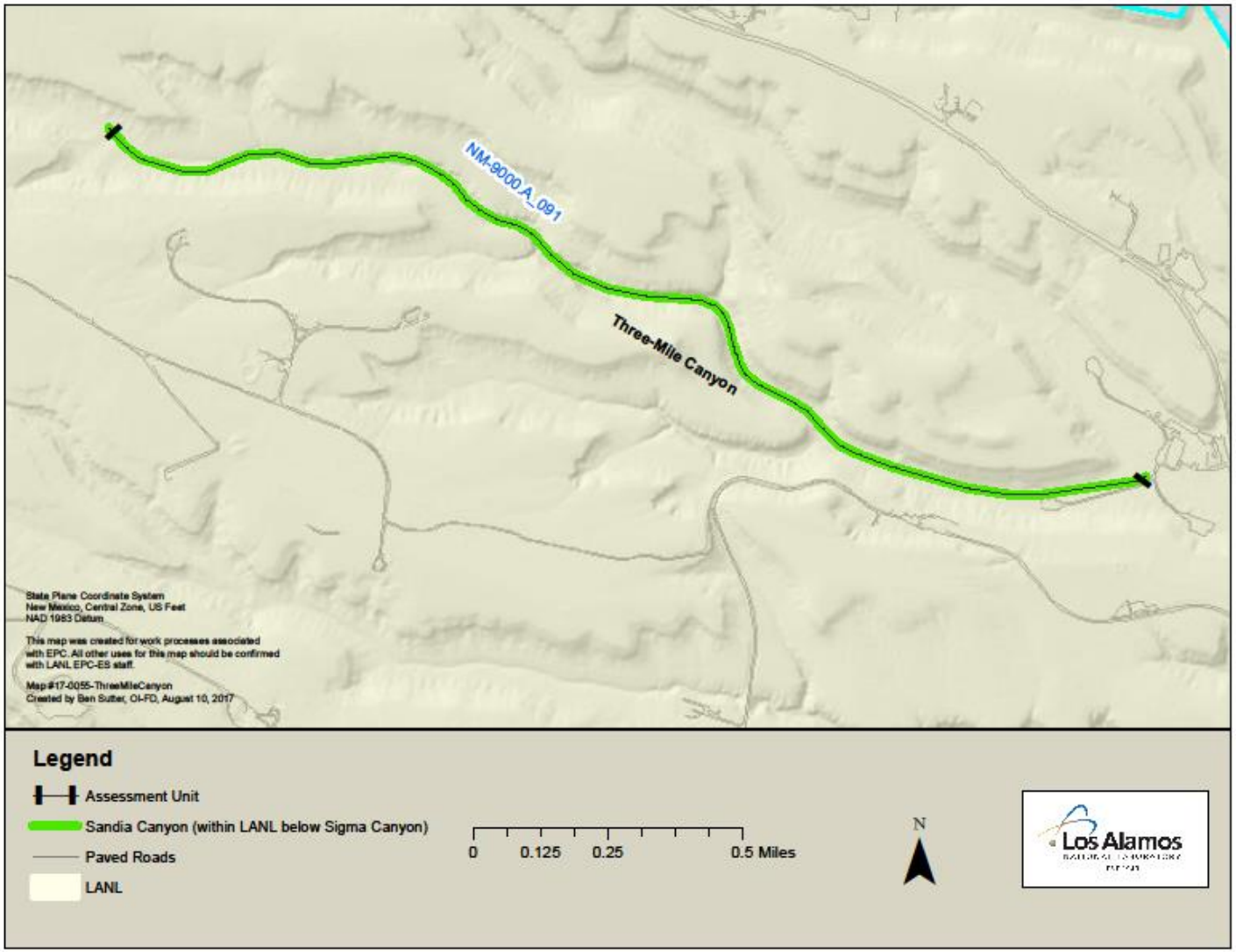

Figure 9. Contingent assessment unit in Three-mile Canyon to be sampled for aquatic life

Note: This ephemeral and intermittent segment (Assessment Unit NM-9000.A_091) will be sampled for aquatic life in the spring and summer of 2018 if needed.