DRAFT ENVIRONMENTAL ASSESSMENT FOR FRONTIER OBSERVATORY FOR RESEARCH INTO GEOTHERMAL ENERGY (FORGE), MILFORD, UTAH

DOE/EA-2070D

PREPARED FOR

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Title: Draft Environmental Assessment for the University of Utah Energy and Geosciences Institute, *Frontier Observatory for Research into Geothermal Energy*, Milford, Beaver County, Utah (DOE/EA-2070D)

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Abstract: The United States (U.S.) Department of Energy (DOE) National Energy Technology Laboratory (NETL) prepared this Environmental Assessment (EA) to analyze the potential environmental, cultural, and socioeconomic impacts of providing cost-shared funding to a proposed project to design and build the Frontier Observatory for Research into Geothermal Energy (FORGE). The FORGE program was designed to establish a dedicated field laboratory site where the subsurface scientific and engineering community would develop, test, and improve technologies and techniques for the creation of cost-effective and sustainable enhanced geothermal systems (EGS) in a controlled, ideal environment. The proposed Utah FORGE site is approximately 10 miles northeast of Milford in Beaver County, Utah, on private, State of Utah, and U.S. Bureau of Land Management (BLM) lands. The DOE's proposed action is to provide cost-shared funding to the Energy and Geoscience Institute (EGI) at the University of Utah and its partners for the proposed Utah FORGE site. The project would include one or more deep geothermal research wells, monitoring wells, groundwater wells, a modular office structure, utility tie-ins, and monitoring equipment.

Availability: DOE encourages public participation in the NEPA process. A notice of availability was placed in the Beaver County Journal on January 31, 2018, to announce the beginning of the 30-day public review and comment period. The draft EA is available for public review beginning January 31, 2018. The draft EA is available on DOE's National Energy Technology Laboratory web site, https://www.netl.doe.gov/library/environmental-assessments and DOE's NEPA web site at https://energy.gov/nepa/nepa-documents. The draft EA is also available at the Milford Public Library at 400 South 100 West, Milford, Utah and at the Salt Lake City Library at 210 East 400 South, Salt Lake City, Utah. DOE will accept comments through March 2, 2018. DOE will accept late comments to the extent practicable.

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CHAPTER 1. PURPOSE AND NEED

1.1. Introduction and Background

Congress directed the U. S. Department of Energy (DOE), through provisions within the Energy Independence and Security Act of 2007 (EISA), Title VI, Subtitle B, to conduct "research, development, demonstration, and commercial application of the technologies and knowledge necessary for enhanced geothermal systems to advance to a state of commercial readiness." As a result, the DOE's Office of Energy Efficiency and Renewable Energy (EERE) Geothermal Technologies Office initiated a program known as the Frontier Observatory for Geothermal Research (FORGE). The FORGE program was designed to establish a dedicated field laboratory site where the subsurface scientific and engineering community would develop, test, and improve technologies and techniques for the creation of cost-effective and sustainable enhanced geothermal systems (EGS) in a controlled, ideal environment. In natural geothermal systems, conditions are not always ideal for power generation despite the presence of heat. EGS can be used in areas with near-surface heat but insufficient permeability or water for natural geothermal reservoirs to have formed. The establishment of FORGE would greatly facilitate development of an understanding of the key mechanisms controlling a successful EGS.

1.1.1. Selection Process

In order to implement the FORGE program, DOE issued Funding Opportunity Announcement DE-FOA-0000890 on July 17, 2014 to request proposals for the FORGE site. DOE conducted a competitive merit review of the proposals and selected five projects to proceed to the planning phase of project development in April 2015.

The FORGE program consists of three phases: 1. Planning, 2. Site Characterization and Preparation, and 3. Technology Testing and Evaluation. In order to select the optimal location for the FORGE project, the proposed projects undergo competitive down-selections at critical points in the project.

- **Phase 1, Planning**: During Phase 1, the objective was to complete technical and logistical planning tasks that demonstrate the site's viability and the team's full commitment and capability to implement Phase 2 and 3.

  Phase 1 was completed by all five selected projects in September 2016, and DOE competitively assessed each project location for technical merits and potential environmental impacts prior to selecting two projects to proceed to Phase 2. The two projects selected include proposed FORGE sites near Milford, Utah and Fallon, Nevada. Phase 2, Site Characterization and Preparation, was further sub-divided into site activities.
- **Phase 2A**: Phase 2A consisted of the completion of an environmental information volume to assist DOE in assessing the environmental resource areas and potential impacts of the project. Phase 2A also required the installation of a preliminary seismic array to assess regional seismicity and the development of a techno-economic assessment of proposed infrastructure requirements to support FORGE operations during latter stages of the project. Phase 2A was completed by both proposed project teams in March 2017.
- **Phase 2B, Site Characterization**: Phase 2B will take approximately 12 months and commenced in the first quarter of 2017. It includes the drilling of a deep scientific research well to a depth of 7,536 feet to verify that the Utah FORGE site has the characteristics required for FORGE. (Drilling of the well is complete.) Geophysical surveying, including a three-dimensional (3-D) reflection seismic survey using vibroseis trucks, would augment these activities. In addition, initially a groundwater investigation well was planned to be drilled during Phase 2B to a depth of

1,000 feet to assess water availability and groundwater temperature beneath the project area. Recent economic analyses of groundwater supply costs have resulted in deferring this well to a later phase of the project. Following Phase 2B, the two remaining project sites will be assessed for technical merit and potential environmental impacts, and the final FORGE location will be selected.

Following Phase 2B, the two remaining project sites would be assessed for technical merit and potential environmental impacts, and the final FORGE location would be selected. The final FORGE project site would proceed to Phase 2C and be fully instrumented for surface and subsurface investigation and be readied for R&D technology testing and evaluation during Phase 3.

- **Phase 2C, Site Preparation**: If the Utah FORGE site is selected, Phase 2C would take approximately 8 to 12 months and would include the construction of infrastructure elements to support operations. These elements would include electric power and fiber optic lines to the FORGE area, a 2-acre fenced compound containing a 1,000-square-foot office and secure storage facilities to support research, on-site activities and a communications hub, water wells and associated surface pipelines, the FORGE Phase 3 well pad, and seismic monitoring holes up to 1,000 feet deep. Monitoring equipment, including tiltmeters and global positioning system (GPS) monuments, would also be installed.
- **Phase 3, Site Operation**: If the Utah FORGE site is selected, Phase 3 would be a 5-year term during which the subsurface scientific and engineering community could apply to use FORGE as a field laboratory for projects to test EGS technologies, techniques, and instruments. Phase 3 would include the drilling and stimulation of at least one injection well and one production well, both expected to be strongly deviated. Monitoring of flow between the injection and production wells would allow for measurement of the efficiency of heat being extracted from the host rock. A pre-existing well, Acord-1, would be cleaned out and made available for testing tools. Extensive scientific monitoring would be conducted at the well site and in the surrounding area. The DOE would decommission the well site at the end of Phase 3, which is expected to be in 2024.

The proposed Utah FORGE site is approximately 10 miles northeast of Milford in Beaver County, Utah, on private, State of Utah, and U.S. Bureau of Land Management (BLM) lands. The Utah FORGE team is currently working under a DOE Cooperative Agreement for tasks in Phase 2B. Both the Nevada and Utah sites will complete the Phase 2B tasks. Phase 2C and Phase 3 are not yet funded or contracted and would be undertaken only on the final selected site, expected to be awarded by the DOE in the second quarter of 2018.

1.2. Purpose of and Need for the Department of Energy Action

EGS are engineered reservoirs, created where there is hot rock but little to no natural permeability and/or fluid saturation. During EGS development, subsurface permeability is enhanced via fluid injection, thermal rock-fluid interaction, chemical stimulation, or other safe, well-engineered stimulation processes that re-open pre-existing fractures or create new ones. These open conduits increase permeability and allow fluid to circulate throughout the rock. This fluid transports heat to the surface where electricity can be generated with existing power generation technologies. The development of EGS would provide access to domestic, geographically diverse, and carbon-free sources of clean energy. EGS have the potential to generate approximately 100 gigawatts (GW) of renewable, baseload power in the United States, which is about 10% of current U.S. power production capacity (DOE 2014). These systems would provide reliable baseload power but could also be ramped up to generate additional electricity during peak demand periods. While there are a number of historical and active EGS projects worldwide, technical barriers to commercialization remain, such as a thorough understanding of techniques to effectively stimulate fractures in different rock types; techniques capable of imaging permeability enhancement and evolution from the reservoir scale to the resolution of individual fractures; effective zonal isolation for multistage stimulations; directional drilling/stimulation technologies for non-vertical well configurations; and long-term reservoir sustainability and management techniques.

The purpose of and need for the DOE action is to advance the FORGE initiative by providing financial assistance to those sites that have the best chance of achieving the program's objective. The FORGE initiative's objective is to develop a research and development field laboratory that enables cutting-edge EGS research, drilling, and technology testing, and that identifies a replicable, commercial pathway to EGS. The FORGE initiative also includes extensive instrumentation of the site to capture and share FORGE data in real time, as well as activities designed for broad community outreach.

FORGE would focus on techniques to effectively stimulate large fracture networks in various rock types, technologies for imaging and monitoring the evolution of fluid pathways, and long-term reservoir sustainability and management techniques. These types of EGS advances would reduce industry risk and help facilitate deployment of EGS nationwide. The establishment of FORGE is the critical next step towards creating a commercial pathway for EGS, as it would promote transformative and high-risk science and engineering at a scale beyond the EGS demonstration projects funded by the DOE, and beyond what the private sector is financially capable of pursuing on its own.

1.3. National Environmental Policy Act and Related Regulations

The National Environmental Policy Act (NEPA) was enacted in 1970 and encourages environmental protection and informed decision-making. The NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences, and take actions that protect, restore, and enhance the environment (40 Code of Federal Regulations [CFR] 1500.1(c)). This is achieved through the development of environmental assessments (EAs) and environmental impact statements (EISs) to provide public officials with relevant information, including a "hard look" at the potential environmental consequences of proposed projects. The NEPA process must be completed for every major federal action significantly affecting the quality of the human environment, unless the activity is allowed by law or specifically excluded from environmental analysis. This Environmental Assessment (EA) has been prepared because the Proposed Project (consisting of Phases 2B, 2C, and 3, [see section 2.3]) is a major federal action with the potential to significantly affect the human environment.

The Proposed Project and the analyses of its potential effects in this document conform with and meet the requirements of other statutes, regulations, plans, programs, and policies of affiliated tribes, other federal agencies, and state and local governments to the extent practicable. Those statutes, regulations, plans, programs, and policies that pertain to resources that may be affected by the Proposed Project include the following:

- 36 CFR 800 (Protection of Historic Properties)
- The American Indian Religious Freedom Act of 1978, as amended (42 United States Code [USC] 1996)
- The Archaeological and Historic Preservation Act of 1974, as amended (16 USC 469 et seq.)
- The Archaeological Resources Protection Act of 1979, as amended (16 USC 470aa et seq.)

- The Native American Graves Protection and Repatriation Act of 1990, as amended (25 USC 3001 et seq.) and 43 CFR 10 (Native American Graves Protection and Repatriation Regulations)
- Executive Order 13175 of November 6, 2000 (Consultation and Coordination With Indian Tribal Governments)
- The Federal Land Policy and Management Act of 1976, as amended (43 USC 1701 et seq.)
- NEPA (43 USC 4321 et seq.)
- 54 USC 300101 et seq. National Park Service (NPS) and Related Programs (formerly known as the National Historic Preservation Act [NHPA] of 1966)
- The Clean Water Act of 1977, as amended (33 USC 1251 et seq.)
- The Clean Air Act (CAA) of 1963, as amended (42 USC 85 et seq.)
- The Endangered Species Act (ESA) of 1973, as amended (16 USC 1531 et seq.)
- Executive Order 13186 of January 10, 2001 (Responsibilities of Federal Agencies to Protect Migratory Birds)
- U.S. Fish and Wildlife Service (USFWS) Bald and Golden Eagle Protection Act, as amended (16 USC 668 et seq.)

1.3.1. Prior NEPA Review

The Utah FORGE project site proposed by the Energy and Geoscience Institute (EGI) at the University of Utah and its partners is located near the town of Milford in Beaver County, Utah. DOE assessed the project as required by the NEPA and issued a categorical exclusion to the project prior to Phase 1 and again prior to Phase 2A of the project. In Phase 2B, EGI proposed a 3-D seismic reflection (vibroseis) survey of the FORGE project site. This included areas of private land, State of Utah School and Institutional Trust Lands Administration land, and BLM land in Beaver County, Utah. Since the BLM land would be impacted by the survey, BLM initiated an EA, FORGE Milford Valley Vibroseis Survey (UT-C010-2016-0042-EA), to analyze the potential impacts of this action as required by NEPA. The BLM issued the Final EA and a Finding of No Significant Impact (FONSI) in February 2017. DOE reviewed and concurred with BLM’s findings and hereby incorporates it by reference in this Environmental Assessment as Appendix A. Additional activities performed under Phase 2B, including other outdoor tests and a test well on state lands were assessed and DOE issued a categorical exclusion. Copies of all categorical exclusions for the proposed project are included in Appendix B.

1.4. Conformance with Land Use Plans

Regional and local plans that are applicable to the FORGE area include the Zoning Ordinance of Beaver County (Beaver County 2010) and the *Cedar Beaver Garfield Antimony Record of Decision/Resource Management Plan* (CBGA RMP) (BLM 1984). The portions of these plans that are relevant to the FORGE project are described below.

1.4.1. Zoning Ordinance of Beaver County

The proposed Utah FORGE site is zoned as a Multiple Use District (MU-20) under the Beaver County Zoning Map (Beaver County 2017). As stated in the Zoning Ordinance of Beaver County:

> The purposes of Multiple Use Districts are to establish areas in mountains, hillsides, canyons, mountain valleys, deserts, and other open and generally underdeveloped lands where human habitation would be limited in order to protect land and open space resources and to reduce unreasonable requirements for public utility and service expenditures through uneconomic and unwise dispersal and scattering of population; to encourage use of the land, where appropriate, for forestry, grazing, agriculture, mining, wildlife habitat, and recreation; to avoid excessive damage to watersheds, water pollution, soil erosion, danger from brushland and to promote health, convenience, order, prosperity and general welfare of the inhabitants of Beaver County. (Beaver County 2010)

Conditional uses are allowed in Multiple Use Districts, including activities proposed for the FORGE project, such as drilling for energy-related products, electric transmission lines, telecommunication sites/facilities, accessory buildings customarily incidental to approved conditional uses, as well as other uses similar to the allowable conditional uses and judged by the planning commission to be in harmony with the character and intent of the Multiple Use District (Beaver County 2010).

1.4.2. Cedar Beaver Garfield Antimony Record of Decision/Resource Management Plan

The proposed Utah FORGE site contains BLM-administered lands that are in the planning area for the CBGA RMP. The CBGA RMP includes an objective to provide for “the authorization of legitimate uses of public lands by processing use authorization such as rights-of-way (ROWs), leases, permits, and State land selections in response to demonstrated public needs” (BLM 1984:5). The CBGA RMP also includes an objective to “provide maximum leasing opportunity for oil, gas, and geothermal exploration and development by utilizing the least restrictive leasing categories necessary to adequately protect sensitive resources” (BLM 1984:19).

For air resources, the CBGA RMP includes an objective to assure compliance with the CAA. The FORGE project would comply with all applicable laws, regulations, and policies pertaining to air resources. Potential impacts on air resources are described in section 3.3.2.

For water resources, the CBGA RMP includes an objective to “improve watershed conditions on areas identified with significant erosion condition problems and on other sensitive watershed areas (riparian areas)” and to “avoid the deterioration of or improve watershed condition on all other Federal lands” (BLM 1984:95). The CBGA RMP also includes an objective to “ensure production of quality water as required by State and Federal legislative acts and regulations for onsite and downstream users” (BLM 1984:95). The FORGE project would acquire all necessary water rights and comply with all applicable laws, regulations, and policies pertaining to water resources. Potential impacts to water resources are discussed in section 3.4.2.

1.5. Permits and Approvals Required

The FORGE project would comply with all county, state, and federal standards and permitting requirements, including collection of environmental baseline data, environmental review, stipulations and conditions of permits, mitigation processes, and reclamation activities following FORGE activities. Table 1-1 provides a summary of authorizations that need to be obtained before particular Proposed Project activities begin.

Table 1-1. Preliminary List of Permits, Authorizations, or Coordination Needed

Agency or Entity	Permits, Authorizations, or Coordination
Utah SITLA	Lease for use of land/subsurface
BLM Cedar City Field Office	Letter of agreement for casual use: geophysical survey
BLM Cedar City Field Office	Right-of-way grant for temporary water pipeline
BLM Cedar City Field Office	Right-of-way grant for power line extension
BLM Cedar City Field Office	Right-of-way grant for fiber optics along road
Utah Department of Natural Resources – Division of Water Rights	Certificate of appropriation
Utah Department of Natural Resources – Division of Water Rights	Authorization to drill
Utah Department of Environmental Quality – Division of Water Quality	Underground injection control permit
Utah Department of Environmental Quality – Division of Water Quality	Stormwater Utah Pollutant Discharge Elimination System general permit
Utah Department of Environmental Quality – Division of Water Quality	Input on storage and containment of fuel or other flammable or hazardous material
Utah Department of Environmental Quality – Division of Water Quality	Groundwater discharge permit (to be determined)
Utah Department of Heritage and Arts - SHPO	Historic, cultural, or archaeological area of potential effects map for approval
Beaver County Planning	Conditional use permit
Beaver County Building Department	Building permit
Beaver County	Encroachment permit or easement for water line
Southwest Utah Public Health Department	Septic system permit

1.6. Scoping for the Environmental Assessment

Scoping is the process by which the federal agency with NEPA oversight solicits internal and external input on the issues, impacts, and potential alternatives that are to be addressed in the EA. External scoping is required for EISs but is optional for EAs (40 CFR 1501.7). No external scoping was conducted for this EA. An internal review of potential issues and resources associated with the Proposed Project was conducted by the DOE.

CHAPTER 2. PROPOSED PROJECT AND ALTERNATIVES

2.1. Introduction

This EA analyzes the potential effects of implementing the Proposed Project and the No Action Alternative. The No Action Alternative is considered and analyzed to provide a baseline against which to compare the impacts of the Proposed Project. No other alternatives were brought forward for detailed analysis.

2.2. Department of Energy Proposed Action

The DOE's proposed action is to provide cost-shared funding to the EGI and its partners for the proposed Utah FORGE site. If approved, the DOE proposes to provide EGI with approximately $20 million of financial assistance through Phase 2C. Phase 3 funding is not yet appropriated, but could be approximately $130 million. The University of Utah EGI team would use their portion of the financial assistance to fully instrument, characterize, and permit the Utah FORGE site for an underground laboratory to conduct cutting-edge research on EGS.

Through the FORGE initiative, the DOE seeks to develop and demonstrate new technologies in harnessing geothermal energy, with the purpose of developing methods for creating EGS in areas with near-surface heat but insufficient permeability or water for natural geothermal reservoirs to have formed. The proposed action would further the objectives of the FORGE initiative by providing funding to collect new data on conditions at the Utah FORGE site and detailed information to determine if the Utah site has the characteristics required for FORGE.

2.3. Proposed Project

The Utah FORGE project cooperative agreement is managed by the EGI at the University of Utah. Day-to-day management is performed by a team of members from EGI and the Utah Geological Survey.

The following sections provide detailed descriptions of the Proposed Project's location, site plan, and three remaining phases of activity: site characterization (Phase 2B), site preparation and support infrastructure (Phase 2C), and site operation (Phase 3).

2.3.1. Project Location and Site Plan

The proposed Utah FORGE site (hereafter the FORGE area) is located in Beaver County, Utah. The FORGE area covers almost 2 square miles of land managed by the State of Utah School and Institutional Trust Lands Administration (SITLA) (Section 32, Township 26 South, Range 9 West) and land privately owned by Smithfield Hog Production Swine Feed Mill (Smithfield) (the northern half of Section 31, Township 26 South, Range 9 West and the western half of Section 5, Township 27 South, Range 9 West) (see Figure 2-1). The FORGE project area (hereafter the project area) is defined as the surface disturbance footprint in the FORGE area. The center of the project area is approximately 12 miles by road northeast of Milford.

All landowners and land managers have agreed to allow geoscientific exploration of the project area. SITLA and Smithfield have agreed to the drilling of wells on their land as part of FORGE operations. The sections adjoining the project area are made up of some SITLA and private land, but the major land manager is the BLM. Access to the project area is from State Route 257 (Milford to Delta highway) via Geothermal Road to Antelope Point Road, and then to Salt Cove Road. The project office would be located next to Antelope Point Road, approximately 3 miles from the FORGE area.

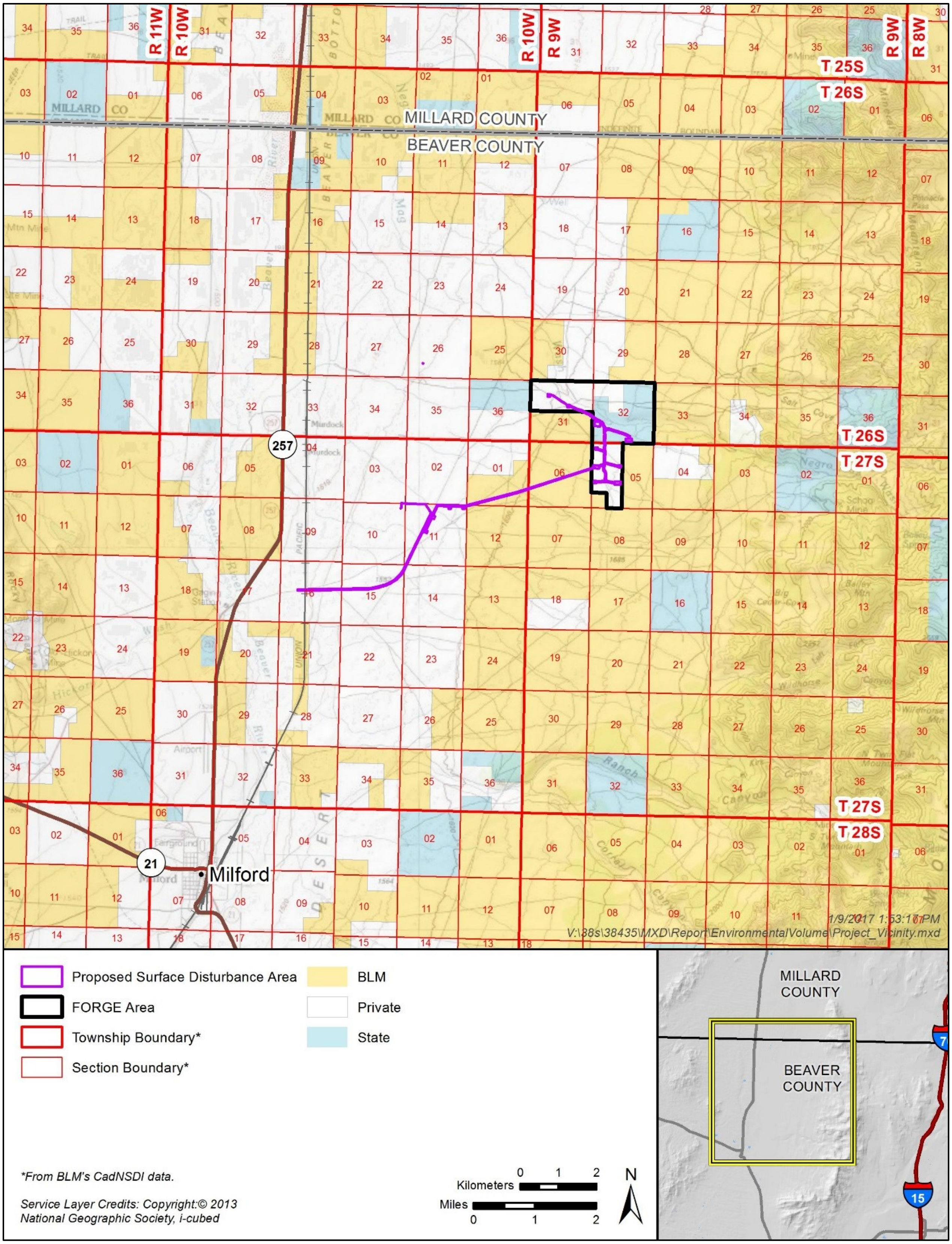

Figure 2-1. General project location.

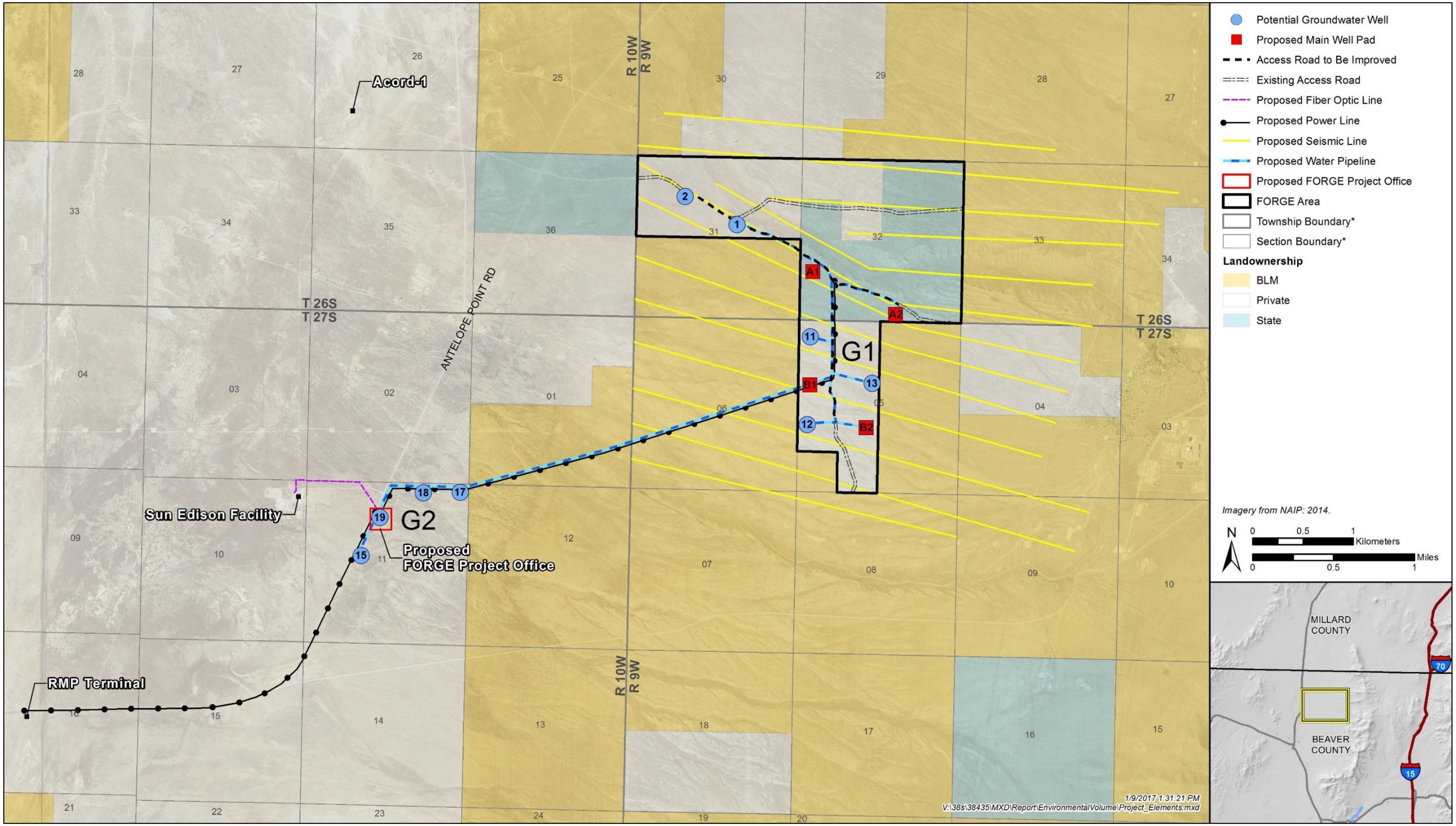

Figure 2-2. Utah FORGE site project elements.

Figure notes: Solid red squares show locations where deviated FORGE production and injection wells could be drilled. Based on the available data, the wellheads for the FORGE wells for Phase 3 would be located at A1. The deep vertical test well drilled in Phase 2B is at A2. The toes of the production and injection wells at A1 in Phase 3 would be beneath the well at A2. Groundwater wells may be drilled at the blue circles during Phase 3 (numbers refer to water rights). Economic analysis indicates that the most suitable location for the groundwater wellfield is at G2, near the project office. This would mean the power line does not extend past the project office.

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2.3.2. Phase 2B: Site Characterization

Site characterization consists of four elements: surface-based geoscientific surveying, development of well pads and access, and drilling of a deep geothermal scientific investigation well.

2.3.2.1. SURFACE GEOSCIENTIFIC SURVEYING

Surface geoscientific surveying involves taking measurements on the ground surface in the FORGE area and in surrounding lands. The technologies consist of a variety of geological and geophysical surveys, including geologic mapping, gravity measurements, resistivity surveys (magnetotelluric [MT] and time-domain electromagnetic [TDEM] surveys), soil gas surveys, seismic monitoring using existing stations and Nodal seismometers, and a 3-D seismic reflection survey (vibroseis). A Light Detection and Ranging (LiDAR) survey was flown in late October 2016 over the FORGE area and adjacent land, and apart from some follow-up ground-truth investigation of possible faults, surface geoscientific surveying would involve no surface impact. Sites would be accessed by foot from existing roads and most of the measurements would be made in a few hours or less. Figures 2-3, 2-4, and 2-5 show the approximate extent of activities.

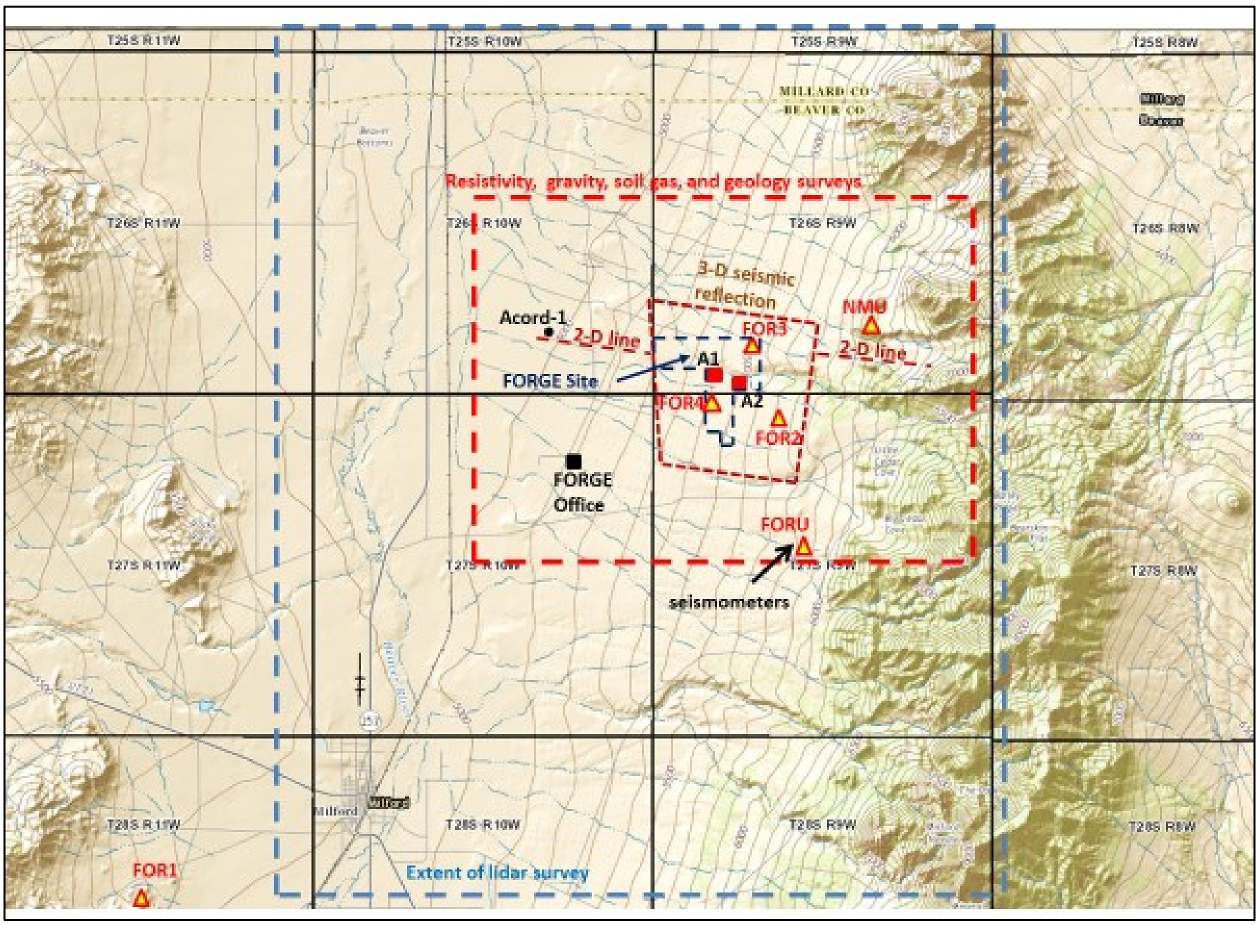


Figure 2-3. Extent of surface geoscientific surveys for Phase 2B.

Figure Notes: Blue dashed lines denote the extent of the LiDAR survey. Red dashed lines denote resistivity (MT and TDEM) and gravity and soil gas surveys. Dark red short dashed lines denote 2-D and 3-D seismic reflection surveys. Red-yellow triangles denote seismometer sites. Topography is at 100-foot intervals in the background (the proposed office site is at 5,100 feet, pad A2 is at 5,500 feet, and pad A21 is at 5,400 feet above sea level).

With the exception of the MT survey and the 3-D seismic reflection survey, these activities are considered by the BLM Cedar City Field Office to be casual use (Burghard 2016). Casual use is defined as activities ordinarily resulting in no or negligible disturbance of public lands or resources (43 CFR 3809.5).
The MT survey involves digging by shovel a 2-foot hole for a vertical magnetometer at the center of an electrode-magnetometer array at each measurement site. This survey may be conducted in April 2019 during PacifiCorp's annual shut down for maintenance of the Blundell Geothermal Plant so that power generation from the Blundell Geothermal Plant does not interfere with the measurements. BLM staff is considering proposed MT sites (see Figure 2-4), and a letter of agreement is expected once the site locations are approved. All sites are within walking distance of existing roads, and equipment can be carried to the sites for measurements. MT survey instruments would be left in place for 24 hours and then removed.

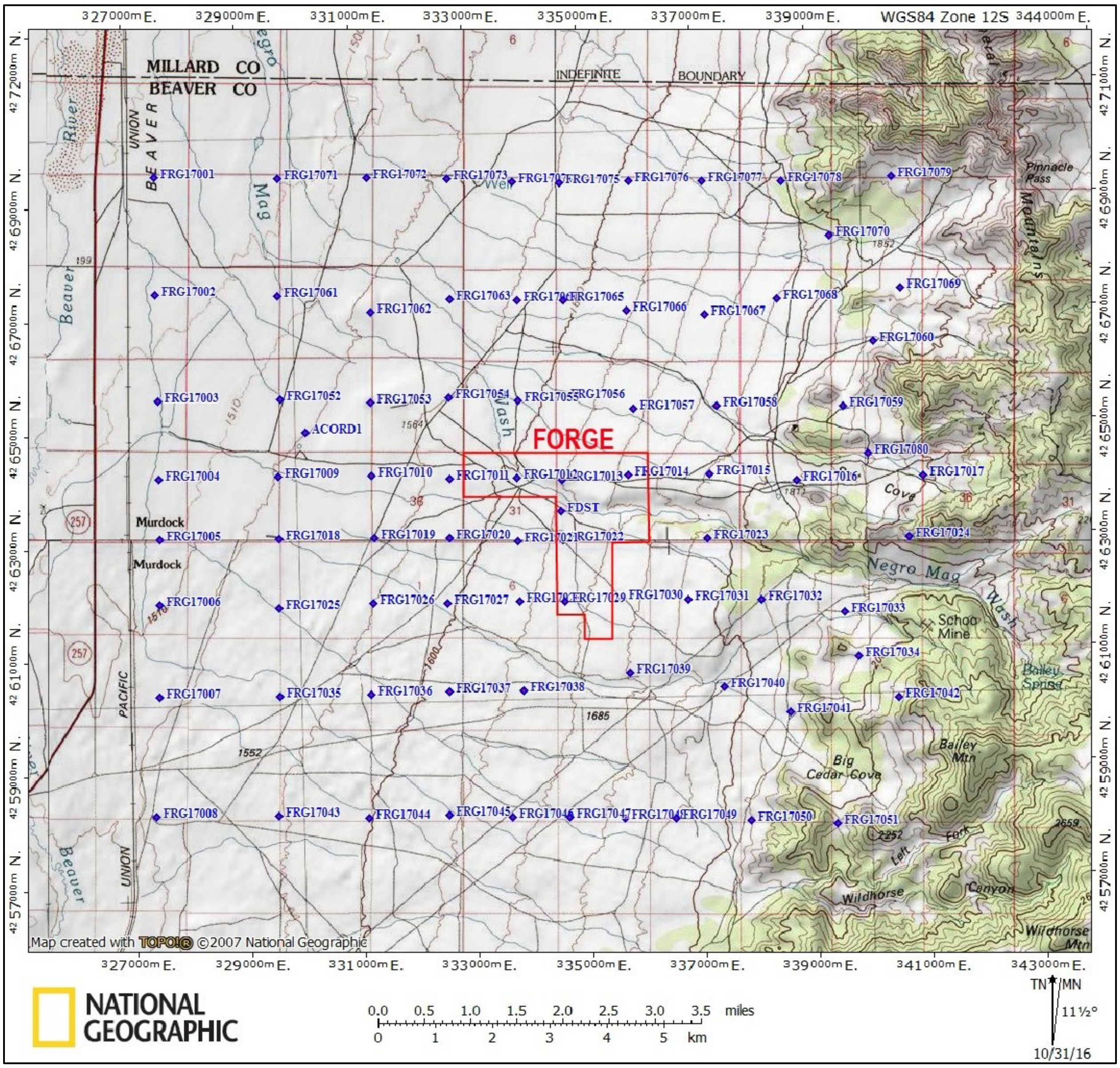


Figure 2-4. Proposed sites for MT measurement submitted to BLM Cedar City Field Office.

The proposed 3-D seismic reflection survey would involve a pair of vibroseis trucks traversing cross-country. The trucks would stop every 160 feet along 13 lines spaced approximately 0.2 mile apart to vibrate the ground beneath the trucks for approximately 1 minute. Figure 2-5 shows the array of 13 vibroseis lines (black dotted lines aligned approximately northwest to southeast) and the array of surface geophones (red dotted lines aligned approximately north to south). The 3-D seismic reflection survey area would cover 6.5 square miles centered on the FORGE area. Two 2.5-mile 2-D seismic reflection lines would also be recorded on existing roads west and east of the 3-D survey area. The survey is currently scheduled for November 2017 to avoid the nesting season and to avoid early spring when trucks may cause ruts in soft soils. The proposed 3-D seismic reflection survey requires the preparation of an EA under NEPA by the BLM Cedar City Field Office. The EA was completed in February 2017, and the BLM has granted permission to conduct the seismic survey.

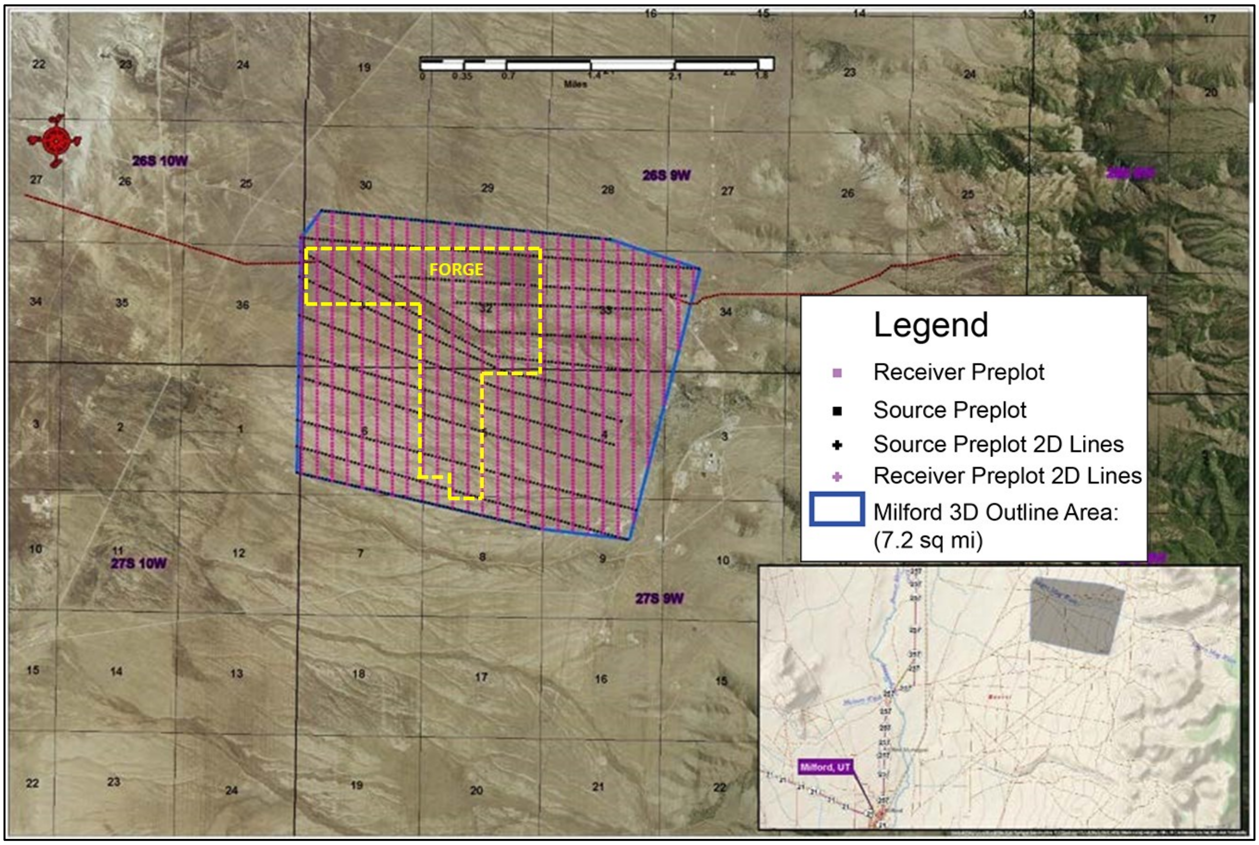


Figure 2-5. Proposed 3-D seismic reflection survey.

Figure Notes: The outline of the FORGE site is shown in yellow. Black dotted lines show the locations of the vibroseis lines; the geophones would be located along the red dotted lines. Inset shows location relative to Milford.

2.3.2.2. WELL PADS AND ACCESS

Four well pads (A1, A2, B1, and B2) where deep wells could be drilled are proposed for the FORGE area (see Figure 2-2). During Phase 2B, only pad A2 would be required, which is where the deep scientific research well (7,536 feet deep) was recently drilled. Improvements were made to the road access and to well pad A2 before April 1, 2017 (ahead of nesting season). A groundwater investigation well (1,000 feet deep) was originally planned to be drilled at pad B1 but has been deferred because of economic considerations.

The Phase 2B and 3 well pad (likely A1) would be leveled and graveled to ensure a suitable base, and would be of sufficient size to accommodate the following:

- Drill rig and drill tower laydown area
- Drill pipe and casing storage area
- On-site trailers for drilling and EGI-contracted personnel (e.g., drilling crew, tool pusher, EGI representatives, mud loggers, mud man)
- Mud materials and safety equipment storage shed
- Fuel tank
- Portable generators
- Parking and turnaround area for service vehicles (including pump trucks, cement trucks, material suppliers) and worker and visitor vehicles
- Lined reserve pit (or sump) to hold mud and cuttings
- Holding tanks for fire water, injection testing, and Diagnostic Fracture Injection Tests (DFIT) in Phase 2B, and water storage for stimulation activities and heat sweep testing in Phase 3
- Trash container
- Eye wash station

After receiving concurrence from the Utah State Historic Preservation Office (SHPO) on appropriate mitigation for cultural resources, pad A2 was bladed to remove vegetation and a layer of gravel was added in late March 2017. Pad A2 covers approximately 2 acres.

Construction of the well pad (or pads) and the lining of the reserve pits would take approximately 2 weeks and require the use of a backhoe, or backhoe and bulldozer. If cut and fill are required to level the site, the reserve pit would be constructed in cut and designed to maintain 2 to 3 feet of freeboard. The well pad would be graded to drain into the reserve pit. No channeling of stormwater to surface waters would occur. Natural drainage patterns would be maintained outside of the graded pad area. On-site vegetation would be removed and placed alongside the well pad to provide habitat. Approximately 6 inches of topsoil would be removed and stored alongside the pad for reclamation and reseeding when the pad is decommissioned. If necessary, the reserve pit would be fenced and netted to limit access by wildlife, cows, and birds.

All well locations would be accessed using existing roads (see Figure 2-2). The existing two-track road from its intersection with Salt Cove Road is used to access pad A2. Access improvements to this pad were completed in August 2017. Where the two-track road crosses BLM land, gravel was placed up to 4 inches deep after the central ridge was bladed level. The existing 10- to 12-foot width of this road was not changed. The two-track that extends south from Section 32 into Section 5 would be similarly leveled during Phase 2C, when a water line connecting to the G2 groundwater wellfield would be needed. Road blading would begin after concurrence is received from the SHPO.

2.3.2.3. GROUNDWATER INVESTIGATION WELL

One 1,000-foot groundwater investigation well was originally proposed for drilling early in Phase 2B at pad B1 (see Figure 2-2). The well was designed to confirm groundwater characteristics (including temperature) in the G1 groundwater wellfield portion of the FORGE area. However, recent economic analysis of groundwater supply costs indicates significant savings if the project uses the G2 groundwater wellfield near the project office instead. For this reason, the 1,000-foot groundwater investigation well has been deferred to a later phase of the project.

Figure 2-6 presents the design features of the groundwater investigation well. The well would be drilled with a standard truck-mounted drill rig and would use a tank for drill mud and cuttings instead of digging a reserve pit. The groundwater investigation well would require approximately 1 week for drilling. A decision would be made at the time the project requires this well whether to drill with mud or foam. Monitoring of drilling circulation temperature and chemistry would occur as drilling proceeds. The bottom-hole temperature at 1,000 feet is expected to be approximately 150 degrees Fahrenheit (°F). A drilling blowout preventer would be installed on the well. The FORGE area is on an alluvial fan and comprises sand to gravel-sized outwash material from granite in the adjacent Mineral Mountains. The well would not reach the granitic bedrock, so the cuttings would be similar to the outwash gravel at the site. Cuttings would be sampled during drilling, and the remaining cuttings would be spread around the drill pad. A water truck would bring water to the site from an existing private water well located 7 miles to the north.

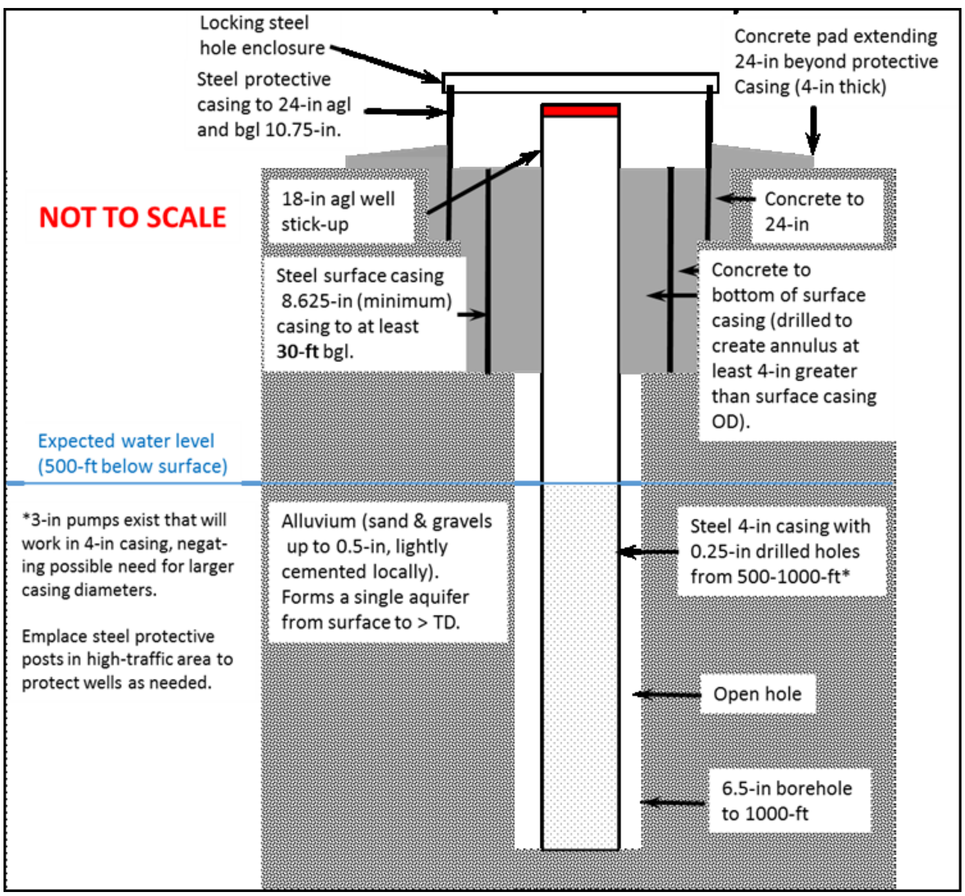


Figure 2-6. Design of groundwater investigation well.

If the groundwater investigation well is drilled, its water levels would be measured and its water chemistry would be analyzed at approximately 3- to 4-month intervals as part of a long-term groundwater quality monitoring program. Additional groundwater monitoring of other wells may take place. Handheld equipment would be used for the monitoring surveys.

2.3.2.4. DEEP GEOTHERMAL SCIENTIFIC RESEARCH WELL

Drilling of a vertical well to 7,536 feet on pad A2 began on July 31, 2017. The site was cleared of personnel and equipment and the rig was released on September 25, 2017. This well will not be produced or used for injection after drilling, and traffic related to use of the well will be light during Phases 2C and 3.

The drilling rig was delivered in sections and constructed on-site (drilling started on July 31, 2017). The well design is shown in Figure 2-7, and the approximate layout of pad A2 is shown in Figure 2-8. Granitic bedrock was encountered between 3,176 feet and 3,196 feet, and the estimated temperature at total depth is 390°F to 400°F. The well has been sampled and logged for physical properties, including rock type, temperature, permeability, and subsurface structures. A final survey will be conducted on November 2, 2017.

Two cores were taken from the well: one from 6,800 feet to 6,810.25 feet, and the second from 7,440 to 7,452.15 feet. Permeability assessment was conducted in the open hole once the well reached total depth. After a 7-inch casing was run from the surface to an appropriate depth, Diagnostic Formation Injection Tests (DFITs) were conducted. These tests provide information needed to predict the behavior of the granite when it is stimulated in Phase 3. Maximum wellhead pressures were greater than 3,000 pounds per square inch (psi) but less than 4,000 psi. This well will remain accessible throughout the project for further testing and monitoring during Phases 2C and 3. During stimulation of the deep production and injection wells drilled from pad A1 in Phase 3, geophones would be installed in the well at pad A2 for high-resolution seismic monitoring and fracture mapping.

The well took 54 days to drill, with approximately 6 days required to erect and take down the rig. Testing and logging took approximately 3 days. The site will remain accessible throughout the life of the project.

A plan of operation for the drilling and testing of this well was submitted to the State Engineer for approval. The plan was approved by the Office of the State Engineer on March 7, 2017.

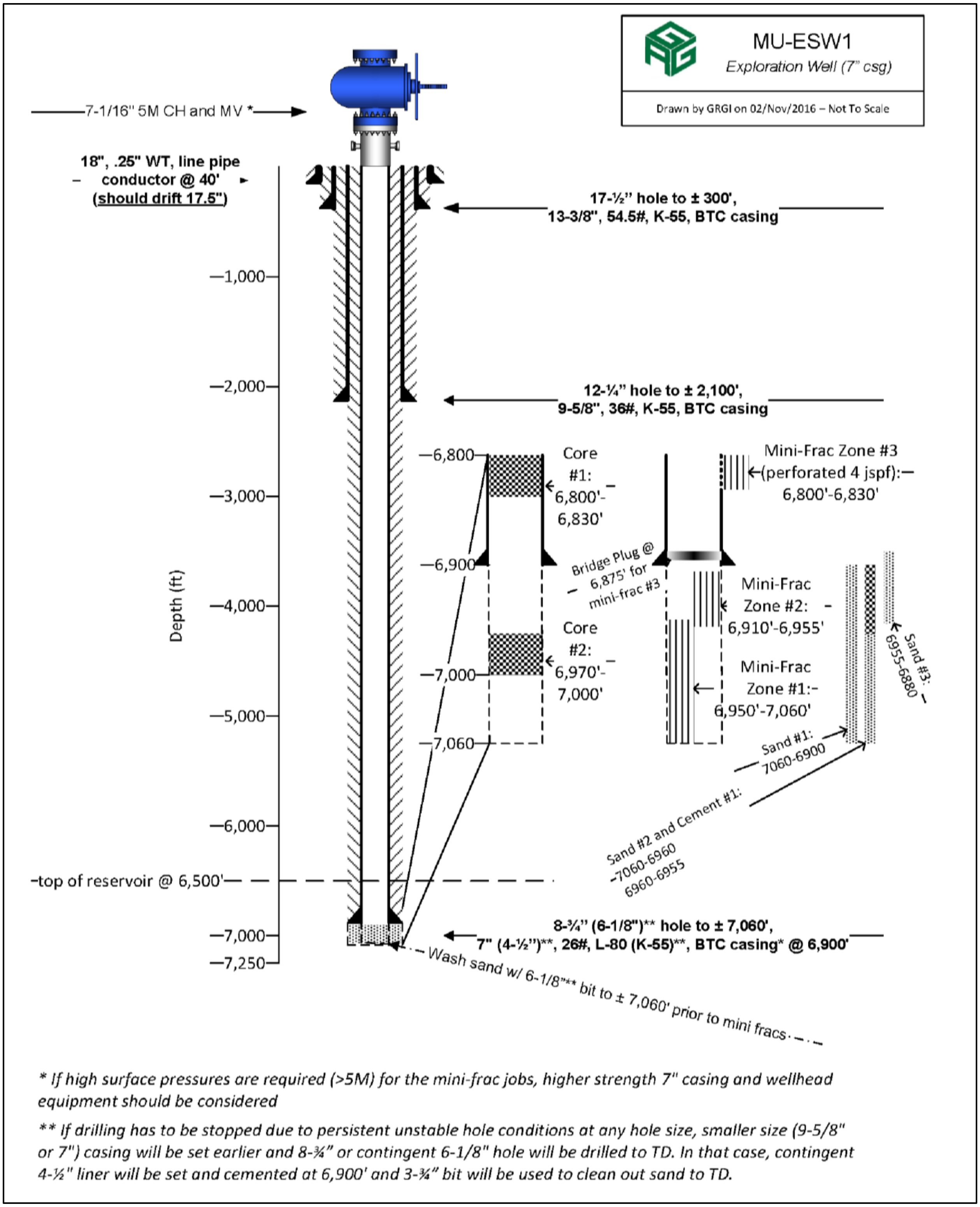


Figure 2-7. Design of the deep geothermal scientific research well at pad A2 during Phase 2B.

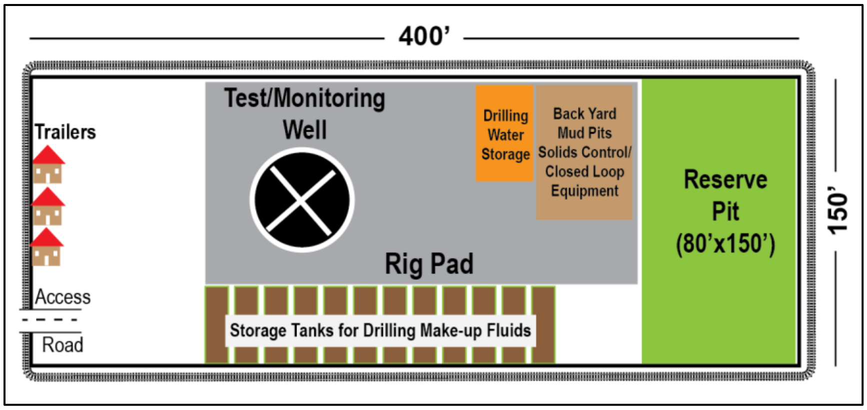


Figure 2-8. Pad layout for the deep geothermal scientific well at pad A2.

As noted previously, the pad includes a reserve pit, space for the drill rig and support equipment, and trailers for use by the drilling crew and EGI-University of Utah personnel. The reserve pit and wellhead are fenced and the wellhead is protected with a locked gate. The reserve pit is lined with plastic and may be used during the stimulations to store water.

2.3.3. Phase 2C: Site Preparation

Activities during the 8 to 12 months of Phase 2C would be mostly restricted to the FORGE area and to Section 11, Township 27 South, Range 10 West, east of Antelope Point Road (on land owned by Smithfield). These activities include development of the project office and support facilities; construction of a power line and communication lines; development of groundwater wellfields for drilling, stimulation, and flow testing activities; drilling of seismic monitoring drillholes for high-precision seismic monitoring; and installation of a network of survey monument and tiltmeter sites to measure any significant ground surface deformation.

2.3.3.1. OFFICE SITE

The project office and support facilities would be located in Section 11 adjacent to the road (see Figure 2-2). The office site would include the office building, a fenced area where vehicles or equipment could be safely stored, a groundwater well, and storage containers to house equipment and tools. A gravel driveway would be constructed from Antelope Point Road to a parking area. The office building would consist of a modular unit with approximately 1,300 square feet of space built on foundations. It would have a septic tank. The office building would provide space for meetings, safety training, communications, visitors, and other daily activities. It would contain a bedroom for times when overnight accommodations are necessary, but it is anticipated that visitors and site personnel would use existing overnight facilities in Milford or Beaver. The parking area next to the office building could also temporarily house trailers used in support of the project. A groundwater supply well would be sited next to the office for sanitary needs and to supply water for emergencies (firefighting). Its capacity may be sufficient to contribute to the other nearby supply wells sited in Section 11 (see Figure 2-2). The office site and adjacent fenced area would cover approximately 2 acres.

The office site would also serve as the hub for a new power line that would run adjacent to Antelope Point Road from the present Rocky Mountain Power terminal near the Union Pacific Railroad crossing on Geothermal Road. An existing fiber optic line runs to SunEdison's maintenance facility on the west side of Antelope Point Road less than 1 mile from the proposed office site. Discussions with SunEdison and South Central Communications (owners of the line) have opened up the possibility of linking to the fiber optic node to connect to the FORGE office (see Figure 2-2). It is anticipated that a variety of monitoring instruments would telemeter data to the office for transfer to the internet.

No new access roads would be required to reach the office site. A utility corridor would connect the project office and the FORGE area, as shown on Figure 2-2. Based on present analyses supporting a groundwater wellfield at G2 near the project office, a water pipeline would be placed in the corridor, supplying water to pad A1. A two-track road would provide light vehicle access along the corridor for maintenance purposes. The main access to the FORGE area would be via Antelope Point Road and Salt Cove Road.

2.3.3.2. POWER LINE

Rocky Mountain Power would construct an electric distribution (power) line and would provide transformers at the points of service delivery at the appropriate voltages. Electricity would be used for the office facilities and to power pumps for the groundwater wells. A transfer pump would be required to move the water from a surge (collector) tank adjacent to the groundwater wells, through a pipeline in the utility corridor, to a water storage tank at pad A1. The location of the proposed power line is shown on Figure 2-2. The line would originate at the present Rocky Mountain Power terminus next to the Union Pacific Railroad crossing on Geothermal Road. It would parallel Antelope Point Road to a hub at the proposed office site. The project has considered extending this line across approximately 2 miles of BLM land and then continuing it north to the FORGE area. However, recent economic analyses indicate that it is more cost-effective to terminate the power line at the project office. If the line is extended to the FORGE area in Phase 3, the 100-foot-wide utility corridor would allow flexibility in siting poles to avoid sensitive resources.

2.3.3.3. COMMUNICATION LINES

As discussed in the office site description, a fiber optic line currently connects to the SunEdison facility maintenance office. Negotiations have begun to see whether the fiber optic line can be extended to the office site (see Figure 2-2). Connection to monitoring instruments in and around the FORGE area would be through telemetry to a hub at the project office site.

2.3.3.4. GROUNDWATER WELLFIELDS

Two to three groundwater wells would be required to provide flowrates of up to 500 gallons per minute for the drilling, stimulation, and flow testing activities in Phase 3. The wells would be approximately 1,000 feet deep and approximately 10 inches in diameter. The wellhead and bottom hole locations would be at least 100 feet from property boundaries to comply with BLM and Utah regulations. As previously discussed, two options (G1 and G2) exist for the location of these groundwater wells (see Figure 2-2).

- G1 Option: The G1 groundwater wellfield would be in Section 5 less than 1 mile from well pads A1 and A2. Potential groundwater well locations are shown as 11, 12, and 13 on Figure 2-2. Groundwater is expected to be approximately 500 feet below the ground surface and measure approximately 150°F. The permeability of the groundwater at G1 is not known, which is why an investigation well was originally planned for Phase 2B at site B1.
- G2 Option: The G2 groundwater wellfield would be at the proposed office site. Potential groundwater well locations are shown as 15, 17, 18, and 19 on Figure 2-2. This area has favorable conditions for groundwater wells. A production test of the well at the nearby SunEdison facility indicated that the alluvium and lake sediments have sufficient permeability for two to four wells to produce a sustained flow of 500 gallons per minute. The water level is at a depth of approximately 80 feet and has a temperature of approximately 90°F. The G2 wells would likely

be 600 to 800 feet deep. If the G2 option is implemented, a 2.5-mile surface pipeline would be required to connect the wellfield to the FORGE area. The pipeline would be located in the power line utility corridor.

An economic analysis of power line costs to the G1 groundwater wellfield versus piping the water from the G2 groundwater wellfield with a power line half the length shows that the G2 wellfield results in water supply costs at pad A1 that are less than a third of the G1 water supply costs. For this reason, Phase 2B focuses on the drilling and testing of the deep well at A2. The pump test of the SunEdison well provides the critical information required to optimize the design of G2 supply wells. A plan of operation for these wells would be submitted to the State Engineer during Phase 2C.

Well locations 1 and 2, shown on Figure 2-2, may be required as disposal wells during Phase 3 and are also included in this analysis. They are located downgradient from pad A1 and may be required if there is excess or surplus water stored at pad A1. Water rights exist for these wells, but a plan of operation would need to be submitted to the State Engineer prior to their drilling and use. Any groundwater well used for water disposal as part of the Proposed Project would be authorized by the Utah Division of Water Quality (UDWQ). These wells would be treated as Underground Injection Class 5 wells and authorized by rule. Water would be disposed into the same geothermal aquifer from which the water is extracted.

2.3.3.5. SEISMIC MONITORING DRILLHOLES

Up to ten 500-foot-deep drillholes could be drilled on non-federal land around the FORGE area for high-precision seismic monitoring. An additional two to four seismometer sites may be placed on bedrock outcrops on the west and east sides of north Milford Valley. The drillholes would be drilled using a truck-mounted drill rig, similar to the rigs used for drilling groundwater wells. No drilling pads or reserve pits would be constructed. The area of disturbance for each seismic monitoring drillhole would be approximately 50 feet by 50 feet in size. Cuttings would be spread on-site. The drillholes would be cased with 6-inch-diameter casing, and each would contain a single three-component geophone. Electricity would be provided by a solar panel, and seismic data would be telemetered to a hub at the office site. Figure 2-9 shows an example of the surface equipment that would be situated next to the drillhole. Equipment may be fenced to protect it from livestock.

Figure 2-9. Surface equipment at a seismic monitoring site at the Raft River geothermal field.

Figure Notes: The geophone is located at the bottom of the capped 300-foot drillhole in the lower right. Data are telemetered to a hub more than 1 mile away. The yellow poles keep cows and horses away from the cement pad and wire attached to the geophone.

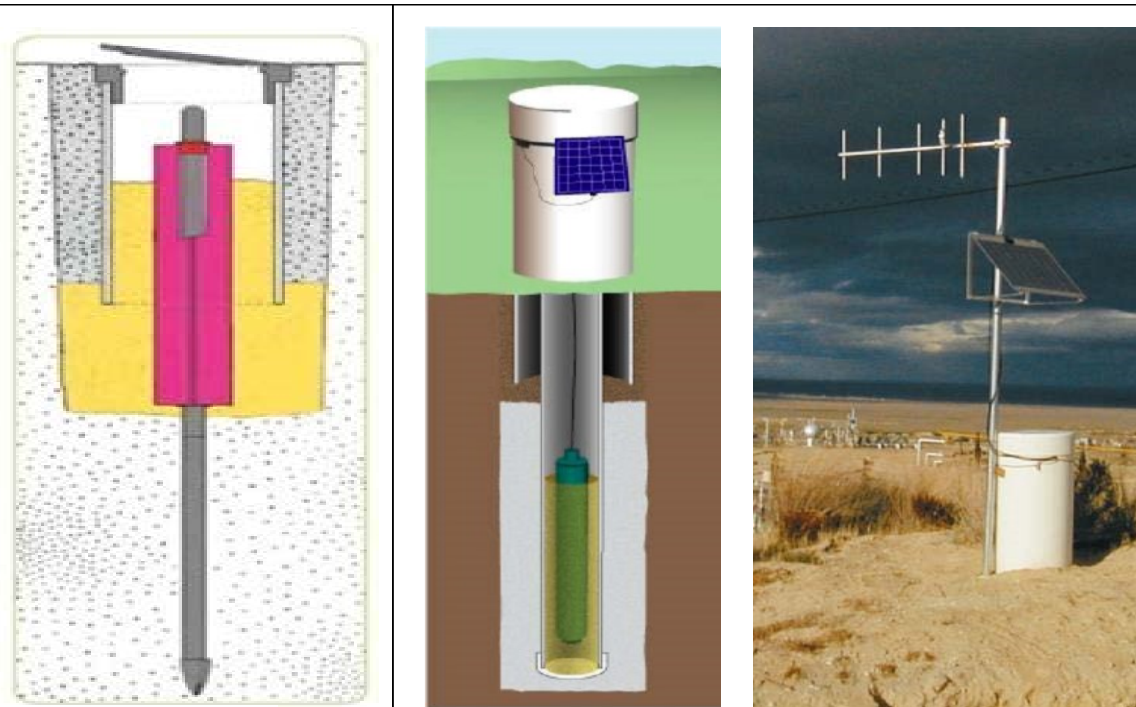
2.3.3.6. SURVEY MONUMENT AND TILTMETER SITES

To detect and measure any significant ground surface deformation, a network of 31 survey monument stations (sometimes called benchmarks) and two survey base monument stations (for a total of 33 stations) would be installed during Phase 2C. The network of survey monument stations is intended to monitor elevation changes in and around the FORGE area. All stations would be sited near existing roads.

A truck-mounted auger would be used for each drillhole. No drilling pads would be constructed. The area of disturbance for each station would be approximately 20 feet by 20 feet in size. Cuttings would be spread on-site. For each station, a rod would be driven into the soil with a grease-filled sleeve surrounded by sand to effectively decouple the rod from near-surface movements. The rod would be driven into the ground 8 to 12 feet deep at each station site, unless refusal occurs because of boulders and/or cobbles. A marked bronze survey cap would be installed on the top of each rod.

Each monument station would be levelled several times during Phase 2C to determine the elevation at the sites prior to the major drilling and testing in Phase 3. Accuracy within several millimeters is expected. To conduct measurements at each site, a hand-held antenna would be balanced on the top of the survey cap, and a GPS receiver would record the precise location.

Nine tiltmeters may also be installed on non-federal land within 2 miles of the FORGE area. These instruments are sensitive to tilt of the ground surface and would supplement the GPS measurements. The tiltmeter consists of an aluminum tube that is held in place with clean, dry sand at the bottom of a 12-meter-deep hole cased with cemented 10-centimeter-diameter PVC pipe (Figure 2-10). The surface disturbance at each station would measure approximately 20 feet by 20 feet. The hole would be dug with a geotechnical or rat-hole driller using a simple flight auger. Sites in loose sand may require use of a water swivel to keep the hole open until pipe emplacement and cementing are complete. Cuttings would be spread on-site. Electricity would be provided by a solar panel, and the data would be telemetered to a hub at the office site.



A. GPS monument B. Tiltmeter site

Figure 2-10. Schematic cross sections of A. a National Geodetic Survey–style monument and B. a surface tiltmeter. The picture on the right in B. is an example of a typical surface tiltmeter instrumented site.

2.3.4. Phase 3: Site Operation

Most of the Phase 3 activities would be in the FORGE area. Phase 3 consists of the drilling of FORGE deep production and injection wells and cleaning out the existing Acord-1 Well.

2.3.4.1. FORGE DEEP PRODUCTION AND INJECTION WELLS

Phase 3 would consist of the drilling of at least two deep, deviated wells beneath the FORGE area and the creation of fractures connecting these wells in the hot granite. A variety of short-term and long-term flow tests would inject cool water down one well and produce hot water from the second well. Experiments would test the efficiency and effects (e.g., seismic noise) of sweeping heat from the granite by circulating water. The preferred location for these wells is at pad A1, and the deviation direction based on the present understanding of the stress direction is toward pad A2 (see Figure 2-2). Pads B1 and B2 would be available if a second location for these wells is needed. All well trajectories would remain inside the FORGE area boundaries. The wells would require a plan of operation to be approved by the Utah State Engineer's Office and by the UDWQ in Utah Department of Environmental Quality.

2.3.4.1.1. Drilling

The plan of operation for the deep wells would provide specifications on anticipated formations; the mud system; potential water intervals; the casing and cementing program; and testing, logging, and stimulation activities that would be conducted during the drilling program. Surface and other casings would be set with cement to prevent migration of drillhole fluids, to prevent contamination of any fresh water aquifers penetrated by the drillhole, and to isolate potential permeable zones.

Each geothermal well would be drilled with a large rotary drill rig. During drilling, the top of the drill rig mast would be less than 155 feet above the ground surface, and the rig floor could be 20 to 30 feet above the ground surface. The typical drill rig and associated support equipment (i.e., rig floor and stands; draw works; mast; drill pipe; trailers; mud, fuel, and water tanks; diesel generators; and air compressors) would be brought to the prepared pad on 20 to 25 large tractor-trailer trucks. Additional equipment and supplies would be brought to the well site during ongoing drilling, stimulating, and testing operations. As many as 10 or more tractor-trailer truck trips would occur on the busiest day. However, on average, two or three large tractor-trailer trucks (delivering drilling supplies and equipment) and 15 to 20 small trucks, service vehicles, and worker vehicles would be driven to the well site each day throughout the estimated 84-day drilling process, including rigging times (60 days of actual drilling). Difficulties encountered during the drilling process, including the need to work over or to re-drill the hole[1], could increase the time necessary to successfully complete and stimulate each well. The drill rig would be moved from the well site as soon as possible after each well has been drilled and any initial stimulations completed. It is anticipated that the funding schedule would result in hiatuses of up to 1 year between the drilling of the first and second wells and between the initial stimulation of the toe of the first well and the completion of stimulation activities. This would require the drill rig and stimulation equipment to be mobilized and demobilized at least twice.

A crew of nine to 15 workers would conduct drilling 24 hours per day, 7 days per week. A temporary man camp would be located at the pad to accommodate workers. Researchers and visitors would stay in Milford or Beaver.

Each well would be drilled with a combination of drilling fluids to maintain drillhole pressures. The anticipated fluid type is water with 3% by volume micronized cellulose (drilling plan approved by Jim Goddard, Well Drilling Specialist, Utah Division of Water Rights, March 7, 2017). The mud weight is monitored to ensure proper weighting of the drilling fluid for anticipated drillhole pressures. Weighting agents could include barite ($BaSO_4$). In the unlikely event that areas of very low pressure are encountered, air could be added to the drilling fluid (via a compressor package) to reduce the weight of the drilling fluids in the hole. In the unlikely event that lightened drilling is implemented, the FORGE team has substantial experience. The fluid may need to be misted or foamed (water, surfactant, nitrogen, or air), but this is not anticipated. The reciprocal unlikely event is overpressure. Blowout prevention equipment would be installed on the well, and the drilling fluid can be weighted up with barite if necessary. The well would be shut in and/or backpressure exerted on the annulus while weighting material is brought in.

[1] Each well may need to be re-drilled if mechanical or other problems occur while drilling or setting casing that would prevent proper completion of the well in the targeted zone. Well re-drilling may consist of re-entering and re-drilling the existing well bore, re-entering the existing drillhole and drilling and casing a new drillhole, or sliding the rig a few feet on the same well pad and drilling a new hole through a new conductor casing. A variety of stimulation techniques may be employed.

The geothermal wells would be drilled and cased to a measured depth of 11,500 feet at a true vertical depth of approximately 8,000 feet. The design plan may be altered by the project manager, depending on downhole conditions encountered, with the goal being a successful casing, cementing, and stimulating program within the target rock formation. Blowout prevention equipment, which is typically inspected and approved by the Utah State Engineer, would be used during drilling below the surface casing.

Hydraulic stimulation of each well would take approximately 30 days, with 6 days of stimulation and 4 days of drilling; the remaining days would be spent in set up and tear down.

2.3.4.1.2. Water Use

Water would be required for drilling the deep wells, for the subsequent fracture injecting testing, and during long-term circulation tests once a pair of wells is connected through fractures in the subsurface. The Proposed Project has acquired 300 acre-feet per year of water rights to meet the needs of the project. Smithfield have agreed to lease an additional 200 acre-feet if required. During the flow testing, the injected cool water would be produced as heated water is cooled and recirculated. A portion of the water (50 acre-feet per year) is for consumptive use to allow for evaporative cooling of the produced hot water. Alternatively, air cooling may be employed. Water storage tanks on the FORGE site would be used for drilling and stimulation. The ground beneath the tanks would be compacted and graveled to ensure stability. The tanks would be covered to prevent birds from accessing the water and may be fenced to prevent casual access. At the end of the flow tests, the water stored in the tanks can be disposed of in the groundwater production wells or other nearby wells assigned and permitted by the UDWQ as disposal wells. Monitoring of water quality would accompany the heat sweep tests.

2.3.4.1.3. Well Design

The FORGE wells would be drilled on a 5-acre pad, preferably pad A1. The wells would be drilled over a period of approximately 2 years. Up to three intervals (stages) near the toe of the first well would be stimulated. Fracture formation and growth would be monitored and would use the local network of seismometers and data from surface and downhole logging of temperatures, pressures, and flow rates. The following year, the second well would be drilled to intersect the fractures produced in the first well. A circulation test would be conducted at low pump pressures to determine the extent of the connection between the two wells. It is anticipated both wells would require stimulation in their highly deviated sections below approximately 6,500 feet. Each well would be monitored for temperature, pressure, flow rate, and environmentally benign tracers throughout the life of the project. Additional testing would likely occur to determine the changes in behavior of individual injection and production zones. Figure 2-11 illustrates the well design details.

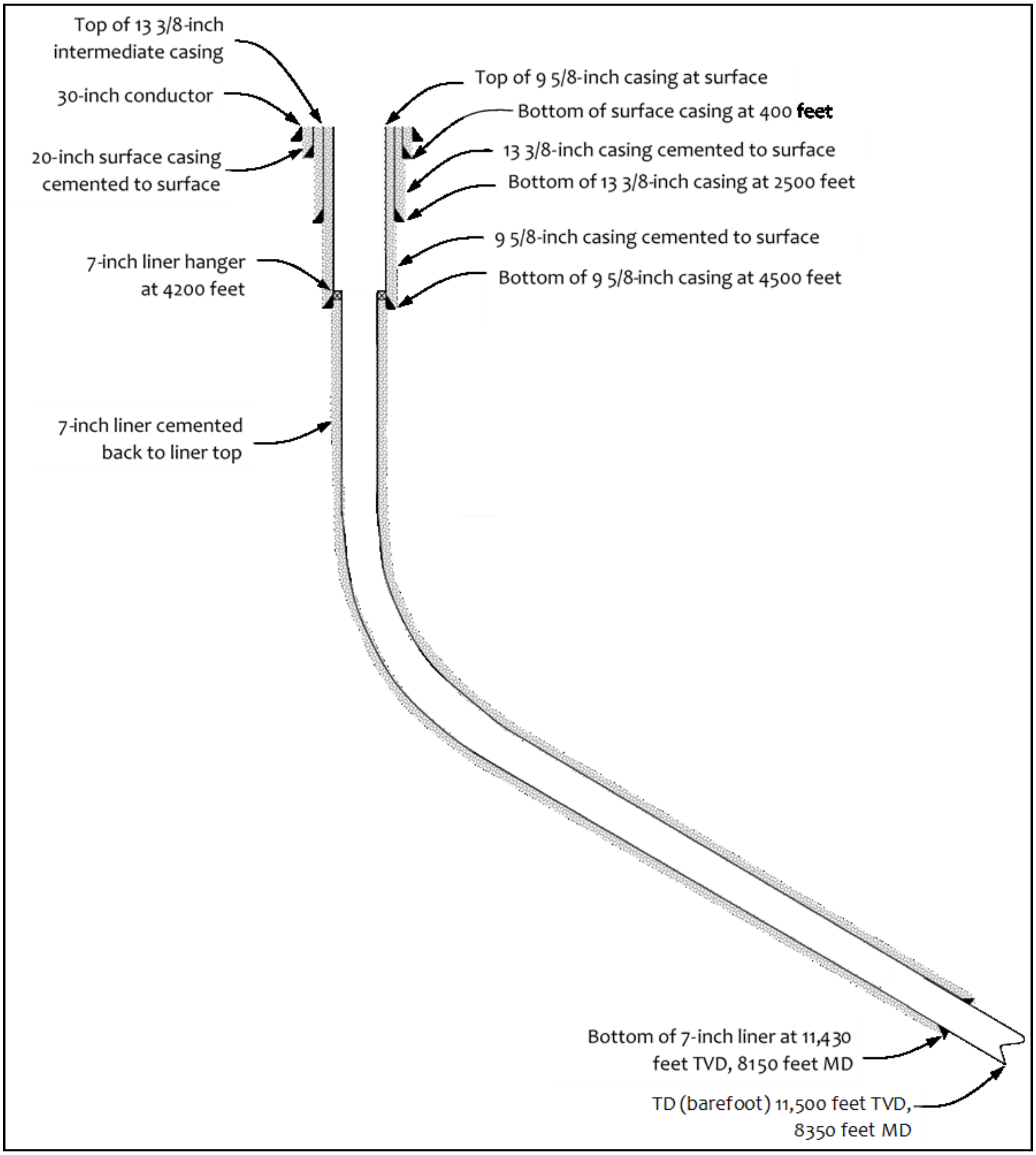


Figure 2-11. Plan for the deep production and injection wells drilled during Phase 3.

2.3.4.1.4. Well Pad Layout

Pad A1 would be approximately 600 feet by 400 feet in size. Figure 2-12 provides the pad layout. Two wellheads are shown in the figure, but the pad is large enough for three wellheads. The pad would accommodate tanks for water storage to provide make-up water, which could be necessary once long-term circulation testing occurs. The infrastructure on the pad would vary depending on whether a deep well is being drilled or stimulated, or circulation testing is occurring.

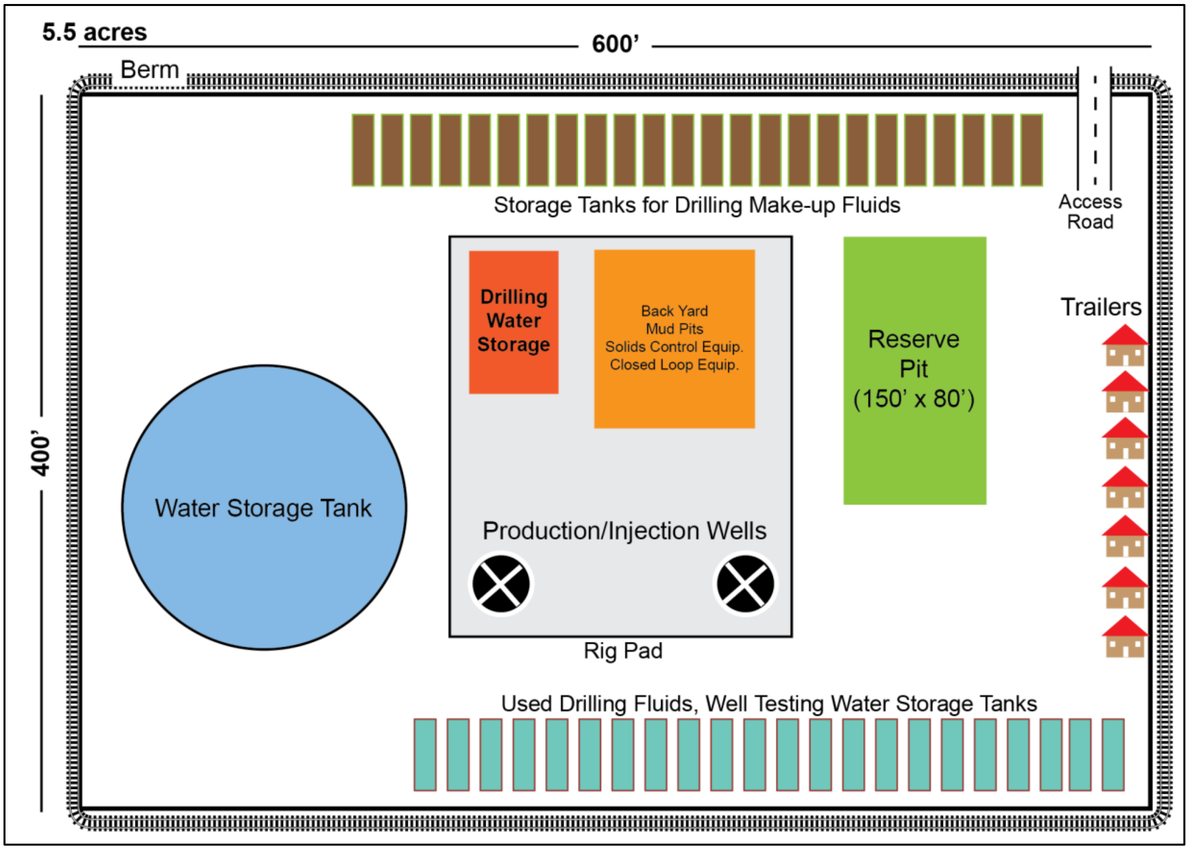


Figure 2-12. Pad layout for the deep production and injection well at pad A1.

2.3.4.1.5. Circulation Flow Tests

Once two deep wells are present on the pad, circulation testing would begin. This would involve injecting cooled water down one hole into fractures in the hot granite at depth, and pumping out the heated water in the second nearby production well. The hot water would be cooled by a variety of methods such as evaporation, mixing with cold water, or by air cooling in closed vessels. The method would vary according to the scientific objectives of the test. Some tests could last several months. Make-up water could be required if there are subsurface losses from the stimulated reservoir.

Circulation testing would be conducted after both wells are drilled and stimulated, and the injected fluid is successfully circulating between wells. Environmentally benign tracers would be added to the injected fluid to evaluate the extent of recirculation. Each test would consist of flowing the produced water to the injection well while monitoring geothermal fluid temperatures, pressures, flow rates, chemistry, and tracer contents. Depending on the purpose of the test and the scientific questions being addressed, the produced water may be temporarily stored in the steel tanks, cooled to varying degrees, or reinjected directly into the injection well with little cooling. Injectivity tests may also be conducted on each well without production of the water from the second well to evaluate the effects of thermal or other stimulation techniques.

2.3.4.2. ACORD-1 WELL

As part of Phase 2C activities, the Acord-1 well (a pre-existing well) would be cleaned out for testing tools (see Figure 2-2). The total depth of the well is 12,650 feet. The well was lightly plugged when it was abandoned in 1980. Access to the well is from an existing two-track road. A drill rig would remove the two cement plugs (50 feet thick and 200 feet thick) and all mud in the hole. The mud and any cement cuttings would be removed to a landfill if required after chemical testing. The cleanout operation would use water from an existing well located 1,000 feet from Acord-1, for which the project has water rights. Water could also be trucked in from alternative sources.

2.3.5. Surface Disturbance Summary

Table 2-1 provides a summary of the maximum surface disturbance expected during all phases of Proposed Project. A conservative approach was used to calculate potential surface disturbance for all project elements. For example, acres of disturbance for the proposed power line were calculated using a 100-foot corridor to capture temporary disturbance from overland equipment use, staging areas, and pulling and tensioning sites. Acres of long-term disturbance from poles and/or a water pipeline and the adjacent two-track access road would actually be less. Also, Beaver County is in the process of confirming that the power line along Geothermal Plant and Antelope Point Roads can be sited within an existing corridor adjacent to the roads. If this were to occur, it would reduce the impacted area by 35 acres.

Table 2-1. Project Surface Disturbance Estimates for all Phases of the Proposed Project

Project Elements (Known Locations)	Surface Disturbance (acres)
Well pads (A1, A2, B1, and B2)	13.41
Access roads (two to A2, north-south road in Section 5, and connecting roads to A1, A2, B1, and B2)	5.71
Power line (including connections to A1, A2, B1, and B2) Water pipeline and utility corridor with two-track access road	85.96* No new disturbance; would be in power line corridor.
Fiber optic line	1.64
Office site (includes well 19)	1.55
Groundwater wellfield (G1 option) wells 11, 12, and 13 (and connecting access roads and power corridor)	8.67
Groundwater wellfield (G2 option) wells 15, 18, and 17 (and connecting access roads, and power corridor, plus additional water pipeline corridor between 15 and the office site)	5.57
Other potential groundwater sites	7.04
Wells 1 and 2	
Water line from well 1 to A1	
Acord-1 (existing well)	0.01
Total	**129.56**
Project Elements (Unknown Locations)	**Surface Disturbance (assumed acres)**
10 seismic monitoring drillholes (50 x 50 feet each)	0.57
42 survey monument and tiltmeter sites (20 x 20 feet each)	0.39
Total	**0.96**

* If the power line terminates at the office site, the disturbance acreage decreases.

2.3.6. Decommissioning and Reclamation

The DOE has specified that the FORGE project would be decommissioned at the end of Phase 2B if it is not selected to proceed to Phase 2C and beyond, or after 5 years of testing at the end of Phase 3. Based on the present understanding, decommissioning is expected either in 2018 or in 2024.

All wells would be plugged and abandoned according to the stipulations of the Utah State Engineer. Well abandonment would typically involve plugging the drillhole with cement sufficient to ensure that fluids would not move laterally into different aquifers. If required, the wellhead (and any other equipment) would then be removed, the casing cut off below ground surface, and the hole backfilled to the surface. However, the landowner may request that the wellhead be preserved with liability transferred to the landowner. The well pad and any associated new access road would be restored in conformance with landowner and permit agency requirements. Reclamation typically includes re-grading the affected surfaces to approximate pre-project contours, removing applied gravel, spreading the topsoil removed during construction of the well pad, and re-vegetating with native seed mixtures or other plants preferred by the landowners.

Liquids from the reserve pits would be allowed to evaporate, pumped back down the geothermal well, or disposed of in accordance with the project-specific requirements of the permit and oversight agencies. Excess fluids that are compatible with the environment would be used as dust inhibitors on roads, if allowed by permitting agencies.

The solid contents remaining in the reserve pits, typically consisting of non-hazardous, non-toxic drilling mud and rock cuttings, would be tested in accordance with existing state standards or with project-specific requirements of the drilling and water permitting agencies. If inert, the material would be spread and dried nearby within the FORGE area, and then buried in the on-site reserve pit. If burial on-site is not authorized, the solids would be removed and either used as construction material on private lands or disposed of in a waste disposal facility authorized to receive and dispose of such materials. After the materials buried in the reserve pit have been removed or compacted and stabilized, the reserve pit area would be reclaimed.

All associated infrastructure such as the office building, tanks, and pipelines would be removed. Roads that have been constructed would be re-vegetated if required by the landowner. All drilling and testing equipment would be removed from the site.

2.3.7. Applicant-Committed Environmental Protection Measures

Applicant-committed environmental protection measures (ACEPMs) are specific means, measures, or practices that are incorporated into a proposed action. Standard operating procedures, stipulations, and best management practices are usually considered ACEPMs. The following ACEPMs are incorporated into the Proposed Project:

- Roads, well pads, and the office site would be graveled to reduce fugitive dust and the potential for erosion.
- Fugitive dust would be controlled by the surface application of water.
- A stormwater pollution prevention plan (SWPPP) would be developed and would include measures designed to control erosion and prevent excess sediment from discharging to surface water.
- A spill prevention and countermeasure control (SPCC) plan would be developed to ensure proper response to and mitigation of any fuel spills.
- Containment berms would be constructed around any hazardous material storage areas and fuel tanks. An impermeable liner would be placed in the containment berms around fuel tanks.
- Reserve pits or sumps would be lined with bentonite or nylon-reinforced plastic liner to prevent seepage to groundwater.

- A grouting and casing program for the construction of all wells would be implemented to prevent the degradation of groundwater quality during and after well drilling.
- Surface and other casings would be set with cement to prevent the migration of produced fluids and contamination of non-geothermal aquifers.
- Blowout prevention equipment would be used while drilling below the surface casing.
- Properly weighted drilling mud would be used.
- During drilling operations, a minimum of 10,000 gallons of cool water and 12,000 pounds of inert, non-toxic, non-hazardous barite would be stored at the well site for use in preventing uncontrolled well flow.
- Employees present during the drilling phase would use proper personal protective equipment to avoid damages to hearing or health.
- Appropriately-sized culverts would be installed as needed for surface water line crossings.
- Well pads and access roads would be monitored for weeds. Any necessary weed treatment would be conducted to eliminate further spreading, following a program approved the authorized state or federal agency.
- All equipment used for construction and drilling would be power washed before on-site arrival to remove any invasive, non-native weed seeds.
- Prudent speed limits would be observed in and around the FORGE area to protect wildlife and reduce the risk of vehicle-animal collisions.
- Big game and other animals would be protected through the fencing of each reserve pit or sump.
- If construction occurs during migratory bird breeding season, pre-construction surveys would be conducted for migratory birds and raptor nests.
- Protection measures for cultural resources in the FORGE area would include identifying allowable travel areas; identifying areas to be avoided during construction, maintenance, and operation; and preventing site looting through periodic monitoring by the BLM and SITLA, with environmental training provided to all project employees.
- Interim reclamation of reserve pits, access roads, and portions of well pads that are not needed for operations or operational facilities would be conducted.
- Disturbed areas such as well pads would be reseeded.
- Final soil stabilization would be implemented to prevent sediment discharge.

2.4. Reasonable Range of Alternatives

NEPA requires the DOE to assess the range of reasonable alternatives to the proposed action. Because the DOE's proposed action is limited to providing financial assistance in cost-sharing arrangements to selected applicants in response to a competitive funding opportunity, DOE's decision is limited to either accepting or rejecting the project as proposed by the proponent, including its proposed technology and selected sites. Only two projects have proceeded through the multi-step selection process to this phase of work, and those are the only projects available for selection as the final FORGE project. The DOE's consideration of reasonable alternatives to the Utah FORGE project is therefore limited to the FORGE project proposed in Fallon, Nevada, and the No-Action Alternative. The FORGE project proposed for Fallon, Nevada, (Fallon Frontier Observatory for Research in Geothermal Energy (FORGE) Geothermal Research and Monitoring) is the subject of an EA initiated by the BLM due to its location on BLM land. Since the proposed Fallon, Nevada, FORGE project will be fully analyzed in DOI-BLM-NV-CO10-2018-

005-EA, DOE will not reiterate the analysis of that alternative in this document. This DOE EA and the BLM EA for the Fallon site will be completed prior to the final selection of the FORGE project location. DOE will use the completed EAs to provide environmental information when deciding whether or not to fund the EGI's Utah FORGE project.

Alternatives must be considered if there are unresolved conflicts concerning alternative uses of available resources (section 102(2)(E) of NEPA). For an EA where there are no unresolved conflicts concerning alternative uses of available resources, only the proposed action requires consideration. No such resource conflicts were identified. For these reasons, only the Proposed Project and No Action Alternative are analyzed in this EA.

2.4.1. No Action Alternative

Under the No Action Alternative, DOE would not provide cost-shared funding to the proposed project and the FORGE initiative would not go forward at the Utah FORGE site. No additional research would occur at this location and no new data or information on the conditions and characteristics of the Utah FORGE site would be obtained. The proposed Utah FORGE site would remain undeveloped. If no action is taken for the Utah FORGE project, the DOE may select the FORGE project proposed in Fallon, Nevada, or take no further action.

CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1. Introduction

This chapter describes the existing environment and trends in the area that would be affected by the Proposed Project or the No Action Alternative, and discloses the potential environmental consequences of the alternatives on the affected environment. As discussed previously, the FORGE area is defined as the proposed Utah FORGE site. The project area is the surface disturbance footprint of the Proposed Project.

For the purposes of this document, an *environmental impact* is defined as a change in the quality and/or quantity of a given resource due to a modification in the existing environment as a result of the Proposed Project. Impacts may be beneficial or adverse, direct or indirect, and of short-term or long-term duration. Unless otherwise specified, impacts of short-term duration begin with the implementation of Phase 2B and end after 5 years of testing at the end of Phase 3. Long-term impacts are those that would occur or remain after this time. Direct impacts are caused by the action and occur at the same time and place; and indirect impacts from an action occur later in time and/or are removed in space.

Impacts may vary in degree from a slightly discernible change in the environment to a total change in the environment. The significance of these impacts is determined using the criteria set forth by the Council on Environmental Quality at 40 CFR 1508.27 and the professional judgment of the specialists doing the analyses; it is assessed using the two key elements of context and intensity. The context in which impacts occur can be local, regional, and/or national. Intensity refers to the severity of the effect.

This EA uses generally available environmental data and data collected in the FORGE area to describe the affected environment and to predict environmental effects that could result from the Proposed Project and No Action Alternative. A level of uncertainty is associated with any set of data in terms of predicting outcomes, especially when natural systems are involved. The predictions described in this analysis are intended to allow comparison of the No Action Alternative to the Proposed Project, as well as to provide a method to determine whether activities proposed by the applicant would be expected to comply with applicable federal, state, and local regulations.

3.2. Land Use

The FORGE area is located in northeastern Beaver County, Utah, approximately 4.5 miles northeast of Milford, Utah (estimated population 1,409). The analysis area for effects to land use is a 0.5-mile buffer around the periphery of the project area (Figure 3-1). This area was chosen because it captures the existing land uses most likely to be affected by the Proposed Project. This analysis area is 6,751.4 acres and comprises 457.3 acres of state land, 2,070.0 acres of federal BLM-administered land, and 4,224.1 acres of private land.

3.2.1. Affected Environment

The federal BLM-administered land in the analysis area is available for multiple uses, as defined by the Federal Land Policy and Management Act of 1976 (43 USC 1702(c)). Existing uses of the BLM-administered land in the analysis area include the leases and ROWs listed in Table 3-1. According to BLM's CBGA RMP maps, the analysis area contains land that the BLM manages for activities such as livestock grazing and geothermal leasing (BLM 1984).

The state land in the analysis area is administered by SITLA. The objective for SITLA lands is to optimize and maximize trust land uses for support of the beneficiaries over time (Utah Administrative Code R850-2-200). Beneficiaries include state institutions such as public schools, state hospitals, teaching colleges, and universities. To address this objective, SITLA will do the following (Utah Administrative Code R850-2-200):

1. Maximize the commercial gain from trust land uses for SITLA lands consistent with long-term support of beneficiaries.
2. Manage SITLA lands for their highest and best trust land use.
3. Ensure that no less than fair market value (FMV) be received for the use, sale, or exchange of SITLA lands.
4. Reduce risk of loss by reasonable trust land use diversification of SITLA lands.
5. Upgrade SITLA land assets where prudent by exchange.
6. Permit other land uses or activities not prohibited by law that do not constitute a loss of trust assets or loss of economic opportunity.

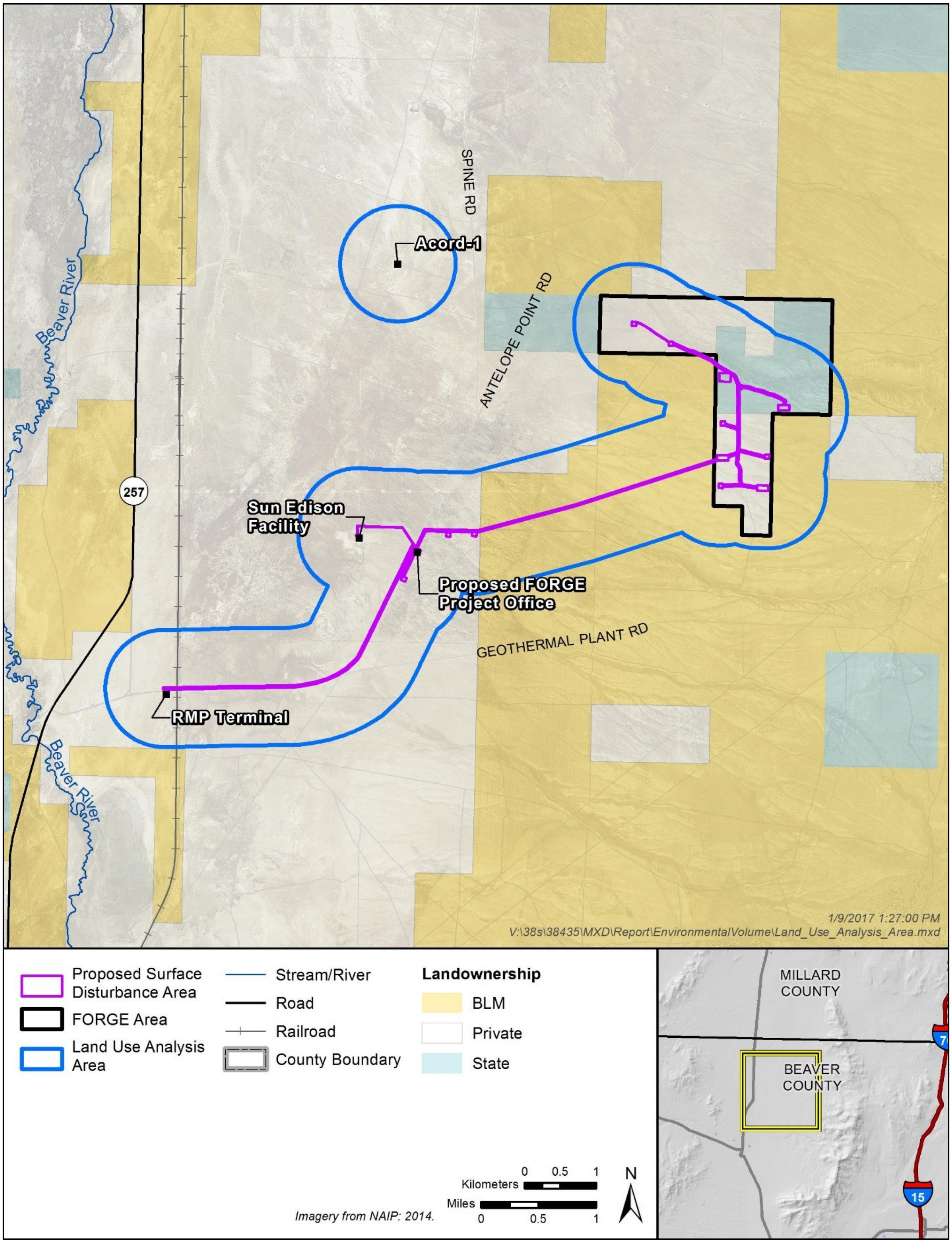


Figure 3-1. Land use in the project area, FORGE area, and land use analysis area.

Table 3-1. Summary of Leases and Rights-of-Way on Bureau of Land Management–Administered Lands in the Analysis Area

Serial Number	Owner	Case Type/Commodity	Acres	Location
UTU-014990	PacifiCorp	Geothermal lease completed pre-2005/geothermal	40.0	T27S, R9W, Section 9, Subdivision SWSE
UTU-027386	Energy Minerals Inc. and PacifiCorp	Geothermal lease completed pre-2005/geothermal	1,173.3	T26S, R9W, Section 34, N2NE, SENE, NENW; T26S, R9W, Section 34, Subdivision MS4976B; T26S, R9W, Section 34, Lots 1, 4–7; T26S, R9W, Section 35, W2W2, SESW; T27S, R9W, Section 3, all
UTU-027388	PacifiCorp	Geothermal lease completed pre-2005/geothermal	200.0	T27S, R9W, Section 4, SESE; T27S, R9W, Section 9, E2E2
UTU-027389	PacifiCorp	Geothermal lease completed pre-2005/geothermal	680.0	T27S, R9W, Section 10, all; T27S, R9W, Section 11, NWNW
UTU-027392	PacifiCorp	Geothermal lease completed pre-2005/geothermal	440.0	T27S, R9W, Section 15, W2NE, W2, NWSE
UTU-051402	PacifiCorp DBA Utah Power and Light	ROW, pipeline, other/other energy facilities	37.1	T26S, R9W, Section 33, E2NE; T26S, R9W, Section 34, SWNW, NWSW; T27S, R9W, Section 3, S2NE, SENW, N2SW, SWSW, W2SE; T27S, R9W, Section 3, Lot 2; T27S, R9W, Section 10, S2NW
UTU-058158	PacifiCorp DBA Utah Power and Light	ROW, pipeline, other/other energy facilities	5.4	T26S, R9W, Section 33, NENE; T26S, R9W, Section 34, NWSW; T26S, R9W, Section 35, NWNW; T27S, R9W, Section 3, Lots 2, 3
UTU-066583O and UTU-66583X	BLM and PacifiCorp	Geothermal participating area and geothermal unit agreement/geothermal	3,542.3	T26S, R9W, Section 34, NENE, NENW, NWNE, SENE; T26S, R9W, Section 34, Lots 1–9; T26S, R9W, Section 35, W2W2, SESW; T27S, R9W, Section 2, S2NW,SW; T27S, R9W, Section 2, Lots 3–4; T27S, R9W, Section 3, S2N2,S2; T27S, R9W, Section 3, Lots 1–4; T27S, R9W, Section 4, SESE; T27S, R9W, Section 9, E2E2, SWSE; T27S, R9W, Section 10, all; T27S, R9W, Section 11, NWNW; T27S, R9W, Section 15, W2, W2NE, NWSE; T27S, R9W, Section 16, E2, E2, W2
UTU-068164	Kern River Gas Transmission	ROW, oil and gas pipelines/ oil and gas facilities	762.1	T26S, R9W, Section 35, SE
UTU-092127	ORMAT Nevada Inc.	Geothermal lease completed post-2005/geothermal	3,160.0	T26S, R9W, Section 29, entire section; T26S, R9W, Section 27, entire section; T26S, R9W, Section 28, entire section; T26S, R9W, Section 33, entire section; T26S, R9W, Section 34, W2W2; T26S, R9W, Section 35, E2, E2NW, NESW

As discussed in section 1.4, the analysis area is zoned as a Multiple Use District (MU-20) under the Beaver County Zoning Map (Beaver County 2017). Conditional uses are allowed in Multiple Use Districts, including activities proposed for the FORGE project, such as drilling for energy related products, electric transmission lines, telecommunication site/facilities, accessory buildings customarily incidental to approved conditional uses, as well as other uses similar to the allowable conditional uses and judged by the Planning Commission to be in harmony with the character and intent of the Multiple Use District (Beaver County 2010).

The analysis area and surrounding lands are primarily rural and are bisected by highways, a rail line, major and minor power and gas pipeline utility corridors, and energy-generation facilities.

Nearby roads include State Route 257 to the west, as well as various paved and unpaved county roads in all directions around the project area. A Union Pacific Railroad line runs north to south immediately west of the project area. A wind farm operated by Milford Wind is adjacent to the project area to the northeast. The wind farm is Utah's largest wind energy project, producing 306 megawatts with 97 wind turbines. PacifiCorp's Blundell Geothermal Plant is located approximately 1.5 miles east of the project area. PacifiCorp's Sigurd-Red Butte 345-kV transmission line is located just east of the project area, as is a Kern River natural gas pipeline. The nearest occupied residences are in Milford, Utah, which is approximately 4.5 miles southwest of the project area and approximately 10 miles southwest of the proposed well pads.

3.2.2. Environmental Consequences of the Proposed Project

The Proposed Project would result in a total of 124.9 acres of surface disturbance using the G1 groundwater wellfield option and a total of 121.9 acres of surface disturbance using the G2 groundwater wellfield option. Table 3-2 lists the acres of surface disturbance by landownership type.

Table 3-2. Acres of Landownership Affected by Project Surface Disturbance

Landownership Type	Surface Disturbance (acres)	Surface Disturbance (percentage of analysis area)
Private land	82.4	1.9%
State land	19.5	4.3%
BLM-administered land	27.7	1.3%

Note: Surface disturbance caused by both groundwater wellfield options (G1 and G2) is included in the acreage calculations in this table. Acreage calculations in this table do not include 0.57 acre for 10 seismic monitoring drillholes or 0.39 acre for survey and tiltmeter sites, because their locations are unknown at this time.

Investigating the FORGE area's potential for geothermal energy sources would be consistent with the current land uses in the FORGE area and surrounding lands, which include energy generation facilities, a natural gas pipeline, and a transmission line. PacifiCorp's Blundell Geothermal Plant is to the east, the Milford Wind Farm is to the north, a Kern River natural gas pipeline is to the east, and a PacifiCorp transmission line is to the east. The project's consistency with applicable land use plans is discussed in section 1.4.

The main impact that the Proposed Project would have on existing land uses would be a temporary increase in traffic on county-maintained roads in and around the FORGE area. The largest volume of traffic to the FORGE area would occur during construction of the office site and mobilization and demobilization of the drill rigs (which would occur at different times). It is estimated that approximately two to three large tractor-trailer trucks and approximately 15 to 20 small trucks, service vehicles, or worker vehicles would be driven to the FORGE area each day during drilling, on average. The use of up to 23 vehicles during drilling activities would result in a maximum 2.5% increase in the lower local annual average daily traffic (AADT) (920) and a maximum 2.2% increase in the higher local AADT (1,055) (Utah Department of Transportation [UDOT] 2015). AADT is the total volume of vehicle traffic on a road for a year, divided by 365 days.

People using the county-maintained roads in and around the FORGE area to access nearby facilities, such as the wind farm and geothermal plant, as well as people using the roads to access the Mineral Mountains to the east, may experience traffic delays during periods of project construction and during the mobilization and demobilization of the drill rigs. However, because of the rural setting and the current minimal use of the county-maintained roads in the FORGE area, the impact is expected to be both minor and temporary.

There are several existing leases and ROWs on BLM-administered land in the analysis area (see Table 3-1). Most of these leases and ROWs occur to the east of the project area. No adverse impacts to existing leases or ROWs are expected from the project because project proponents would have to obtain permission from any affected ROW- or lease-holders before conducting any project activities that occur within the existing lease or ROW boundaries. The FORGE project proponents would also work with Beaver County to place a potential temporary water line parallel to Salt Cove Road, for which Beaver County holds a prescriptive easement. Other permits and agreements that the project would need to obtain before conducting project activities are listed in Table 2-2.

The project's disposal of waste and wastewater would comply with all applicable laws and regulations. Therefore, no impacts to land use are expected.

3.2.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped. No changes to land use would occur as a result of the FORGE project.

3.3. Atmospheric Conditions and Air Quality

The analysis area for impacts to atmospheric conditions and air quality is Beaver County, Utah. This area was chosen because it is a typical spatial boundary used to determine compliance with the National Ambient Air Quality Standards (NAAQS) established in the CAA. A county is often selected to be the geographic area evaluated or designated as meeting or not meeting NAAQS. Beaver County is 2,586 square miles, or 1,655,040 acres, in size (Utah State Library 2016).

3.3.1. Affected Environment

3.3.1.1. AIR QUALITY REGULATIONS AND AMBIENT AIR QUALITY

3.3.1.1.1. National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (EPA) has established NAAQS to limit the amount of air pollutants considered harmful to public health and the environment. Primary and secondary standards have been set for six criteria pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2),[2] ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM). Ground level ozone is not directly emitted into the air but is created by chemical reactions between NO_x and volatile organic compounds (VOCs) in the presence of sunlight. The primary standards provide public health protection and include protection for sensitive populations such as children and the elderly. Secondary standards provide public welfare protection, which includes protection against decreased visibility and damage to animals, crops,

[2] The EPA uses NO_2 as the indicator for the larger group of nitrogen oxides (oxides of nitrogen) or NO_x. However, emissions are usually reported as NO_x.

vegetation, and buildings (EPA 2016a). Areas that do not comply with NAAQS requirements for criteria pollutants are considered nonattainment areas. A particular geographic region may be designated an attainment area for some pollutants and a nonattainment area for others. Nonattainment areas are required to develop comprehensive state plans to reduce pollutant concentrations. Beaver County is currently in attainment with the NAAQS (Utah Division of Air Quality [UDAQ] 2013). As a result, the General Conformity Rule does not apply to the FORGE project (the General Conformity Rule ensures that actions taken by federal agencies in nonattainment and maintenance areas are consistent with the state's plans to meet NAAQS [CAA Section 176(c)]).

Compliance with NAAQS is demonstrated by monitoring for ground-level atmospheric air pollutant concentrations. UDAQ operates and maintains a network of air quality monitoring stations across the state of Utah to collect ambient air quality data and to evaluate compliance with the NAAQS. No monitoring stations are located in Beaver County.

Air emissions sources generally fall into two broad categories: mobile and stationary. Mobile sources consist of on-road vehicles and non-road vehicles and engines (e.g., aircraft, locomotives, all-terrain vehicles, lawnmowers). Stationary sources are non-moving, fixed sources of air pollution that emit pollutants through process vents/stacks or through fugitive releases. Stationary sources are classified as major or minor. A major source emits or has the potential to emit a regulated air pollutant in quantities above defined CAA thresholds. Stationary sources that are not major are considered minor sources. The FORGE project would be a minor source.

3.3.1.1.2. Prevention of Significant Deterioration

The Prevention of Significant Deterioration (PSD) is a CAA New Source Review permitting program for new and modified major sources of air pollution that are located in attainment areas. It is designed to prevent NAAQS violations, to preserve and protect air quality in sensitive areas, and to protect public health and welfare (EPA 2016b). Under PSD regulations, EPA classifies airsheds as Class I, Class II, or Class III. Congress designated certain existing areas as mandatory Class I areas, which preclude re-designation to a less-restrictive class. Class I areas are those areas allowing for very little deterioration of air quality. They are areas of special national or regional natural, scenic, recreational, or historic value for which PSD regulations provide extra protection. Class II areas allow moderate deterioration, and Class III areas allow more deterioration, but in all cases, pollutant concentrations cannot violate any of the NAAQS (NPS 1981). Utah has five Class I areas (all national parks); the closest are Zion National Park approximately 67 miles southeast of the project area and Bryce Canyon National Park approximately 68 miles south of the project area (EPA 2016c). All portions of Utah outside of Class I areas are designated as Class II areas. The project area is located in a Class II area. Industrial growth is allowed in these areas (Utah Air Quality Board 2006).

A PSD increment prevents the air quality in clean areas from deteriorating. It is the maximum allowable increase in concentration allowed to occur above a baseline concentration set for a particular pollutant. Significant deterioration is said to occur when the amount of new pollution would exceed the applicable PSD increment (EPA 2016b). The allowable PSD increments of new pollution are very small in Class I areas.

PSD requirements are applicable to a source if it has the potential to exceed the major source thresholds of either 100 or 250 tons per year of a regulated pollutant, depending on the type of pollutant. For stationary source categories listed in the regulation, the threshold is 100 tons per year. For unlisted source categories, such as geothermal operations, the threshold is 250 tons per year. PSD regulations would not apply to the Proposed Project because it does not have the potential to emit 250 tons per year of any air pollutant (i.e., it is not a major source).

3.3.1.1.3. Air Quality-Related Values

An *air quality–related value* (AQRV) is defined as a resource "for one or more Federal areas that may be adversely affected by a change in air quality. The resource may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource" identified by a federal land manager for a particular area" (Federal Land Manager's Air Quality Related Values Work Group 2010). The requirement to assess impacts to AQRVs is established in the PSD rules. The federal land manager for each Class I area has the responsibility to define and protect the AQRVs at such areas, and to consider whether new emissions from proposed major facilities (or modifications to major facilities) would have an adverse impact on those values. Because the Proposed Project does not meet the applicability requirements of the PSD rule, no assessment of AQRV impacts is needed.

3.3.1.1.4. Other Air Quality Regulations

Section 111 of the CAA requires the EPA to establish federal emission standards for source categories that cause or contribute significantly to air pollution (New Source Performance Standards [NSPS]). NSPS regulations limit emissions from source categories to minimize the deterioration of air quality. Stationary sources are required to meet these limits by installing new equipment or adding pollution controls to older equipment. NSPS standards for internal combustion engines could apply to the Proposed Project, depending on the type of equipment selected for the project.

Section 112 of the CAA requires the EPA to promulgate regulations establishing emission standards for each category or subcategory of major sources and area sources of hazardous air pollutants (HAPs). These standards are called the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). HAPs (e.g., benzene, perchloroethylene, and mercury) are known or suspected to cause cancer or other serious health effects. EPA regulates HAPs through NESHAPs Maximum Achievable Control Technology (MACT) standards, which are individual emissions standards developed for a particular industrial stationary source category. Each MACT standard typically applies to major sources in the industrial source category; major sources are those that emit more than 10 tons per year of a single HAP or 25 tons per year of any combination of HAPs (EPA 2016d). Some MACT standards apply to area sources, which are facilities emitting below the major source threshold. Area source MACT standards may apply to the Proposed Project, such as the Reciprocating Internal Combustion Engine MACT (40 CFR 63 Subpart ZZZZ), depending on the type of equipment selected for the project. However, portable engines are exempt from this rule. EPA also regulates HAPs from mobile sources such as highway vehicles and non-road equipment; at least six rules or control programs have been promulgated to reduce these emissions.

Section 169A of the CAA established a national visibility goal to prevent future visibility impairment and remedy any existing impairment in national parks and wilderness areas (Class I areas). Visibility refers to the clarity with which scenic vistas and landscape features are perceived at great distances. Impairment refers to human-caused air pollution. In 1999, the EPA promulgated the Regional Haze Rule to address regional haze, which refers to haze that impairs visibility in all directions over a large area. Haze forms when sunlight encounters particle pollution in the air. The Regional Haze Rule calls for state and federal agencies to work together to establish goals and emission reduction strategies to improve visibility in Class I areas (EPA 2001). States are required to address visibility in their state implementation plans. The Utah Regional Haze State Implementation Plan focuses on emissions monitoring and tracking, SO_2 reductions, and facilities emitting large quantities of air pollution such as power plants. It does not outline requirements that would apply to a small source such as the Proposed Project (Utah Air Quality Board 2015).

3.3.1.2. EMISSIONS IN THE ANALYSIS AREA

An emissions inventory is a summary of criteria pollutant and HAP emissions for a particular source during a given time period. The most recent emissions inventories for Beaver County (2011 and 2014) are summarized in Table 3-3.

Table 3-3. 2011 and 2014 Emissions in the Air Quality Analysis Area (Beaver County)

Pollutant	Beaver County Emissions (tons/year)	
	2011	2014
CO	13,876.0	8,145.0
NO_x	2,079.0	2,066.0
PM_{10}	2,655.0	2,499.0
$PM_{2.5}$	436.0	446.0
SO_x	75.0	15.0
VOCs	26,490.0	24,666.0
HAPs (acrolein, ethylene dibromide, formaldehyde, and total polycyclic aromatic hydrocarbons)	None reported	0.3

Note: PM_{10} = PM between 2.5 and 10 micrometers in diameter, and $PM_{2.5}$ = PM less than 2.5 micrometers in diameter.

Source: UDAQ (2011, 2014).

In 2011 in Beaver County, area sources emitted the most CO, and on-road mobile sources emitted the most NO_x. In 2014, on-road mobile sources emitted the most CO (other than biogenics, which are emissions from natural sources such as vegetation and living organisms) and NO_x. Area sources emitted the most PM and SO_x in both 2011 and 2014. The largest source of VOCs in both years was biogenics. All HAPs in the county in 2014 were emitted from the Kern River Gas Transmission Company – Milford Compressor Station. Other point sources of emissions in the county in 2014 were the Milford Copper Mine and Mill, Dairy Farmers of America Cheese and Condensed Milk Processing Plant, Milford Quarry, and Smithfield Hog Production Swine Feed Mill. In addition to the Milford Compressor Station, the Cheese and Condensed Milk Processing Plant, and the Milford Quarry, point sources in Beaver County in 2011 consisted of the Circle Four Feedmill, Marble Mine, and Quality Crushing (UDAQ 2011, 2014).

3.3.1.3. ATMOSPHERIC CONDITIONS

3.3.1.3.1. Local Climate

From 1928 to 2016 in Milford, Utah, the annual average maximum temperature was 65.5°F. The annual average minimum temperature was 33.3°F. During the same time period, the annual average total rainfall was 9.1 inches, the annual average total snowfall was 34.1 inches, and the annual average snow depth was 0 inches (Western Regional Climate Center 2016).

3.3.1.3.2. Climate Change

Global warming refers to the ongoing rise in global average temperature near the Earth's surface. It is caused mostly by increasing concentrations of greenhouse gases (GHGs) (primarily carbon dioxide [CO_2], methane, nitrous oxide [N_2O], and fluorinated gases) in the atmosphere, and it is changing climate patterns. Climate change refers to any significant change in the measures of climate (e.g., temperature, precipitation, wind patterns) lasting for an extended period of time (EPA 2016e). In 2010, the National Research Council concluded that "Climate change is occurring, is caused largely by human activities, and poses significant risks for a broad range of human and natural systems" (National Academy of Sciences 2010).

CO_2 is the primary GHG emitted in the United States (81% of total GHG emissions in 2014); it is followed by methane (11% of total 2014 emissions), N_2O (6% of total 2014 emissions), and fluorinated gases (3% of total 2014 emissions) (EPA 2016f).

In May 2014, the U.S. Global Change Research Program released Climate Change Impacts in the United States: The Third National Climate Assessment (Assessment), a comprehensive report on climate change and its impacts in the United States (Garfin et al. 2014). In the Assessment, the Southwest region includes the states of Arizona, California, Colorado, Nevada, New Mexico, and Utah. According to the Assessment, the decade 2001–2010 was the warmest in the 110-year record for the Southwest region, with temperatures almost 2°F higher than historic averages and with fewer cold air outbreaks and more heat waves. Regional annual average temperatures are projected to rise by 2.5–5.5°F by 2041–2070, assuming continued growth in global emissions. Key climate change highlights for this region include the following, excerpted directly from the Assessment:

- Snowpack and streamflow amounts are projected to decline in parts of the Southwest, decreasing surface water supply reliability for cities, agriculture, and ecosystems.
- The Southwest produces more than half of the nation’s high-value specialty crops, which are irrigation-dependent and particularly vulnerable to extremes of moisture, cold, and heat. Reduced yields from increasing temperatures and increasing competition for scarce water supplies will displace jobs in some rural communities.
- Increased warming, drought, and insect outbreaks, all caused by or linked to climate change, have increased wildfires and impacts to people and ecosystems in the Southwest. Fire models project more wildfire and increased risks to communities across extensive areas.
- Flooding and erosion in coastal areas are already occurring even at existing sea levels and damaging some California coastal areas during storms and extreme high tides. Sea level rise is projected to increase as Earth continues to warm, resulting in major damage as wind-driven waves ride upon higher seas and reach farther inland.
- Projected regional temperature increases, combined with the way cities amplify heat, will pose increased threats and costs to public health in southwestern cities, which are home to more than 90% of the region’s population. Disruptions to urban electricity and water supplies will exacerbate these health problems. (Garfin et al. 2014)

Temperatures in the state of Utah have warmed by approximately 2°F in the last century. Heat waves are becoming more common. Snow is melting earlier in the spring, and the snowpack has been decreasing since the 1950s. In the coming decades, the flow of water in Utah’s rivers is likely to decrease. Overall, the changing climate is likely to increase the need for water but reduce the supply. The frequency and intensity of wildfires are expected to increase, and the productivity of ranches and farms is expected to decrease. Warmer and drier conditions may also increase the ability of pests and diseases to become established (EPA 2016g).

3.3.2. Environmental Consequences of the Proposed Project

Emissions from the Proposed Project would consist of the following:

- Fugitive dust emissions from surface disturbance during all three project phases. Fugitive dust is any PM that is generated or emitted from open air operations and does not pass through a stack or vent.
- Combustion emissions from the use of vehicles and equipment during all three project phases.
- Hydrogen sulfide (H_2S) and other emissions during well drilling and testing.

3.3.2.1. FUGITIVE DUST EMISSIONS FROM SURFACE DISTURBANCE

Surface disturbance would occur during geoscientific surveys, well drilling, access road improvement, construction of the office site, construction of the power and fiber optic lines, construction of the groundwater wellfields and associated water lines, installation of seismic monitoring drillholes, installation of survey monument stations, and installation of tiltmeter sites. Fugitive dust emissions would be generated from surface-disturbing activities such as clearing, excavating, earth-moving, and grading, as well as vehicle travel on dirt roads associated with the project.

The geoscientific surveys include geologic mapping, gravity measurements, an MT survey, soil gas surveys, seismic monitoring using existing stations and nodal seismometers, and a 3-D seismic reflection survey (vibroseis). Of these surveys, only the MT survey and seismic reflection survey would cause surface disturbance. The MT survey would require the digging of 2-foot holes for placement of vertical magnetometers at approximately 79 measurement sites. The digging of holes for this survey would be completed with shovels, creating a very small quantity of short-term, direct fugitive emissions at each measurement site. The seismic reflection survey would use two vibroseis trucks traversing cross-country, stopping every 160 feet along 13 lines spaced approximately 0.2 mile apart to vibrate the ground beneath the trucks for approximately 1 minute. Two 2.5-mile lines of 2-D seismic reflection lines would also be recorded on existing roads west and east of the 3-D survey area. Short-term, direct fugitive dust emissions would result from the surface disturbance caused by vibroseis and vehicle travel overland. The survey would be conducted in the fall to avoid the soft soils of early spring, and the amount of fugitive dust would be limited by the slow speed of overland travel.

Surface disturbance would occur during drilling activities in all three project phases. Drilling for investigation wells, groundwater wells, seismic monitoring drillholes, survey monument and tiltmeter sites, and injection and production wells would be conducted. Well pads would be constructed at some of the wells (which could include space for a reserve pit or sump, a drill rig and support equipment, and crew trailers). Direct, short-term fugitive dust emissions would result from the surface disturbance required for drilling.

Access road improvement would occur during Phase 2B of the project. Construction of the office and support facilities, power and communication lines, and water lines associated with the groundwater wellfield would occur during Phase 2C. Direct, short-term fugitive dust emissions would result from the surface disturbance caused by these activities.

In summary, the fugitive dust caused by project activity surface disturbance would increase local concentrations of PM in the short term and temporarily reduce visibility in the local airshed. Project activities would be sporadic and occur at different times; fugitive dust impacts from different activities would not necessary be additive. The surface disturbance for the project under the G1 groundwater wellfield option would comprise a maximum of 0.008% of the 1,655,040-acre analysis area, with 124.9 acres of total surface disturbance (see Table 2-1). The surface disturbance for the project under the G2 groundwater wellfield option would comprise a maximum of 0.007% of the 1,655,040-acre analysis area, with 121.9 acres of total surface disturbance (see Table 2-1). Based on these percentages, fugitive dust impacts would occur in a small percentage of the analysis area and would not likely impact overall air quality because of their short-term and localized nature.

Fugitive dust emissions would be controlled through the application of water. In addition, the gravelling of roads, well pads, and the office site would be used to avoid windblown dust from vehicle travel. The reseeding of disturbed areas such as well pads would also minimize long-term fugitive dust emissions. Before construction, the FORGE project would likely need to file a notice of intent with the UDAQ to obtain a permit (approval order) for the project. Project activities would be required to adhere to all air quality standards set forth in the approval order, which are anticipated to include measures to minimize fugitive dust. The approval order would also ensure that the analysis area would remain in attainment with NAAQS.

3.3.2.2. VEHICLE AND EQUIPMENT COMBUSTIONS

Combustion emissions from the use of vehicles and equipment (e.g., drill rigs, generators, air compressors) would occur during all three phases of the project. Vehicle use would consist of employee travel to and from the FORGE area, employee travel in the FORGE area to various work sites, and equipment and supply transportation and delivery. Some vehicle travel would also be conducted by research geologists, security staff, and agency staff visitors, and for educational events and field trips. Vehicles such as backhoes and bulldozers would also be used for project activities. Equipment and vehicles would emit criteria and HAP pollutants through fuel combustion, including NO_x, CO, SO_x, PM, CO_2, and some HAPs such as benzene, xylene, and acetaldehyde. Emissions would be localized and would have short-term adverse effects on local air quality that would end at the completion of activities and would not affect most of the analysis area. The quality of air in and near the FORGE area would be temporarily reduced by these emissions.

Project emissions are typically analyzed based on the number and type of vehicles and equipment to be used, as well as the duration of project activities. These details are unknown at this time; however, local traffic counts can be examined to provide context for the representative number of vehicles near the FORGE area relative to typical project numbers. The 2014 AADT on State Route 257 going north from Milford is 920 vehicles between milepost 0.506 and milepost 4.415 (UDOT 2015). The AADT on State Route 257 between milepost 4.415 and milepost 53.589 is 1,055 (UDOT 2015). The largest volume of traffic to the FORGE area would be during construction of the office site and mobilization and demobilization of the drill rigs (which would occur at different times). At this early stage of project planning, it is estimated that approximately two to three large tractor-trailer trucks (delivering drilling supplies and equipment) and approximately 15 to 20 small trucks, service vehicles, or worker vehicles would be driven to the FORGE area each day during drilling, on average. The use of up to 23 vehicles during drilling activities would result in a maximum 2.5% increase in the lower local AADT (920) and a maximum 2.2% increase in the higher local AADT (1,055). Based on these low percentages, pollutant emissions from project activities, though measurable and adverse, would be unlikely to negatively affect the air quality in the analysis area and its current attainment status. In addition, current emission levels in Beaver County (see Table 3-3) are relatively low when compared to other Utah counties (UDAQ 2014).

3.3.2.3. HYDROGEN SULFIDE AND OTHER EMISSIONS

Depending on the chemical composition of the geothermal resource, H_2S emissions could occur during well testing. If a well encounters a producible resource, H_2S could be released from the well during drilling. H_2S could also be vented with steam and non-condensable gases during flow testing. H_2S is known for its pungent odor and is highly flammable and toxic (Occupational Safety and Health Administration 2015). Although there is no NAAQS standard for H_2S, when it is released to the atmosphere, it changes to SO_2, which is regulated under NAAQS.

Emissions of H_2S would be minimized through the use of properly weighted drilling mud, which should keep the well from flowing during drilling. No H_2S emissions would occur during decommissioning because the wells would be plugged.

Natural geothermal systems usually contain varying amounts of highly mineralized water and non-condensable gases. Other potential direct emissions could occur through releases of these non-condensable gases during a loss of well control during drilling. Blow-out prevention equipment would be used while drilling below the surface casing and would prevent such releases. In addition, this project seeks to create and demonstrate a limited permeable fracture system in very hot but nonporous and unfractured rock. It has been previously demonstrated that the hot water produced from this practice has much lower total dissolved solids (TDS) and much fewer and lower concentrations of non-condensable gases than that which occur in naturally formed hydrothermal systems. Based on this fact and the presence of blow-out prevention equipment, the short-term releases of such gases in the project area would not be expected to violate NAAQS standards.

3.3.2.4. CLIMATE CHANGE

Combustion emissions from project vehicles and equipment would include GHGs such as CO_2, N_20, and methane. For example, a diesel internal combustion generator of up to 600 horsepower would emit 4.41 pounds/million metric British thermal units of NO_x and 164 pounds per million metric British thermal units of CO_2 (EPA 1996). Emissions of steam from well testing would also include GHGs, primarily CO_2. GHG emissions cannot be quantified at this early stage of the project; however, emissions would be intermittent and would end at the completion of project activities.

Impacts to climate change would be minor based on the intermittent nature of project activities and the short-term life of the project (5 years).

3.3.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped. No new impacts to air quality would occur as a result of the FORGE project. Existing air pollutant emissions in the analysis area (e.g., emissions from vehicles using roads) would continue.

3.4. Hydrologic Conditions and Water Quality

3.4.1. Affected Environment

3.4.1.1. SURFACE WATER

Information regarding the distribution and location of surface waters in the FORGE area was obtained from the U.S. Geological Survey (USGS) Watershed Boundary Dataset (USGS 2016a) and National Hydrography Dataset (NHD) (USGS 2016b). The FORGE area intersects five subwatersheds within the larger Beaver River and Cove Creek watersheds: the Antelope Spring-Cove Creek, Beaver Bottoms-Beaver River, Milford Municipal Airport-Beaver River, Negro Mag Wash, and Wild Horse Canyon subwatersheds. The subwatersheds are shown in Figure 3-2 and form the analysis area for surface water resources. This area was chosen because it provides a clear topographical boundary against which to measure potential hydrological and water quality impacts.

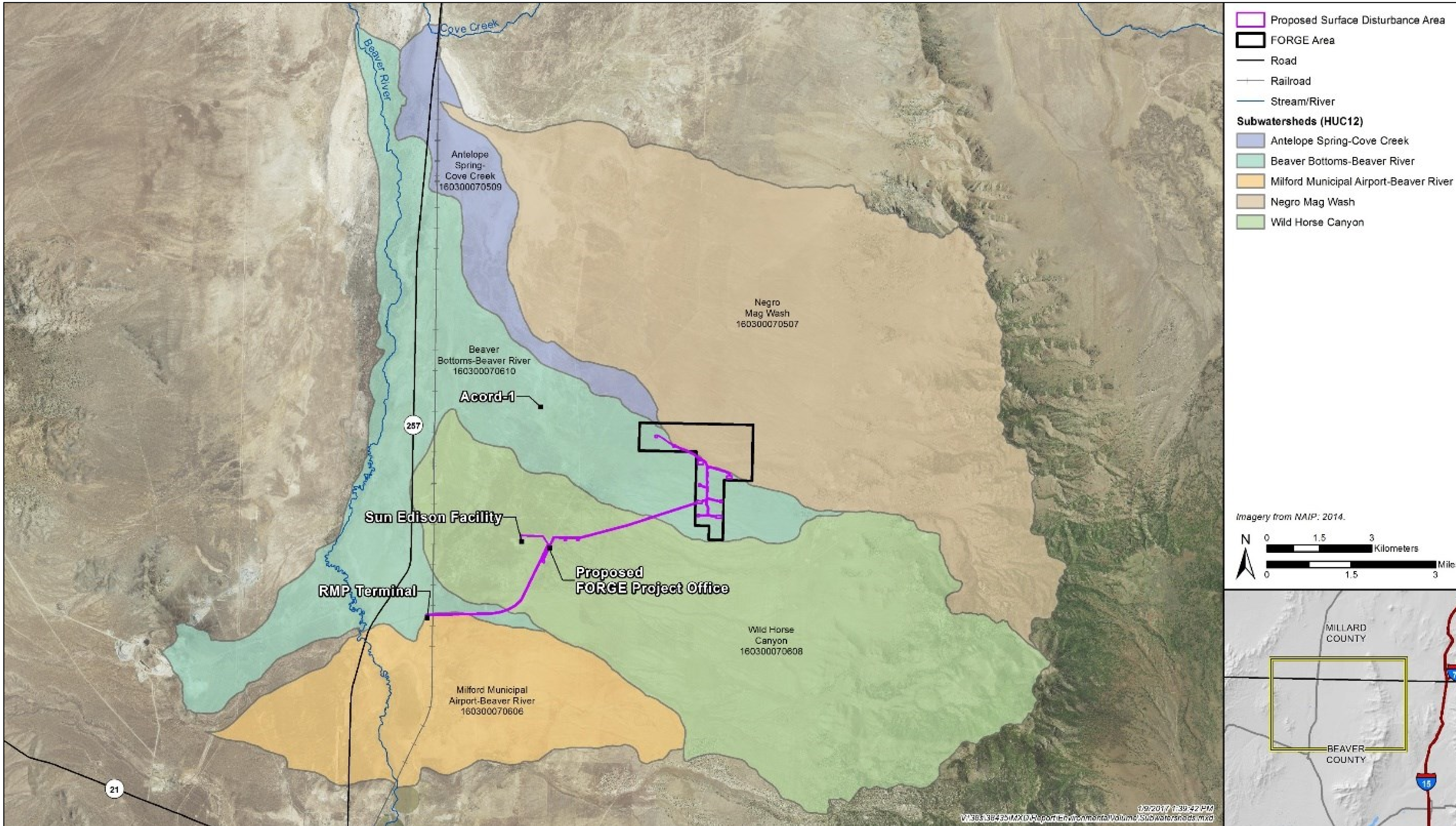


Figure 3-2. Surface water analysis area (subwatershed boundaries).

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The Beaver River watershed is located in the southwest-central part of Utah and encompasses 500 square miles. The Beaver River is the primary drainage of the watershed. The Beaver River originates in the Tushar Mountains, flows through Beaver City and into Minersville Reservoir, then flows through the towns of Minersville and Milford, eventually joining the Sevier River near the Sevier Playa. Flows above Minersville Reservoir vary widely because of spring snow melt, irrigation diversions, and occasional thunderstorms. Stream flows average 114 cubic feet per second (cfs) in early summer, 15 cfs during the winter, and 50 cfs during irrigation season. Beginning a few miles below Minersville Reservoir, the Beaver River is reduced to an ephemeral wash that holds water only during the peak flow season because of irrigation diversions. The project area is approximately 35 miles downstream of the Minersville Reservoir. With the exception of 0.7 mile of perennial flow, Beaver River is considered an ephemeral wash in the analysis area.

The Cove Creek watershed extends from Beaver County into Millard County. Cove Creek is the primary drainage that drains north through the Tushar Mountains. It then turns west at Sulphur Peak running between the south end of the Pavant Range and the Tushar Mountains past Cove Fort, before disappearing in the Beaver Bottoms near an ephemeral portion of the Beaver River. Cove Creek is ephemeral throughout its entirety (Davis 2005).

The hydrologic features located within the five subwatersheds that form the analysis area are listed in Table 3-4 and shown in Figure 3-3. Data from the NHD also identify one lake named Salt Cove Reservoir and 12 springs or seeps. There a few other small reservoirs within the analysis area, including Negro Mag Wash Reservoir, Hamilton/Salt Spring Reservoir, and Dry Reservoir. Each of these four reservoirs is a small, regulating reservoir of less than 20 acre-feet (Utah Division of Water Rights 2017). The full capacity of all of these reservoirs combined is 22.1 acres, which only occurs during the peak runoff season. Because of their small size, remote location, and inconsistent water levels, these reservoirs are likely to be used for stock watering and not recreation.

The only named streams in the surface water analysis area are the Beaver River, Negro Mag Wash, and a very small section of Cove Creek. These streams are predominantly intermittent throughout the analysis area. However, the NHD does list a small section of the Beaver River as perennial within the analysis area. The area identified as perennial is located 1.1 miles west of the proposed power line.

Table 3-4. Hydrologic Features in the Analysis Area

Stream or River (miles)		Connector (miles)	Canal or Ditch (miles)	Lake or Pond (acres)
Intermittent	Perennial			Perennial
283.5	0.7	17.4	6.0	22.1

3.4.1.2. WETLANDS

Wetlands are areas where water covers the soil, or is present either at or near the soil surface all year or for varying periods of time during the year, including the growing season (EPA 2016h). Wetlands in the surface water analysis area were identified using data from the National Wetland Inventory (NWI) program (USFWS 2016a). Wetland areas identified in this dataset are listed in Table 3-5 and shown in Figure 3-4.

Table 3-5. National Wetlands Inventory Wetlands in the Analysis Area

Type of Wetland	Acres
Palustrine	44.1
Riverine	170.6
Lacustrine	0.2

Source: USFWS (2016a).

Palustrine wetlands are wetlands that lack flowing water. Riverine wetlands are wetlands connected by rivers, whereas lacustrine wetlands are wetlands associated with open, standing waterbodies.

Most of the wetlands in the analysis area are associated with intermittent, riverine systems. These systems lack sufficient water to support wetland vegetation. The palustrine wetlands are largely associated with the springs or seeps. The lacustrine wetlands, which make up the smallest percentage of the wetland acreage, are associated with the four, small reservoirs.

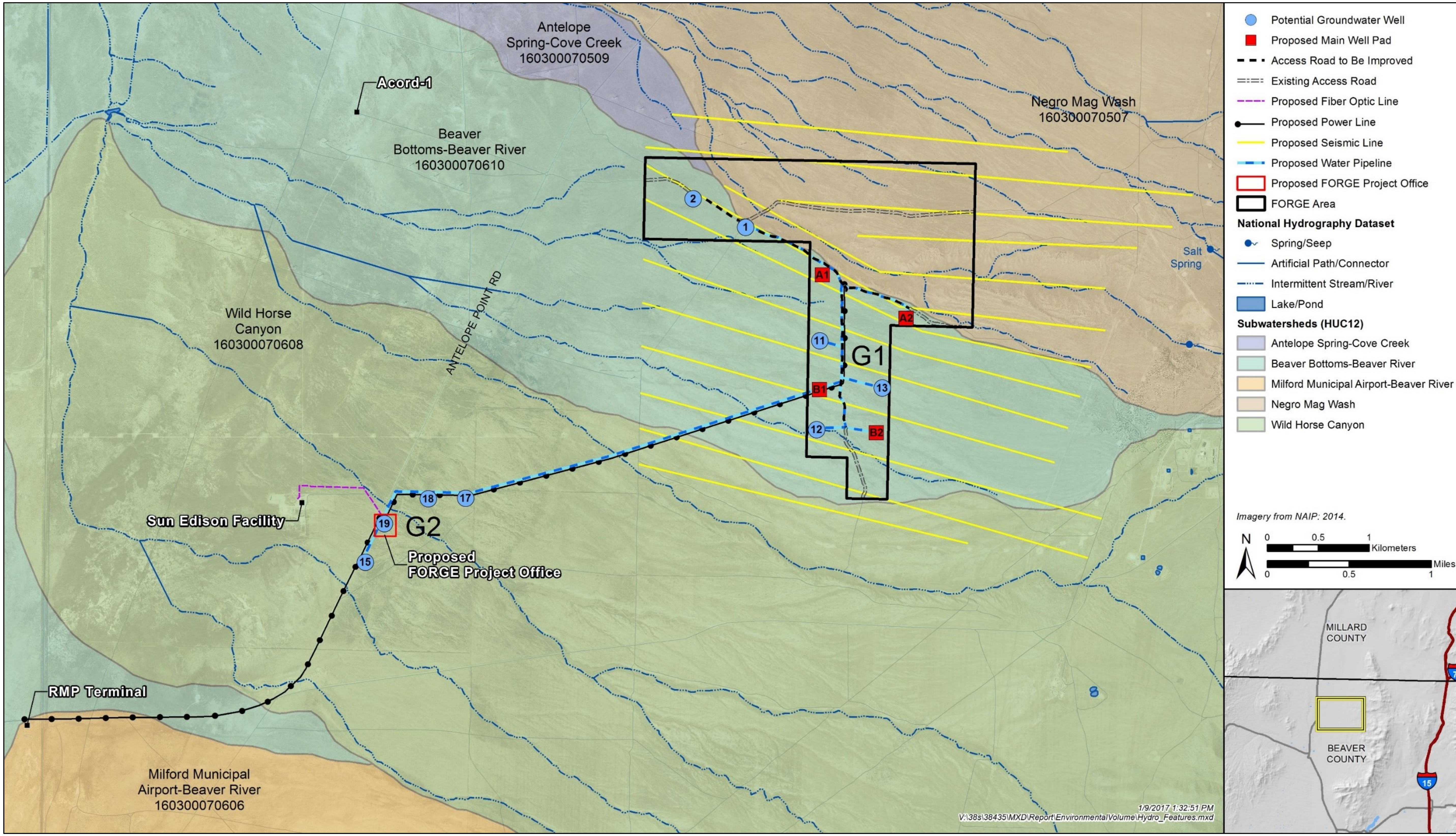

Figure 3-3.Hydrologic features in the project area, FORGE area, and surface water analysis area.

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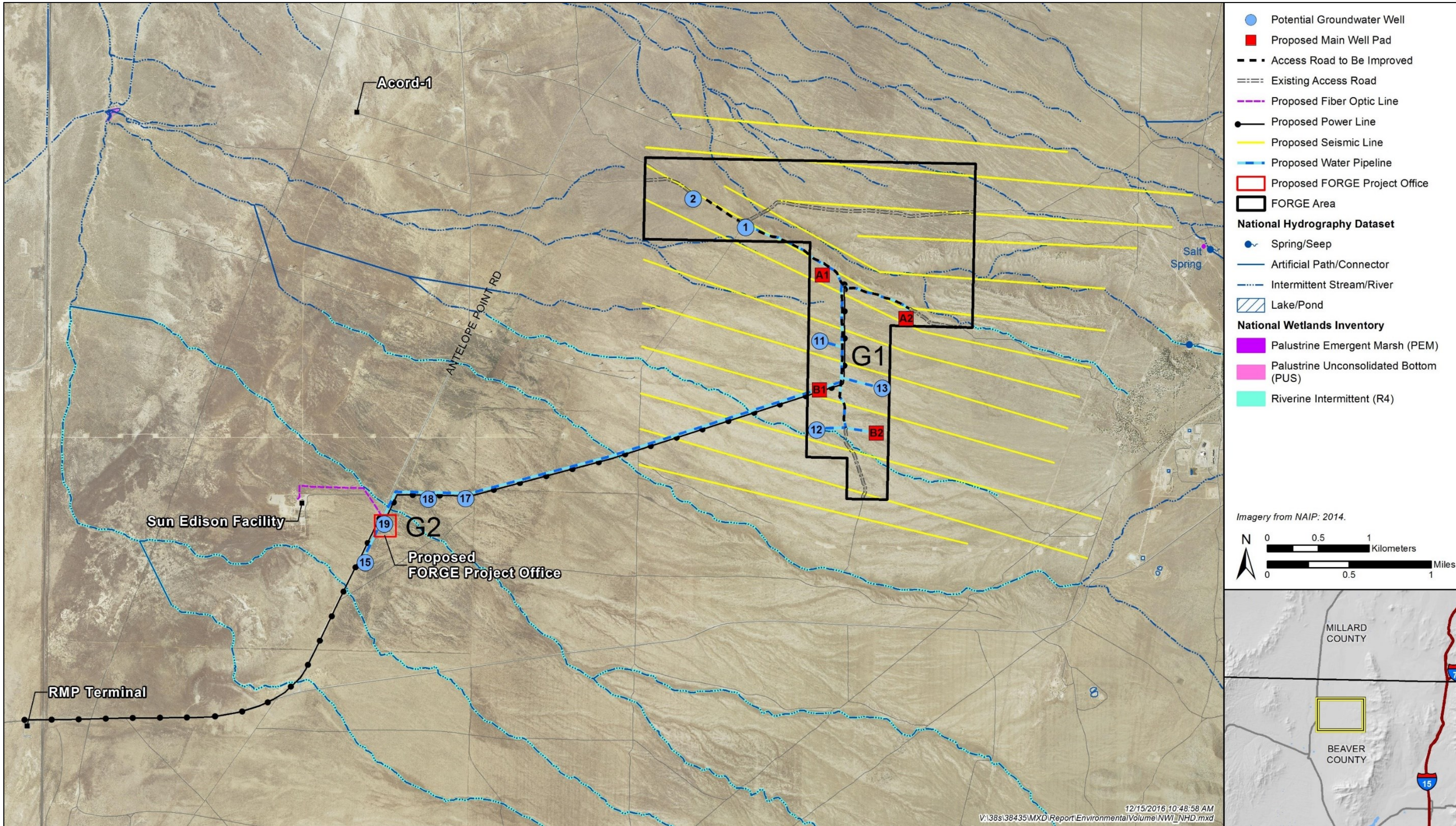

Figure 3-4. National Wetlands Inventory wetlands in the project area, FORGE area, and surface water analysis area.

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3.4.1.3. GROUNDWATER

The analysis area for groundwater is the Milford Basin, which is situated between the Mineral Mountains to the east and the Star Range to the west. This area was chosen because project-related activities associated with groundwater would fall within this basin.

The Great Basin contains a regional aquifer consisting of many individual basins (including the Milford Basin), most of which are hydrologically linked. Although some basins form multi-basin groundwater flow systems through the movement of water through permeable sedimentary deposits or consolidated rock, other basins are linked by rivers or surface water drainages. Some basins are hydrologically isolated. All of the basins sit in structural depressions that have been filled either with alluvial deposits derived from the adjacent mountain ranges or lacustrine deposits derived from Quaternary lakes (Mason 1988). Regional groundwater flow is conceptualized as having two components: 1) a relatively shallow component that moves primarily from mountain ranges to basin fill beneath valley floors, which is superimposed, or 2) a deeper component that moves primarily through carbonate rocks. Deeper groundwater flow mostly discharges at regional springs or in areas of evapotranspiration that are upgradient from terminal sinks such as Great Salt Lake and the Railroad Valley (Prudic et al. 1993). At the regional scale, groundwater flow between hydrogeologic units of the Great Basin may occur where a hydraulic gradient is present, where the intervening mountains are composed of permeable rock that permits groundwater flow, and where substantial groundwater mounding from mountain-block recharge does not occur (Heilweil and Brooks 2011).

Unconsolidated materials underlying the Milford Basin contain the principal groundwater aquifer in the analysis area, which consists of three zones of high permeability separated by zones of low permeability. The zones are hydraulically connected, and the thickness of the aquifer reaches a maximum of approximately 840 feet approximately 21 miles south of Milford (Mower and Cordova 1974). Groundwater in the Milford area flows northwest through consolidated rocks in the northern San Francisco Mountains toward Sevier Lake (Mason 1988). The total amount of groundwater in storage in the Milford area is approximately 40 million acre-feet (Mower and Cordova 1974). The chemical quality of groundwater improves with depth to at least 250 feet; the median concentration of TDS in groundwater samples drawn from wells is 569 milligrams per liter (mg/L) (Mower and Cordova 1974). The Milford area groundwater system is unconfined along the margins of the basin but becomes confined in the center of the southern half of the basin. In this area, the upper 200 to 300 feet of the saturated basin fill is under both unconfined and semiconfined conditions (Mason 1988).

The primary groundwater in and around the FORGE area resides in a shallow unconsolidated basin fill aquifer that overlies impermeable crystalline basement rock. Granitic bedrock is anticipated at a depth of 1,500 to 2,000 feet below ground surface. Based on compiled water levels for groundwater in the unconsolidated basin fill aquifer, the potentiometric surface, which is the level to which groundwater would rise if not trapped in a confined aquifer (Dictionary.com 2017), slopes to the west away from the Opal Mound fault. Groundwater depth beneath the FORGE area is between 200 and 500 feet and at approximately 5,100 feet in elevation. Depth to water in the unconsolidated basin fill in areas surrounding the FORGE deep scientific research well site ranges from tens of feet along the valley floor to greater than 500 feet west of the Opal Mound fault. Potential supply wells are approximately 2.5 miles southwest from this site, where the depth to groundwater is approximately 150 feet.

Groundwater in the FORGE area spans a wide range of chemical compositions from dilute (TDS less than 500 mg/L) to saline (TDS greater than 6,000 mg/L). The springs in the Mineral Mountains discharge dilute calcium bicarbonate ($Ca\text{-}HCO_3$) water, whereas the groundwater at Roosevelt Hot Springs (the Blundell Geothermal Plant), which are 12 miles northeast of Milford near the project area, comprises sodium chloride (NaCl) thermal water. This thermal water fills the shallow aquifer and disperses westward as it migrates downhill. Increasing dilution with cool basinal groundwater is reflected in decreasing TDS from east to west. Groundwater TDS concentrations around the FORGE deep scientific research well site range from 2,000 mg/L to greater than 6,000 mg/L TDS, exceeding both the primary and secondary drinking water standards.

Information regarding groundwater depth and quality in the deeper aquifer beneath the granitic bedrock is not available.

3.4.1.3.1. Current Uses

Much of the near-surface aquifer underneath the FORGE deep scientific research well site is not potable because of high TDS concentrations, and it is not used for human consumption. This non-potable water is generally only used for irrigation, seasonal stock watering, and fire suppression. However, the Milford Basin aquifer is potable from wells in nearby Milford City and in other areas. The source of water for Milford City is a large groundwater reservoir directly beneath the city. The city has developed a series of groundwater wells, ranging from approximately 100 to 500 feet deep. The quality of the water is such that no treatment is necessary at the present time. The supply of water in the groundwater reservoir is essentially infinite for municipal use in the area (Jensen 1978). Because the flow of groundwater in the area is from the southeast to the northwest, the project area is downgradient from all municipal supply wells.

3.4.2. Environmental Consequences of the Proposed Project

3.4.2.1. SURFACE WATER

The features that would be constructed for the Proposed Project would cross five unnamed, intermittent streams in six locations. These NHD-defined intermittent streams are primarily dry and only receive surface flows during peak flow events. The only perennial stream in the analysis area is a 0.7-mile section of the Beaver River, and it is 1.1 miles from the proposed power line. The crossings would result from the power line and accompanying two-track road, the surface water line, and proposed groundwater well 12 (under the G1 groundwater wellfield option). There would be no impacts from the power line because it would span the intermittent streams. The two-track road would cross the stream directly, but impacts would be minimal because the stream rarely has any surface water flow. Surface water line crossings would be minimized by the installation of appropriately sized culverts as needed.

Stormwater runoff would likely increase slightly from vegetation removal and soil compaction during excavation for facilities, road construction, and well pad construction. A SWPPP and associated notice of intent would be filed with the UDWQ for new surface disturbance associated with the project. The SWPPP would include measures designed to prevent excess sediment from discharging to surface waters in the analysis area. The potential for excess sediment runoff from well pads to surface waters would be minimized because erosion control measures such as silt fencing, diversion ditches, water bars, temporary mulching and seeding, and application of gravel or riprap would be installed where necessary immediately after completion of construction activities to avoid erosion and runoff. The reserve pits, access roads, and portions of the well pads that are not needed for operations or operational facilities would be reclaimed as part of interim reclamation. Further prevention of sediment discharge to surface waters would be achieved with final soil stabilization. Therefore, potential surface water impacts due to excess sediment are expected to be minimal and localized to the project area. Effects to surface waters would not occur upgradient of the project area.

The potential for surface water contamination from produced fluids generated at well sites would be minimized because releases of produced fluids would drain to the reserve pit or sump, which would be deep enough to contain all produced fluids plus 2 to 3 feet of freeboard.

The potential for surface water contamination from accidental spills of hazardous materials would be mitigated by containment berms that would be constructed around any hazardous material storage areas. These berms are designed to contain the full volume of stored hazardous materials, including a safety factor, thereby preventing surface water contamination from accidental spills. Additionally, the fuel tank at each well pad would be surrounded by an earthen berm with an impermeable liner to contain accidental spills, and a SPCC would be created and followed to ensure proper response and mitigation of any fuel spills.

3.4.2.2. WETLANDS

According to the NWI, there is 0.3 acre of an intermittent riverine system in the project area. This intermittent riverine system overlaps less than 0.1 acre of the G1 groundwater wellfield option and 0.3 acre of the power line corridor (USFWS 2015). According NHD geospatial data, 709 feet of an intermittent stream intersect 113 feet of the G1 groundwater wellfield option and 596 feet of the power line corridor in the project area (USGS 2011).

The described wetlands could be impacted by ground disturbance associated with construction or drilling activities. Ground disturbance could remove portions of the wetlands, disrupt any surface flow, increase sedimentation, or remove or damage vegetation associated with the wetlands. Geothermal development could also impact these areas through a release of geothermal fluids or other pollutants.

Impacts to wetlands would be minimized through the use of best management practices that limit ground disturbance and prevent the release of fluids or pollutants to the surrounding environment.

3.4.2.3. GROUNDWATER

The potential for groundwater impacts from releases of produced fluids generated at well sites would be mitigated because such releases would discharge to a reserve pit that would be lined with bentonite or nylon-reinforced plastic liner material to prevent seepage to groundwater. A grouting and casing program for the construction of all wells would be implemented to prevent degradation of groundwater quality during and after well drilling. Surface and other casings would be set with cement to prevent migration of produced fluids and the contamination of any non-geothermal aquifers penetrated by the borehole, as well as to isolate any potential zones (water, oil, gas, etc.) other than the geothermal resource. The blow out prevention equipment, which is typically inspected and approved by the Utah State Engineer, would be used while drilling below the surface casing.

During drilling operations, a minimum of 10,000 gallons of cool water and 12,000 pounds of inert, non-toxic, non-hazardous barite would be stored at the well site for use in preventing uncontrolled well flow (“killing the well”), although the likelihood of its necessity is remote for this location.

The potential for groundwater impacts from accidental spills of hazardous materials would be mitigated by preparation of and adherence to a SPCC. The SPCC would ensure that impacts to groundwater from accidental spills of hazardous materials are properly responded to and mitigated. In addition, the fuel tank at each well pad would be surrounded by an earthen berm with an impermeable liner to contain accidental spills and to prevent seepage to groundwater.

The project has acquired 300 acre-feet per year of water rights to meet the needs of the project. Smithfield has agreed to lease an additional 200 acre-feet if required. Total groundwater storage in the local basin is estimated to be 40 million acre-feet (Mower and Cordova 1974). The project's use would be temporary and would only need water for specific activities. It is estimated that not all of the allotted 500 acre-feet would be used for all 5 years of the project. However, if all 2,500 acre-feet allotted were used, it would be 0.006% of the total groundwater in the basin. Therefore, the potential for groundwater depletion is expected to be minimal.

Decommissioning of the project would involve the plugging of all wells, removal of the project components, and full reclamation of well pads and access roads to return the land to a condition approximate or equal to that which existed before the disturbance. Cessation of groundwater withdrawal and injection would return the geothermal reservoir to a condition approximate or equal to that which existed before the Proposed Project. No irreversible or long-term effects to water resources would occur.

3.4.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped; therefore, no new impacts to water resources would occur. Existing uses of water resources in the analysis area would continue, and water resources could be developed for other projects.

3.5. Geologic and Soil Conditions

The FORGE area intersects five subwatersheds within the larger Beaver River and Cove Creek watersheds: the Antelope Spring-Cove Creek, Beaver Bottoms-Beaver River, Milford Municipal Airport-Beaver River, Negro Mag Wash, and Wild Horse Canyon subwatersheds. The subwatershed boundaries are shown in Figure 3-2 and form the analysis area for geologic and soil conditions. This 86,344-acre area was chosen because it provides a clear topographic boundary against which to measure potential impacts to geologic and soil conditions.

3.5.1. Affected Environment

3.5.1.1. GEOLOGIC CONDITIONS

The FORGE area is located within a geologically complex zone that lies inside the southeast margin of the Great Basin and abuts the western edge of the Colorado Plateau (Wannamaker et al. 2001). The FORGE area is within the Roosevelt Hot Springs geothermal area, which covers approximately 46.7 square miles northeast of Milford, Utah (OpenEI 2016). Regional features include folded and imbricated Paleozoic-Mesozoic strata of the late Jurassic through Eocene Sevier orogeny, volcanic and intrusive centers resulting from Tertiary arc magmatism, detachment faulting associated with regional extension, tilting and exhumation of core complexes, and north-south-trending normal faults resulting from Basin and Range extension (Anders et al. 2012; Dickinson 2006). The zone also includes three producing geothermal fields: Cove Fort-Sulphurdale (approximately 16 miles northeast of the FORGE area), Roosevelt Hot Springs, and Thermo Hot Springs (approximately 25 miles southwest of the FORGE area), which are associated with young extensional faults, centers of Quaternary basalt-rhyolite magmatism, and large areas of anomalous heat flow covering more than 62 square miles (Blackett 2007; Kirby 2012; Mabey and Budding 1987; Simmons et al. 2015; Wannamaker et al. 2015).

Table 3-6 lists the acreages of surface geology found in the analysis area. Figure 3-5 depicts the locations of surface geology found in the FORGE area and geologic and soils analysis area.

Table 3-6. Surface Geology in the Analysis Area

Geology	Acres	Percentage
Intrusive rocks (tertiary)	12,567.2	14.6%
Moenkopi, Dinwoody, Woodside, Thaynes, and other formation	123.6	0.1%
Sedimentary and metasedimentary formations	1,279.7	1.5%
Surficial alluvium and colluvium	55,800.5	64.6%
Surficial older alluvium and colluvium	14,058.7	16.3%
Volcanic rocks (rhyolite)	2,362.5	2.7%
Volcanic rocks (tertiary)	151.6	0.2%

Most of the analysis area (approximately 80.9%) and the entire project area is covered by surficial alluvium and colluvium and surficial older alluvium and colluvium. Alluvium is a general name for loose, unconsolidated soil or sediments, which have been eroded, reshaped by water in some form, and redeposited in a non-marine setting. Colluvium refers to loose, unconsolidated sediments that have been deposited at the base of hillslopes by either rainwash, sheetwash, slow continuous downslope creep, or a variable combination of these processes. Surficial alluvium and colluvium (dating to the Holocene and Late Pleistocene epochs) and surficial older alluvium and colluvium (dating to the Pleistocene epoch) are of the Quaternary age and consist of surficial deposits of pluvial Lake Bonneville.

There are two faults near the FORGE area:

- The Opal Mound fault is a prominent high-angle fault along the west side of Roosevelt Hot Springs that dips east and offsets surficial deposits of alluvium and silica sinter; additional north-south-trending normal faults are likely to occur in basement rocks to the west beneath the alluvial cover but are blind to the surface. The length of the mapped trace of the Opal Mound fault is 2.9 miles. This fault is in the analysis area and east of the FORGE area.
- The Negro Mag fault is a high-angle east-west-trending fault, cutting across the Mineral Mountains east of the FORGE area and located within the analysis area. The Negro Mag fault intersects the Opal Mound fault. The length of the mapped trace of the Negro Mag fault is 6.6 miles.

Assuming the entire lengths of the Opal Mound fault and Negro Mag fault rupture during a normal faulting event, the maximum magnitude for these faults are calculated to be magnitude 5.4 and magnitude 5.9, respectively, which are moderate-sized magnitudes (Wells and Coppersmith 1994).

The 2008 USGS National Seismic Hazard Maps (Peterson et al. 2008) show the FORGE area to be in a region of low to moderate seismic hazard. There is a 0.20 to 0.25 probability of an earthquake of a magnitude greater than 5 within 50 kilometers (km) of the FORGE area in the next 20 years, and there is a 10% probability that the peak ground acceleration will exceed 10% g (g is the acceleration of gravity) in the next 50 years. De-aggregation shows that the largest contribution to the 10% probability that peak ground acceleration will exceed 10% g in 50 years comes from earthquakes greater than 6.5 magnitude within 25 km of the site.

Seismic activity in the FORGE area has been monitored by the University of Utah Seismic Station since 1981 (Utah FORGE 2016a). The seismic station is capable of recording events greater than a magnitude of 1.5. No seismic events have been detected in the project area, and despite more than 3 decades of electric production and injection into the gneiss and granite at Roosevelt Hot Springs (production began in 1984), few seismic events are spatially associated with the geothermal field (Utah FORGE 2016a). These events show no apparent relationship to injection volume. Circulation rates through the fracture network created in the FORGE area will be 10 times lower than the injection rates at Roosevelt Hot Springs, implying that the risk of induced seismicity in the FORGE area is minimal (Utah FORGE 2016a).

A review of seismicity in the region over the last 30 years finds the FORGE area is in a region of low seismic risk, manifest as both low magnitudes and low rates (Utah FORGE 2016a). The review found a cluster of seismicity approximately 8 miles northwest of Milford due to quarry blasts. There is another cluster of events 4 miles northeast of Milford that appears to be natural swarm activity, perhaps residual from a magnitude 4.1 earthquake near Milford in 1908. Scattered events occur in the Mineral Mountains, but there is no correlation with production and injection at the Blundell Geothermal Plant since commissioning in 1984. There are no located earthquakes within the FORGE area. Most natural seismicity over the past 30 years is clustered near Milford (0.46 to 3.87 magnitude), and diffuse low magnitude activity occurs beneath the Mineral Mountains.

In addition to the earthquake hazard, there are other known seismic sources in the area. There is a large quarry operation northwest of Milford producing seismic events of similar magnitude (magnitude less than 2) and ground motions to most catalogued earthquakes. Additionally, there is the possibility of small ground motions associated with railway traffic through the city of Milford, and noise sources related to the railroad and air traffic.

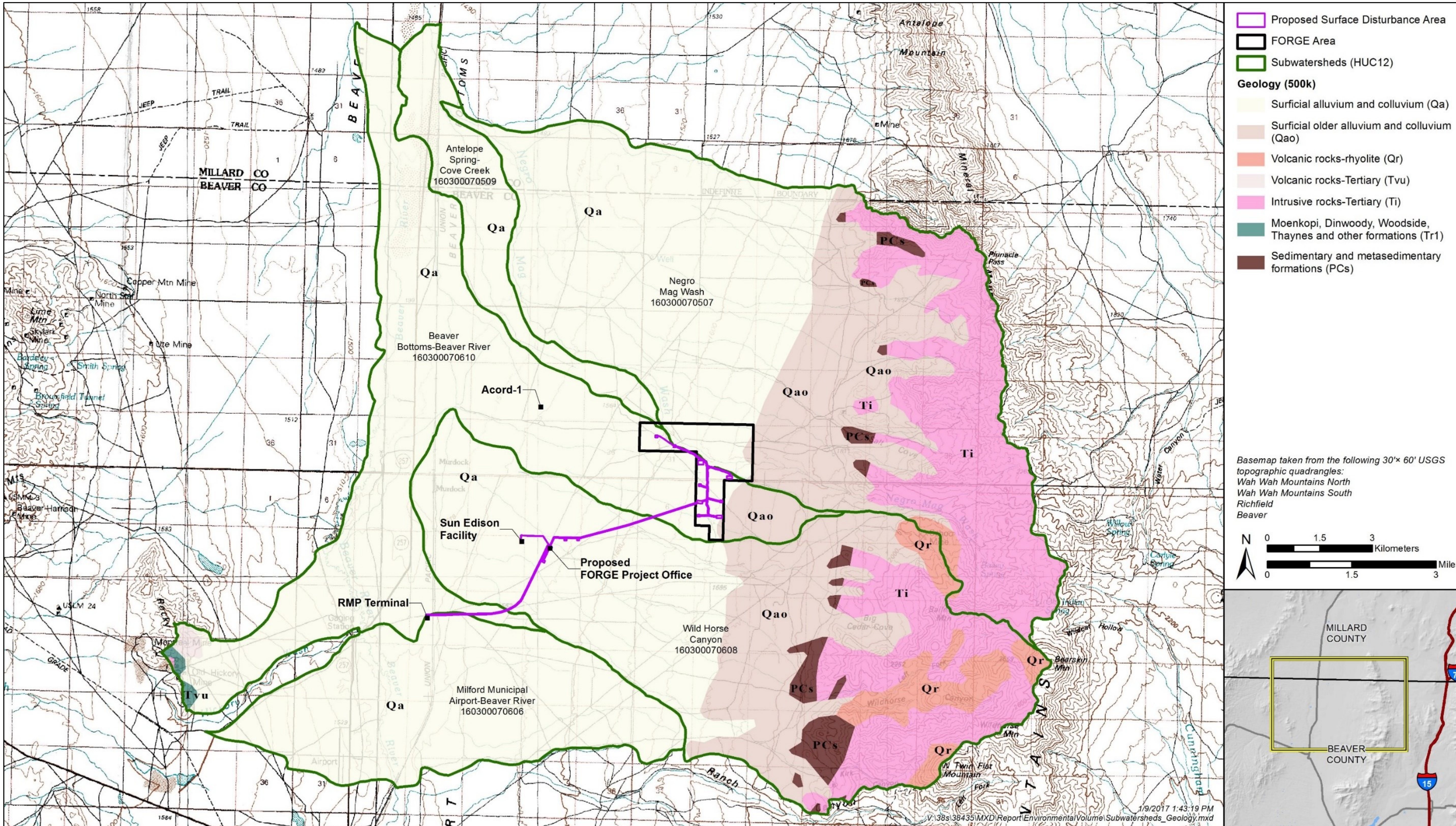

Figure 3-5. Surface geology in the project area, FORGE area, and geologic and soils analysis area.

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3.5.1.2. SOIL CONDITIONS

The most prevalent soil type in the analysis area is Sheeprock-Hiko Peak-Decca, followed by Tosser-Sitar-Hiko Peak, and Rock outcrop-May Day-Cowers-Bearskin. Table 3-7 lists the acreages of different soil types found in the analysis area, and Figure 3-6 depicts the locations of different soil types found in the project area, FORGE area, and soils analysis area.

Table 3-7. Soil Types in the Analysis Area

Soil Type	Acres	Percentage
Garbo-Deerlodge family-Biblesprings	4,637.6	5.4%
Robozo-Avalon family	8,443.7	9.8%
Rock outcrop-May Day-Cowers-Bearskin	15,200.4	17.6%
Rustico-Musinia-Monroe-Hiko Peak-Bandag	3,014.8	3.5%
Segura-Rock outcrop-Itca family-Cropper	768.0	0.9%
Sheeprock-Hiko Peak-Decca	25,487.8	29.5%
Tosser-Sitar-Hiko Peak	15,964.2	18.5%
Ushar-Snake Hollow-Sheeprock-Phage-Blue Star-Blackett	12,827.3	14.9%

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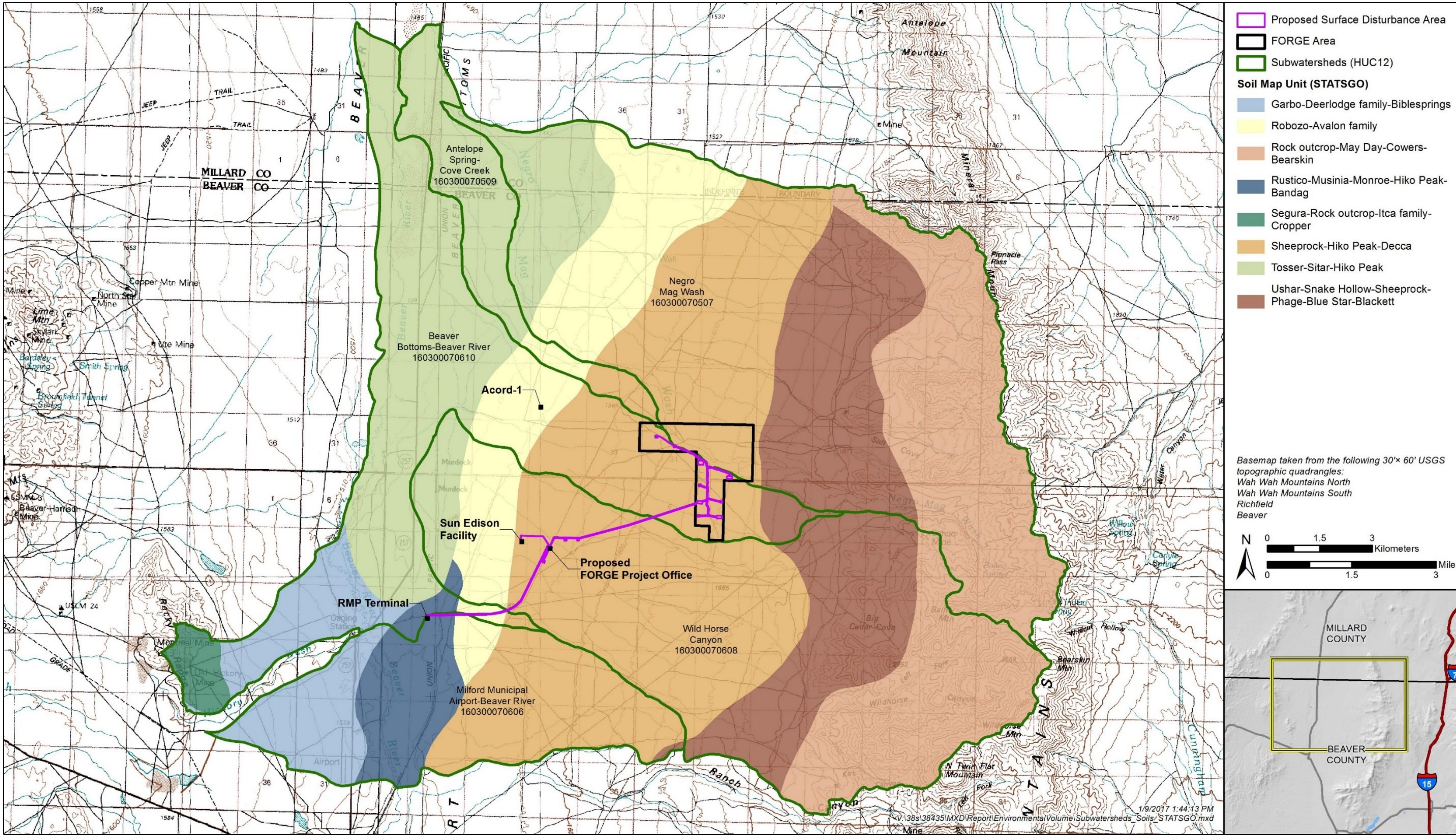

Figure 3-6. Soil types in the project area, FORGE area, and geologic and soils analysis area.

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Three soil types are found in the project area (surface disturbance footprint):

- Sheeprock-Hiko Peak-Decca
  - The Sheeprock series consists of deep, gently sloping to steep, somewhat excessively drained soils that were formed in deep alluvial coarse sand and fine gravel. These soils have rapid or very rapid permeability, with medium and high surface runoff. They are found on rolling hills and scarp faces or terraces. Slopes range from 10 to 30 percent. The distribution of this series is southwestern and northeastern Utah (Natural Resources Conservation Service [NRCS] 2007a). These soils are extremely erodible.
  - The Hiko Peak series consists of very deep, well-drained soils that formed in alluvium and colluvium derived dominantly from basic igneous rocks, limestone, and quartzite. These soils have low to high surface runoff, and moderately high saturated hydraulic conductivity. Hiko Peak soils are found on alluvial fans, fan remnants, and hills. Slopes are 0 to 60 percent. The distribution of this series is extensive in western Utah (NRCS 2012). These soils are slightly erodible.
  - The Decca series consists of very deep, well-drained, moderately permeable soils. These soils have moderate permeability in the solum (surface and subsoil), moderately rapid to rapid permeability in the 2C horizon (deepest soil layer), and slow to medium surface runoff. The Decca series formed in stratified mixed alluvium derived mainly from igneous rocks and quartzite on fan remnants, stream terraces, and rolling hills. Slopes range from 0 to 30 percent. The distribution of this series is moderately extensive in southwestern and south-central Utah (NRCS 2007b). These soils are slightly erodible.
- Robozo-Avalon family
  - The Robozo series consists of moderately deep, well-drained, moderately slowly permeable soils that formed in alluvium and lacustrine deposits derived dominantly from mixed igneous and sedimentary rocks. These soils have low surface runoff and moderately slow permeability. Robozo soils occur on gently sloping alluvial fans and lake terraces and have slopes of 0 to 3 percent. The distribution of this series is not extensive (NRCS 2007c).
  - The Avalon series consists of very deep, well-drained, moderately slowly and moderately permeable soils formed in alluvium derived mainly from sandstone and shale. These soils have slow to medium surface runoff, and moderately slow and moderate permeability. The Avalon series is found on terraces, alluvial fans, dissected fans, and hills, and has slopes of 0 to 25 percent. The distribution of this series is of small extent in western Colorado and central Utah (NRCS 2008a). These soils are highly erodible.
- Rustico-Musinia-Monroe-Hiko Peak-Bandag
  - The Rustico series consists of very deep, well-drained, moderately slowly permeable soils that formed in alluvium derived from mixed rocks. These soils have low surface runoff, and moderately slow and slow permeability. Rustico soils occur on stream terraces and alluvial flats. Slopes are 0 to 2 percent. The distribution of this series is not extensive in southwestern Utah (NRCS 2008b). These soils are very slightly erodible.
  - The Musinia series consists of very deep, well-drained, moderately slowly or slowly permeable soils that formed in alluvium derived from igneous and sedimentary rocks. These soils have very slow to medium surface runoff and moderately slow or slow permeability. The Musinia series is found on alluvial flats and floodplains. Slopes are 0 to 5 percent. The distribution of the series is not extensive in semiarid areas in southwestern and central Utah (NRCS 2007d). These soils are very slightly erodible.

- The Monroe series consists of very deep, well-drained soils that formed in alluvium derived from igneous rocks. These soils have low surface runoff, moderate or moderately slow permeability above 100 centimeters, and moderate to moderately rapid permeability below 100 centimeters. The Monroe series is found on fan skirts, floodplains, and low stream terraces. Slopes are 0 to 4 percent. The distribution of these soils is moderately extensive in western Utah, south-central Idaho, and central Oregon (NRCS 2014a).
- The Bandag series consists of very deep, well-drained, moderately or moderately slowly permeable soils that formed in alluvium derived mainly from intermediate igneous and sedimentary rocks. These soils have low surface runoff and moderate or moderately slow permeability. The Bandag series occurs on fan skirts, toeslopes of alluvial fans and alluvial flats, and has slopes of 0 to 5 percent. The distribution of these soils is moderately extensive in southwestern Utah (NRCS 2014b).

3.5.2. Environmental Consequences of the Proposed Project

3.5.2.1. GEOLOGIC CONDITIONS

The Proposed Project would result in a total of 124.9 acres of surface disturbance using the G1 groundwater wellfield option and a total of 121.9 acres of surface disturbance using the G2 groundwater wellfield option. Table 3-8 lists the acreages of surface geology that the Proposed Project would affect through surface disturbance.

Table 3-8. Acres of Surface Geology Affected by Project Surface Disturbance

Geological Resource	Surface Disturbance (acres)	Percentage in Analysis Area
Surficial alluvium and colluvium	129.0	0.1%
Surficial older alluvium and colluvium	0.5	0.0006%

Note: Surface disturbance caused by both groundwater wellfield options (G1 and G2) is included in the acreage calculations in this table. Acreage calculations in this table do not include the 0.57 acre for 10 seismic monitoring drillholes or 0.39 acre for survey and tiltmeter sites, because their locations are unknown at this time.

Project activities would affect less than 0.5% of the total acreage of each type of surface geology in the analysis area. Geothermal operations usually take place in areas that are tectonically active, and seismic events typically take place in areas with high levels of tectonic activity, such as volcanic regions and fault zones. Some geothermal projects can cause induced seismicity because of changes in reservoir pore pressure due to production (removal) or re-injection of geothermal or other fluids. Injection-induced seismicity is associated with changes in stress or fluid pressure in the Earth's crust, which can accompany withdrawal or injection of fluids during geothermal operations (Cladouhos et al. 2010).

Although not an EGS[3] project, the Roosevelt Hot Springs geothermal system provides a potential analog for investigating induced seismicity at the FORGE area. The Roosevelt Hot Springs system is several miles east of the FORGE area in the same reservoir rocks. Production and injection have been ongoing since 1984. Over 4.16e (4.16×10^{10}) total gallons of water have been injected; 70% being injected into a well that is located adjacent to the Negro Mag fault near its intersection with the Opal Mound fault (Utah FORGE 2016b). Associated seismic activity has been minimal. The Opal Mound fault occurs between the FORGE area and the Roosevelt Hot Spring system. Given the lack of any significant seismicity on this fault over the last 30 years of injection, it is unlikely earthquakes will occur in response to injection at the FORGE area on this structure.

[3] In an EGS, permeability has been increased and injection wells are used to inject and circulate water, where it is heated as it travels to production wells. As the circulating water cools, the engineered fractures, induced seismicity, and chemical dissolution of minerals may also create new permeability, continually expanding the reservoir and exposing more heat to be mined (DOE 2016).

3.5.2.2. SOIL CONDITIONS

The Proposed Project would result in a total of 124.9 acres of surface disturbance using the G1 groundwater wellfield option and a total of 121.9 acres of surface disturbance using the G2 groundwater wellfield option. The project would affect less than 0.5% of the total acreage of each soil type in the analysis area. Robozo-Avalon family soils are rarer than the other two soil types affected by the Proposed Project; however, only 0.1% of the total acreage of that soil type in the analysis area would be affected. Table 3-9 lists the acres of each soil type that would be impacted by the project's surface-disturbing activities.

Table 3-9. Acres of Soil Type Affected by Project Surface Disturbance

Soil Type	Surface Disturbance (acres)	Percentage in Analysis Area
Sheeprock-Hiko Peak-Decca	112.1	0.4%
Robozo-Avalon family	11.0	0.1%
Rustico-Musinia-Monroe-Hiko Peak-Bandag	6.4	0.2%

Note: Surface disturbance caused by both groundwater wellfield options (G1 and G2) is included in the acreage calculations in this table. Acreage calculations in this table do not include 0.57 acre for 10 seismic monitoring drillholes or 0.39 acre for survey and tiltmeter sites, because their locations are unknown at this time.

Direct impacts to soils would include changes in soil functions due to soil exposure from vegetation removal, mixing of soil horizons, potential loss of topsoil productivity, soil compaction, and increased susceptibility to wind and water erosion. Use of equipment for mechanical treatment of vegetation may compact soils, which would reduce soil infiltration rates, leading to increases in overland flow of water, erosion, and displacement of soil. Reclamation of the project area would help avoid a long-term loss of soil or soil fertility at disturbed sites (see section 2.3.4).

Each well pad would be stripped of vegetation and topsoil as part of construction, leading to localized increases in erosion potential. However, gravel would be applied to each well pad to help reduce erosion potential. Removed topsoil would be stockpiled for reclamation. Additional erosion mitigation measures could include reseeding and stabilizing unstable slopes, cut-and-fill areas, stockpiles, and other disturbances. Reclamation and mitigation activities would follow those outlined in the *BLM Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* (The Gold Book) (BLM 2007).

Within the analysis area, there would also be soil disturbance caused by the proposed geoscientific surveys, 10 seismic monitoring drillholes, and 42 survey monument and tiltmeter sites. Impacts to soils from the geoscientific surveys would primarily be compaction from the use of the vibroseis trucks and surface disturbance from digging approximately 76 2-foot-deep holes for the MT survey. A magnetometer would be placed in each of the 2-foot-deep holes for 24 hours and then removed. The holes would then be filled in. The 10 drillholes for seismic monitoring would each create an area of surface disturbance approximately 50 feet by 50 feet in size, for a total of approximately 0.6 acre of soil disturbance for all 10 sites. The 33 survey monuments and nine tiltmeters would each create an area of surface disturbance approximately 20 feet by 20 feet in size. The total soil disturbance from survey monuments and tiltmeters would be approximately 0.4 acre.

The loosening of earthen material and the removal of soil and vegetation would contribute sediment and TDS to the watershed. Most sediment eroded from the project area would be transported by surface runoff from precipitation, which includes winter snowfalls and summer storms. Threat of erosion from snowfall is low because snowfall is low in energy and does not rapidly create overland flow. Thunderstorms would be more likely to produce high-energy (i.e., erosive) runoff, but these storms are infrequent in the project area. Any increase in sediment load or TDS is anticipated to be relatively minor and localized due to mitigation measures and reclamation. Reclamation and mitigation activities would follow those outlined in the BLM Gold Book (BLM 2007).

The potential for increased erosion and sedimentation would be greatest in the short term immediately after construction when disturbed soils are loose, and it would decline over time in areas where reclamation is implemented, and in other areas as natural stabilization occurs.

3.5.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped; therefore, no new impacts to geologic and soil conditions would occur. Ongoing activities in the analysis area or new projects in the FORGE area could cause impacts to geologic and soil conditions.

3.6. Vegetation and Wildlife Resources

3.6.1. Affected Environment

3.6.1.1. VEGETATION

The FORGE area intersects five subwatersheds within the larger Beaver River and Cove Creek watersheds: the Antelope Spring-Cove Creek, Beaver Bottoms-Beaver River, Milford Municipal Airport-Beaver River, Negro Mag Wash, and Wild Horse Canyon subwatersheds. The subwatersheds are shown in Figure 3-2 and form the analysis area for vegetation. This 86,344-acre area was chosen because it provides a clear topographic boundary against which to measure impacts to vegetation.

3.6.1.1.1. Land Cover Types

There are 32 Southwest Regional Gap Analysis Project (SWReGAP) land cover types in the vegetation analysis area. The two most prevalent are Inter-Mountain Basins Big Sagebrush Shrubland, which covers 25,602 acres or 29.7% of the analysis area, and Colorado Plateau Pinyon-Juniper Woodland, which covers 20,463 acres or 23.7% of the analysis area. Three other land cover types that are prevalent in the analysis area are Inter-Mountain Basins Semi-Desert Shrub Steppe (10,929 acres or 12.7%), Inter-Mountain Basins Mixed Salt Desert Scrub (10,099 acres or 11.7%), and Inter-Mountain Basins Greasewood Flat (9,966 acres or 11.5%). Table 3-10 presents the acres of each land cover type in the vegetation analysis area, and Figure 3-7 shows the locations of these land cover types within the project area, FORGE area, and the vegetation analysis area.

Table 3-10. Land Cover Types, Acreages, and Percentages in the Vegetation Analysis Area

SWReGAP Land Cover Types	Acres	Percentage of Analysis Area
Agriculture	5.8	0.01%
Colorado Plateau Mixed Low Sagebrush Shrubland	3.8	0.004%
Colorado Plateau Pinyon-Juniper Woodland	20,462.8	23.7%
Developed, Medium - High Intensity	75.1	0.1%
Developed, Open Space - Low Intensity	381.4	0.4%
Great Basin Pinyon-Juniper Woodland	37.5	0.04%
Great Basin Xeric Mixed Sagebrush Shrubland	1,586.7	1.8%
Inter-Mountain Basins Big Sagebrush Shrubland	25,602.1	29.7%
Inter-Mountain Basins Cliff and Canyon	65.7	0.1%
Inter-Mountain Basins Greasewood Flat	9,966.2	11.5%
Inter-Mountain Basins Mixed Salt Desert Scrub	10,098.6	11.7%
Inter-Mountain Basins Montane Sagebrush Steppe	307.1	0.4%
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	355.7	0.4%
Inter-Mountain Basins Playa	242.3	0.3%
Inter-Mountain Basins Semi-Desert Grassland	623.4	0.7%
Inter-Mountain Basins Semi-Desert Shrub Steppe	10,929.1	12.7%
Inter-Mountain West Aspen-Mixed Conifer Forest and Woodland Complex	43.1	0.05%
Invasive Annual and Biennial Forbland	399.3	0.5%
Invasive Annual Grassland	1,650.8	1.9%
Invasive Perennial Grassland	945.6	1.1%
Recently Mined or Quarried	192.0	0.2%
Rocky Mountain Aspen Forest and Woodland	14.8	0.02%
Rocky Mountain Cliff and Canyon	528.6	0.6%
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	1,208.0	1.4%
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	20.7	0.02%
Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland	203.2	0.2%
Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	113.0	0.1%
Rocky Mountain Ponderosa Pine Woodland	9.8	0.01%
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	17.5	0.02%
Rocky Mountain Subalpine Mesic Meadow	1.3	0.002%
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	7.8	0.01%
Southern Rocky Mountain Montane-Subalpine Grassland	245.1	0.3%

Source: USGS (2004).

The five most prevalent land cover types in the vegetation analysis area, and the plant species associated with them, are described in the paragraphs below.

Inter-Mountain Basins Big Sagebrush Shrubland

This land cover type is typically found in broad basins between mountain ranges, plains, and foothills between 4,900 and 7,500 feet in elevation. These shrublands are dominated by Wyoming or basin big sagebrush (*Artemisia tridentata*). Scattered juniper (*Juniperus* spp.), greasewood (*Sarcobatus vermiculatus*), and saltbush (*Atriplex* spp.) may be present in some stands. Rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), bitterbrush (*Purshia tridentata*), or mountain snowberry (*Symphoricarpos oreophilus*) may codominate disturbed stands (USGS 2005). Common graminoid species include Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), thickspike wheatgrass (*Elymus lanceolatus*), Idaho fescue (*Festuca idahoensis*), needle and thread (*Hesperostipa comata*), basin wildrye (*Leymus cinereus*), James' galleta (*Pleuraphis jamesii*), western wheatgrass (*Pascopyrum smithii*), Sandberg bluegrass (*Poa secunda*), or bluebunch wheatgrass (*Pseudoroegneria spicata*) (USGS 2005).

Colorado Plateau Pinyon-Juniper Woodland

This land cover type is typically found at elevations ranging from approximately 4,900 to 8,000 feet. Pinyon pine (*Pinus edulis*) and/or Utah juniper (*Juniperus osteosperma*) dominate the tree canopy. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include greenleaf manzanita (*Arctostaphylos patula*), Wyoming or basin big sagebrush, littleleaf mountain mahogany (*Cercocarpus intricatus*), alderleaf mountain mahogany (*Cercocarpus montanus*), blackbrush (*Coleogyne ramosissima*), Stansbury cliffrose (*Purshia stansburiana*), bitterbrush, oak brush (*Quercus gambelii*), blue grama, James' galleta (*Pleuraphis jamesii*), or muttongrass (*Poa fendleriana*) (USGS 2005).

Inter-Mountain Basins Semi-Desert Shrub Steppe

This land cover type is typically found at lower elevations on flats and alluvial fans with moderate to deep soils. It is typically dominated by graminoids and has an open shrub layer. Common graminoid species include Indian ricegrass, blue grama, saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*), needle and thread, Sandberg bluegrass, and James' galleta. Shrubs and dwarf-shrubs typically include fourwing saltbush (*Atriplex canescens*), big sagebrush, yellow rabbitbrush, Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir species (*Ephedra* spp.), rubber rabbitbrush, broom snakeweed (*Gutierrezia sarothrae*), and winterfat (*Krascheninnikovia lantata*). Biological soil crusts can be very important in this land cover type (USGS 2005).

Inter-Mountain Basins Mixed Salt Desert Scrub

This land cover type is typically found in saline basins and alluvial slopes and plains. It includes open-canopied shrublands composed of one or more saltbush species (*Atriplex* spp.) such as shadscale saltbush (*A. confertifolia*), fourwing saltbush, spinescale saltbush (*A. spinifera*), or cattle saltbush (*A. polycarpa*). Other shrubs present may include rubber rabbitbrush, yellow rabbitbrush, big sagebrush, Nevada jointfir (*Ephedra nevadensis*), spiny hopsage (*Grayia spinosa*), winterfat, bud sagebrush (*Picrothamnus desertorum*), desert-thorn species (*Lycium* spp.), or horsebrush species (*Tetradymia* spp.) (USGS 2005).

Inter-Mountain Basins Greasewood Flat

This land cover type typically occurs on stream terraces and flats near drainages or may form rings around sparsely vegetated playas. It usually occurs as a mosaic of multiple communities, with open to moderately dense shrublands dominated or co-dominated by *Sarcobatus vermiculatus*. Shadscale saltbush, fourwing saltbush, or winterfat may be present or codominant. If an herbaceous layer is present, it is typically dominated by graminoids such as alkali sacaton, saltgrass, or common spike rush (*Eleocharis palustris*) (USGS 2005).

3.6.1.1.2. Special-Status Plant Species

Three known special-status plant species (e.g., threatened, endangered, and candidate species) have the potential to occur in the analysis area: Frisco clover (*Trifolium friscanum*), Frisco buckwheat (*Eriogonum soredium*), and Ostler's peppergrass (*Lepidium ostleri*) (Utah Division of Wildlife Resources [UDWR] 2015a). All three species are candidates for listing under the ESA. Frisco clover is found in Beaver and Millard Counties on volcanic soils at a total of five sites statewide. All known sites are located west of the analysis area in the San Francisco Mountains, Tunnel Spring Mountains, Beaver Lake Mountains, or south of the analysis area at Blue Mountain (UDWR 2016). Although some of the soils in the analysis area were derived from volcanic rock, there are no known occurrences of Frisco clover in or near the analysis area. Frisco buckwheat and Ostler's peppergrass are known to occur in the San Francisco Mountains in north-central Beaver County. They are narrow endemics restricted to soils derived from Ordovician limestone outcrops. It is unlikely these species occur in the analysis area because there are no limestone outcrops and no known occurrences.

3.6.1.1.3. Noxious Weeds

Two Utah state-listed noxious weed species, Scotch thistle (*Onopordum acanthium*) and whitetop (*Cardaria draba*), are known to occur in the analysis area (Utah Automated Geographic Reference Center 2013). These species and other noxious weed species may occur in the project area.

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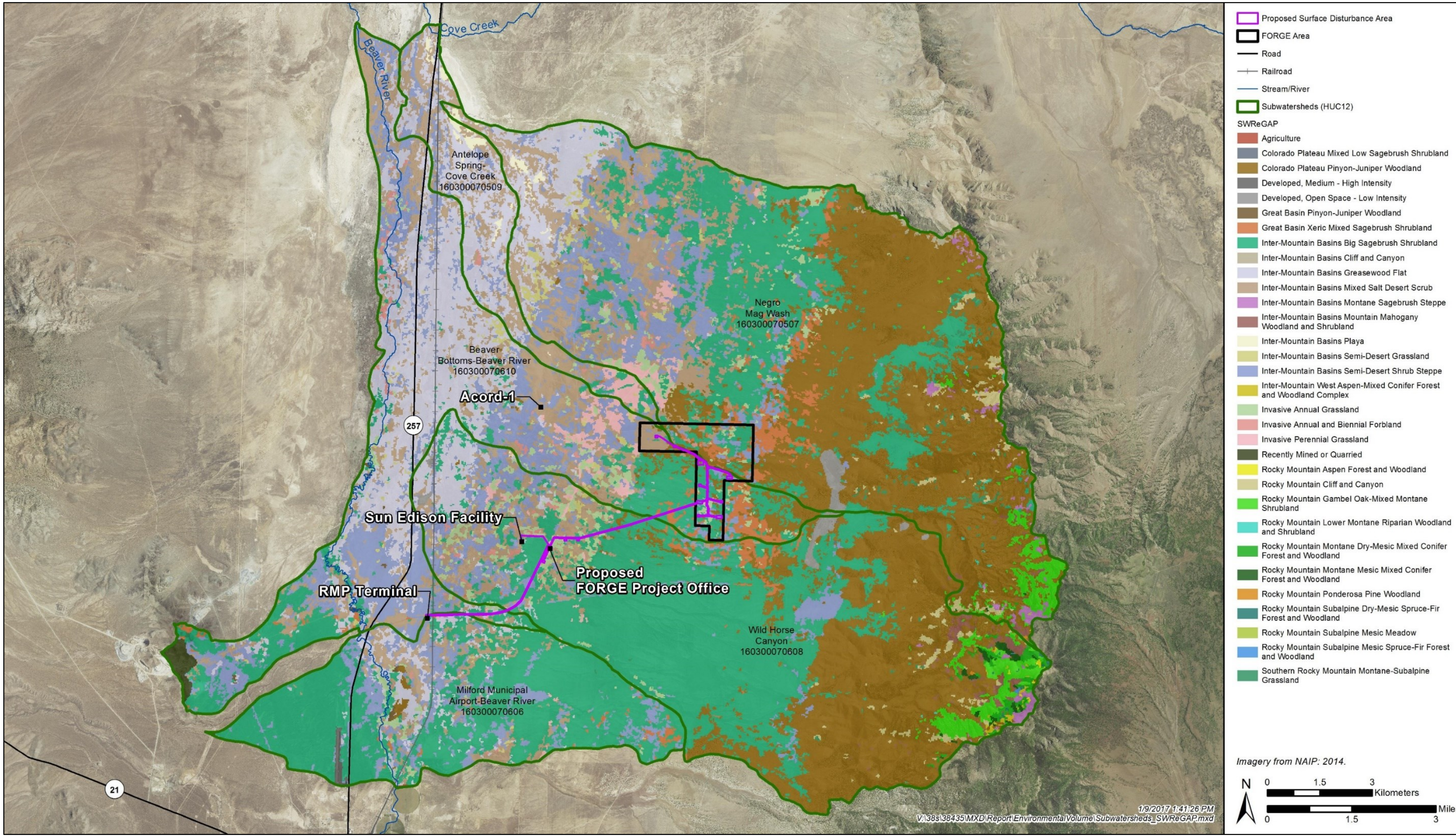

Figure 3-7. SWReGAP land cover types in the project area, FORGE area, and vegetation analysis area.

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3.6.1.1.4. Wetlands and Other Sensitive Areas

Wetlands in the analysis area were identified using NWI data and comprise palustrine, riverine, and lacustrine wetland types. Hydrologic features in the analysis area were identified using NHD data and comprise stream/river, connector, canal/ditch, and lake/pond hydrologic features. Vegetation associated with these wetland and water features is not captured in the SWReGAP land cover data. Wetland and surface water resources are discussed in more detail in section 3.4.1.

3.6.1.2. WILDLIFE

The wildlife analysis area consists of the same five subwatersheds as the vegetation analysis area, and is 86,344-acres in size (see Figure 3-2). This analysis area was chosen because the subwatersheds represent a defined continuous area linked by common watercourses on which wildlife depend. This section provides a discussion of land cover types and habitat in the project area and analysis area; associated general wildlife species, migratory birds, and game species (including black bear [*Ursus americanus*] and game habitat in the analysis area); and information on special-status wildlife species.

3.6.1.2.1. Land Cover Types and Habitat

The identification of land cover types provides information about available wildlife habitat. Land cover types or ecological systems are defined as recurring groups of biological communities found in similar physical environments and influenced by similar ecological processes, such as fire or flooding (USGS 2005). SWReGAP data recognize nine land cover types in the project area and 32 land cover types in the analysis area. The land cover types in the project area and associated acreages for these land cover types in the analysis area are summarized in Table 3-11. Detailed descriptions of the most prevalent land cover types in the analysis area are provided in section 3.6.1.1.1.

Table 3-11. Land Cover Types and Acreages in the Project Area and Analysis Area

SWReGAP Land Cover Types	Project Area (acres)	Analysis Area (acres)
Colorado Plateau Pinyon-Juniper Woodland	12.9	20,462.8
Great Basin Xeric Mixed Sagebrush Shrubland	8.0	1,586.7
Inter-Mountain Basins Big Sagebrush Shrubland	58.2	25,602.1
Inter-Mountain Basins Greasewood Flat	3.5	9,966.2
Inter-Mountain Basins Mixed Salt Desert Scrub	16.1	10,098.6
Inter-Mountain Basins Semi-Desert Shrub Steppe	14.7	10,929.1
Invasive Annual and Biennial Forbland	0.3	399.3
Invasive Annual Grassland	14.7	1,650.8
Invasive Perennial Grassland	1.1	945.6

Note: Both groundwater wellfield options (G1 and G2) are included in the acreage calculations in this table. Acreage calculations in this table do not include 0.57 acre for 10 seismic monitoring drillholes or 0.39 acre for survey and tiltmeter sites, because their locations are unknown at this time.

3.6.1.2.2. General Wildlife

The presence of potential habitat for general wildlife and raptor species was determined by comparing individual species habitat requirements to the SWReGAP land cover types predicted to occur in the project area and analysis area. Land cover in the project area provides habitat for a variety of wildlife species, such as golden eagle (*Aquila chrysaetos*) (mainly foraging), red-tailed hawk (*Buteo jamaicensis*), Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter striatus*), ferruginous hawk (*Buteo regalis*), American kestrel (*Falco sparverius*), horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), loggerhead shrike (*Lanius ludovicianus*), Brewer's sparrow (*Spizella breweri*), sagebrush sparrow (*Artemisiospiza nevadensis*), sage thrasher (*Oreoscoptes montanus*), lark sparrow (*Chondestes grammacus*), black-throated sparrow (*Amphispiza bilineata*), scrub jay (*Aphelocoma californica*), pinyon jay (*Gymnorhinus cyanocephalus*), juniper titmouse (*Baeolophus ridgwayi*), gray flycatcher (*Empidonax wrightii*), ash-throated flycatcher (*Myiarchus cinerascens*), olive-sided flycatcher (*Contopus cooperi*), green-tailed towhee (*Pipilo chlorurus*), mountain bluebird (*Sialia currucoides*), wild turkey (*Meleagris gallopavo*), cottontail rabbit (*Sylvilagus* spp.), black-tailed jackrabbit (*Lepus californicus*), skunk (*Spilogale* spp.), coyote (*Canis latrans*), American badger (*Taxidea taxus*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), small mammals, and multiple reptile species.

3.6.1.2.3. Migratory Birds

Migratory birds and raptors are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 USC 703–712) and the Bald and Golden Eagle Protection Act (as amended in 1962). The MBTA prohibits taking or killing migratory birds and destroying their nests or eggs without a permit. The list of protected migratory birds includes raptors. Executive Order 13186 directs federal agencies taking actions that are likely to have a measurable adverse effect on migratory birds to undertake mitigation measures in support of the MBTA. In Utah, the *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* (Romin and Muck 2002) provides practices and guidelines for consistent raptor management approaches across the state.

Utah Partners in Flight Avian Conservation Strategy lists 24 priority species for conservation efforts (Parrish et al. 2002). There is potential habitat in the analysis area for 23 of the 24 priority species listed (Table 3-12). Because the analysis area lacks extensive riparian habitat, there is no potential habitat for yellow-billed cuckoo. Migratory birds use a variety of habitat types, including pinyon-juniper woodland, wooded riparian, sagebrush-steppe, playa, and grassland, all found in the analysis area.

Table 3-12. Utah Partners in Flight Priority Species in the Wildlife Analysis Area

Priority Species	Breeding Habitat	Wintering Habitat
Abert's towhee (*Melozone aberti*)	Lowland riparian	Lowland riparian
American avocet (*Recurvirostra americana*)	Wetland, playa	Migrant
American white pelican (*Pelecanus erythrorhynchos*)	Water, wetland	Migrant
Bell's sparrow (*Artemisiospiza belli*)	Shrub-steppe, high desert scrub	Low desert scrub
Bell's vireo (*Vireo bellii*)	Lowland riparian	Migrant
Black rosy-finch (*Leucosticte atrata*)	Alpine	Grassland
Black swift (*Cypseloides niger*)	Lowland riparian, cliff	Migrant
Black-necked stilt (*Himantopus mexicanus*)	Wetland, playa	Migrant
Black-throated gray warbler (*Setophaga nigrescens*)	Pinyon-juniper, mountain shrub	Migrant

Table 3-12. Utah Partners in Flight Priority Species in the Wildlife Analysis Area

Priority Species	Breeding Habitat	Wintering Habitat
Bobolink (*Dolichonyx oryzivorus*)	Wet meadow, agriculture	Migrant
Brewer's sparrow (*Spizella breweri*)	Shrub-steppe, high desert scrub	Migrant
Broad-tailed hummingbird (*Selasphorus platycercus*)	Lowland riparian, mountain riparian	Migrant
Ferruginous hawk (*Buteo regalis*)	Pinyon-juniper, shrub-steppe	Grassland
Gambel's quail (*Callipepla gambelii*)	Low desert scrub, lowland riparian	Low desert scrub
Gray vireo (*Vireo vicinior*)	Pinyon-juniper, oak	Migrant
Greater sage-grouse (*Centrocercus urophasianus*)	Shrub-steppe	Shrub-steppe
Lewis's woodpecker (*Melanerpes lewis*)	Ponderosa pine, lowland riparian	Oak
Long-billed curlew (*Numenius americanus*)	Grassland, agriculture	Migrant
Lucy's warbler (*Oreothlypis luciae*)	Lowland riparian, low desert scrub	Migrant
Mountain plover (*Charadrius montanus*)	High desert scrub	Migrant
Sharp-tailed grouse (*Tympanuchus phasianellus*)	Shrub-steppe, grassland	Shrub-steppe
Three-toed woodpecker (*Picoides dorsalis*)	Sub-alpine conifer, lodgepole pine	Sub-alpine conifer
Virginia's warbler (*Oreothlypis virginiae*)	Oak, pinyon-juniper	Migrant
Yellow-billed cuckoo (*Coccyzus americanus*)	Lowland riparian, agriculture	Migrant

Source: Parrish et al. (2002).

According to the geospatial raptor data provided by the BLM Cedar City Field Office and BLM Utah State Office, there are known nest occurrences for red-tailed hawk, ferruginous hawk, golden eagle, prairie falcon, and burrowing owl in the analysis area. There is also a known burrowing owl nest in the project area (Figure 3-8).

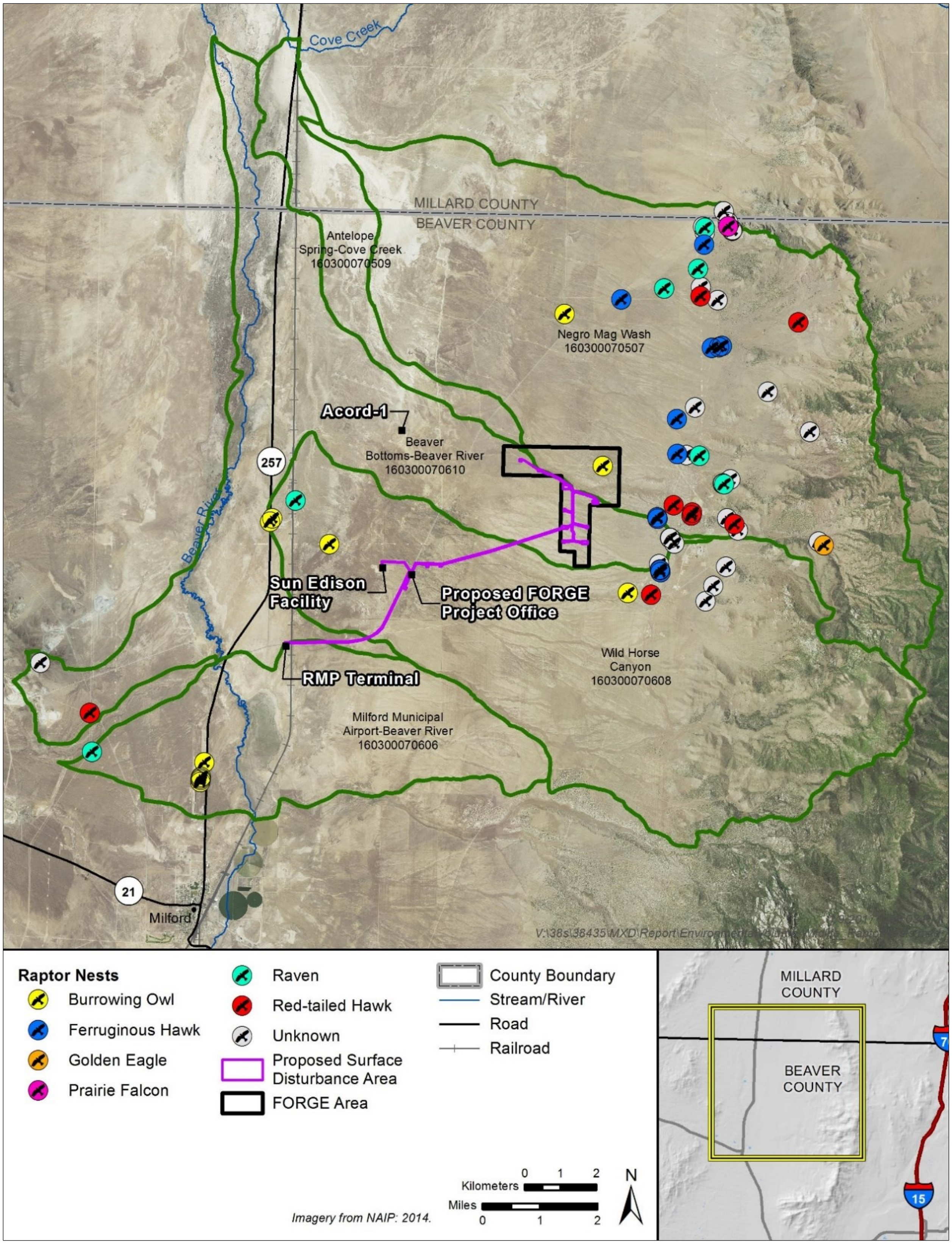

Figure 3-8. Raptor nest occurrences in the project area, FORGE area, and wildlife analysis area.

3.6.1.2.4. Game Species

Based on UDWR geospatial data, the project area and FORGE area contain crucial habitat for pronghorn (*Antilocapra americana*), and the analysis area contains crucial habitat for pronghorn, substantial and crucial habitat for black bear and mule deer (*Odocoileus hemionus*), and substantial habitat for Rocky Mountain elk (*Cervus elaphus nelsoni*). Background on these big game species is provided in the following paragraphs.

The pronghorn is native only to North America and is well known for its speed (it can attain speeds of approximately 45 miles per hour) (UDWR 2009). In Utah, nearly all populations occur in shrub steppe habitat. This habitat is characterized by large expanses of open, low, rolling or flat terrain. Pronghorn are browsers that consume shrubs such as sagebrush, as well as grasses and forbs. The abundance of free water sources is important to the viability of pronghorn populations. By 1900, pronghorn numbers throughout the United States had declined by more than 99% because of fencing, habitat loss, and unregulated hunting. Although most historical habitats are currently occupied, individual herds are much smaller, and many are isolated. Beginning in 1945, transplants of pronghorn in Utah have resulted in a wider distribution across most of Utah's suitable desert habitats. The statewide pronghorn population is currently estimated at 12,000 to 14,000 individuals (UDWR 2009). Currently, habitat degradation and habitat loss (resulting in a lack of succulent forbs and grasses on spring and summer ranges) are major concerns for pronghorn in Utah, as are fencing, livestock, disease, and energy development (UDWR 2009). There are approximately 66,687.6 acres of crucial habitat for pronghorn in the analysis area, and the entire project area (129.6 acres) is designated as crucial habitat for pronghorn. Figure 3-9 depicts the habitat distribution for pronghorn in the project area, FORGE area, and analysis area.

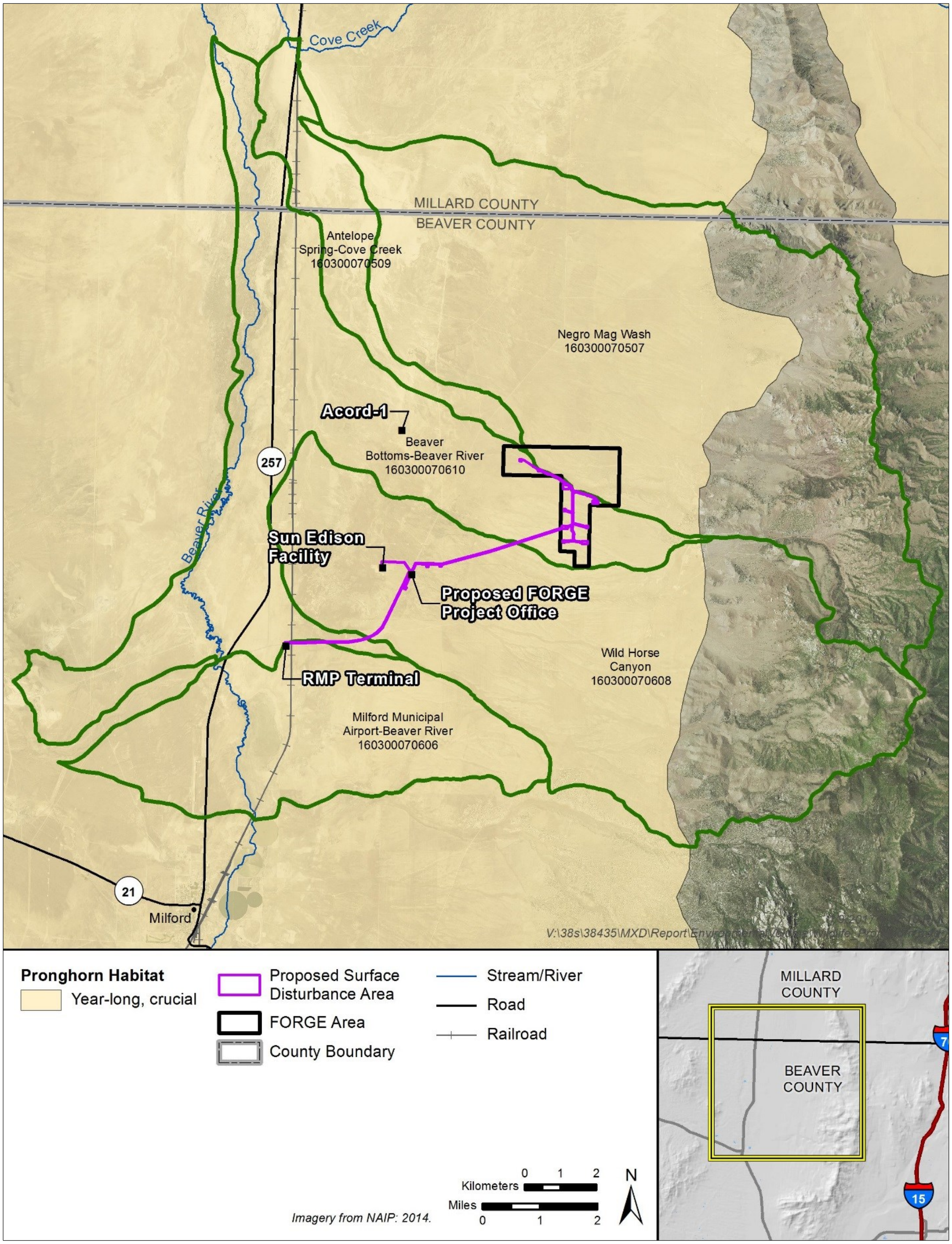

Figure 3-9. Pronghorn habitat distribution in the project area, FORGE area, and analysis area.

Black bear habitat is present in much of the forested areas of Utah. In central Utah, bears use low-elevation mountain brush habitats in the summer and higher-elevation aspen and conifer habitats in the spring and fall. High-quality black bear habitat in Utah consists of large interconnected blocks of land exhibiting high interspersions of aspen, mountain brush, and coniferous plant communities with a healthy herbaceous and shrub component (UDWR 2011). Bears in central and southeastern Utah have been found to prefer mesic, north-slope conifer patches as resting areas year-round. The species is often found near a water source. Utah's black bear population appears to have increased since 1990, but may have recently stabilized (UDWR 2011). The black bear is omnivorous and eats a variety of foods (typically grasses and forbs in the spring, more fruits in the summer, and a mixture of soft mast [fruits] and hard mast [nuts] in the fall), which allows for seasonal diet changes based on availability. In Utah, black bear research has found that vegetative matter is the most important diet item, followed by mast, insects, and animal matter. Bears in central and southeastern Utah forage on grasses and forbs in aspen, aspen-conifer, and mountain brush, in addition to riparian zones and low-elevation timbered canyon bottoms (UDWR 2011). There is no black bear habitat in the project area or FORGE area. However, there are 7,077.0 acres of designated crucial habitat and 10,774.4 acres of designated substantial habitat for black bear in the analysis area. Figure 3-10 depicts the distribution of black bear habitat in the analysis area.

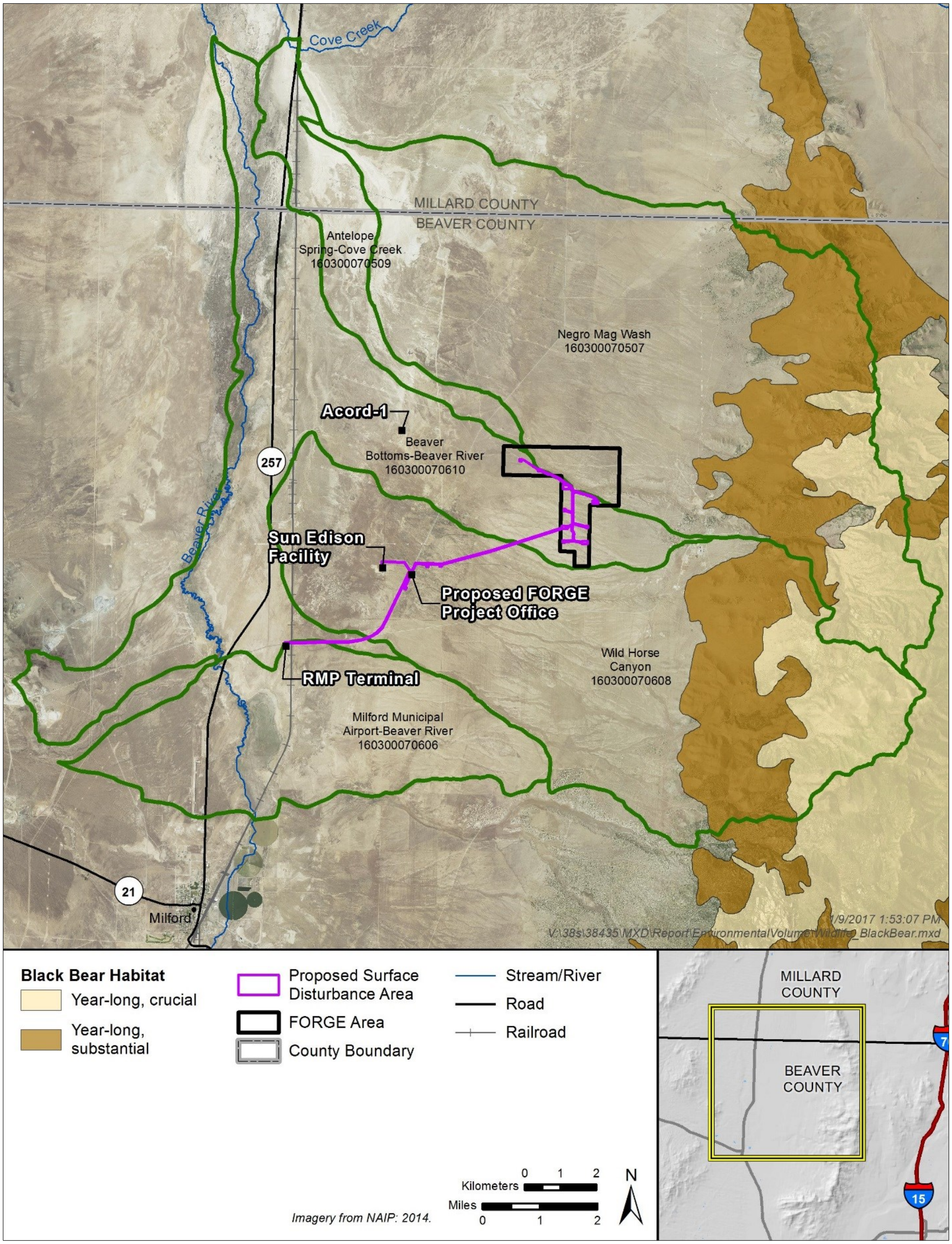

Figure 3-10. Black bear habitat distribution in the analysis area.

Mule deer are found in almost all of Utah, although they are less abundant in desert areas. Currently, 54% of the state is considered mule deer habitat. The deer population in Utah has grown at an average rate of 1.6% over the past 20 years; the population estimate was 79% of the long-term management objective of 425,400 deer in 2013 (UDWR 2014a). Mule deer eat a variety of plants, including browse, forbs, and grasses. They are especially reliant on shrubs for forage during critical winter months. Their habitat is usually characterized by areas of thick brush or trees interspersed with small openings. Mule deer habitat is classified into three main categories (winter, summer, and transitional) based on the season of use. The size and condition of mule deer populations are primarily determined by the quantity and quality of these habitats (UDWR 2014a). Loss and degradation of habitat are thought to be the key reasons for mule deer population declines in western North America over the last few decades. In many parts of Utah, crucial mule deer habitat is continuously being lost or severely fragmented because of human population expansion, development, and natural events (crucial mule deer habitat is defined as habitat essential to the life history requirements of mule deer). Other factors such as predation and disease are intensified with a reduction in habitat quality (UDWR 2014a). There is no mule deer habitat in the project area or FORGE area. However, there are 25,865.2 acres of designated winter crucial habitat and 2,413.9 acres of designated summer substantial habitat for mule deer in the analysis area. Figure 3-11 depicts the distribution of mule deer habitat in the analysis area.

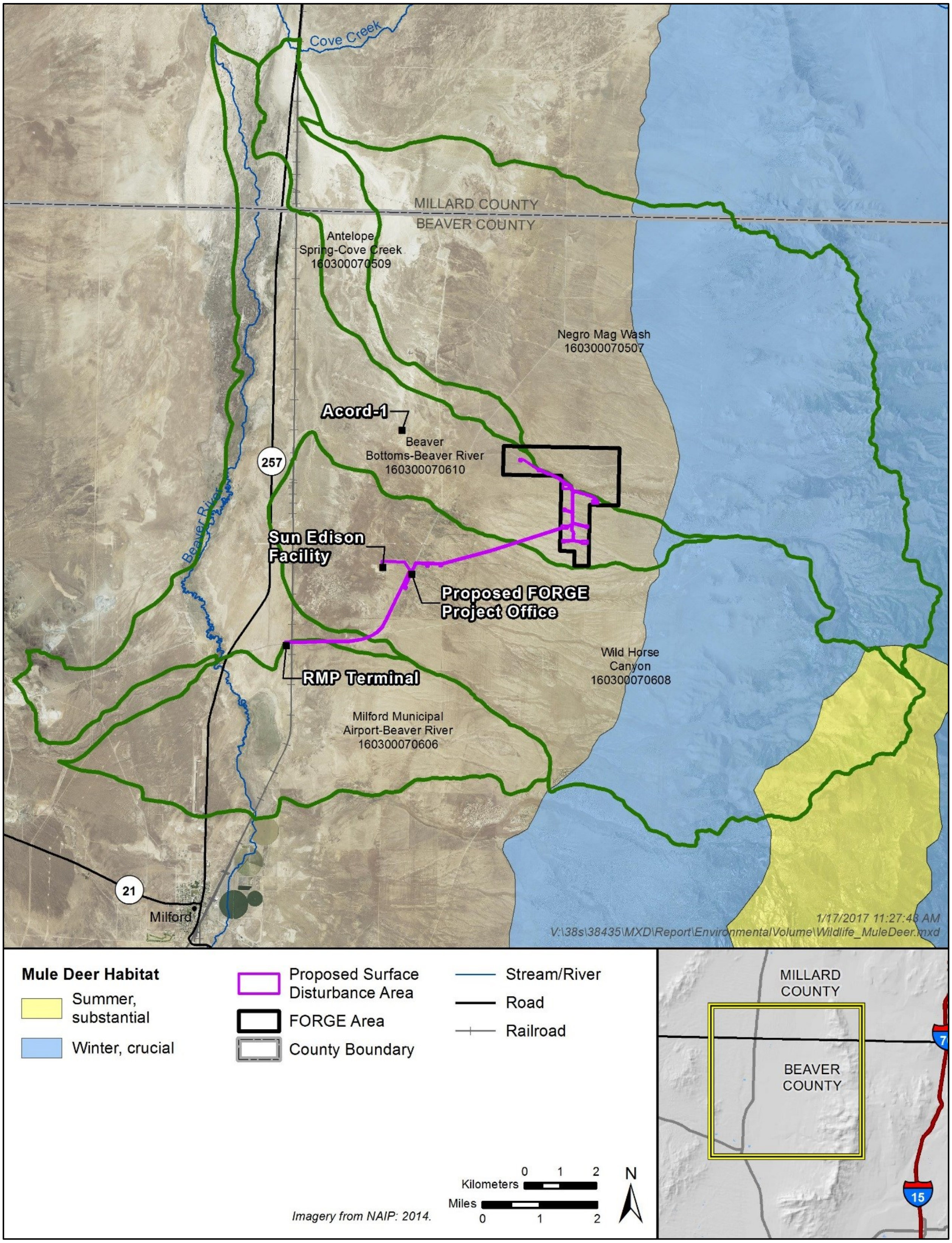

Figure 3-11. Mule deer habitat distribution in the analysis area.

Although there are six recognized subspecies of elk in North America, all of the elk in Utah are of the Rocky Mountain elk subspecies. On 27 of the 38 management units in Utah, elk populations were at or above population objectives in 2014 (UDWR 2015b). Elk are generalists and have a varied diet consisting of grasses, forbs, and shrubs. In Utah, elk live in a variety of habitat types including all of the state's mountains and some of the low deserts. They prefer to spend summers at high elevations in aspen conifer forests and winters in mid- to low-elevation habitats with mountain shrub and sagebrush communities. Elk are closely tied to aspen habitats in Utah, which provide both forage and cover during summer and calving locations in spring. Habitat quality is a major factor in determining elk herd size and is important for healthy and productive elk herds. Crucial elk habitat is being lost, fragmented, or changed in many parts of Utah because of human expansion, development, and fire suppression (UDWR 2015b). There is no Rocky Mountain elk habitat in the project area or FORGE area. However, there are 5,182.0 acres of designated substantial habitat for Rocky Mountain elk in the analysis area. Figure 3-12 depicts the distribution of Rocky Mountain elk habitat in the analysis area.

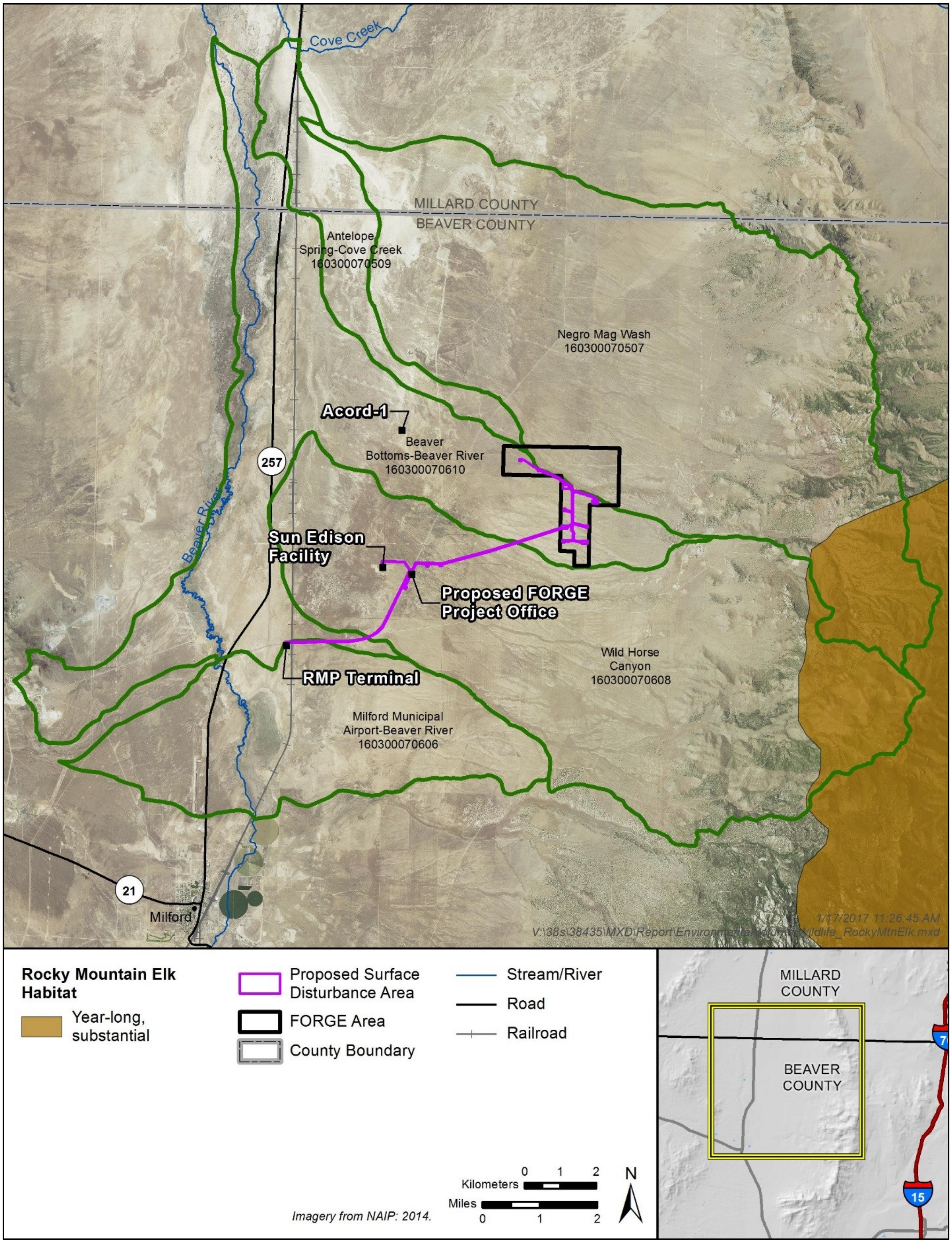

Figure 3-12. Rocky Mountain elk habitat distribution in the analysis area.

In the analysis area, there is also crucial habitat for blue grouse (*Dendragapus obscurus*); substantial habitat for band-tailed pigeon (*Patagioenas fasciata*), chukar partridge (*Alectoris chukar*), and ring-necked pheasant (*Phasianus colchicus*); and suitable habitat for wild turkey (*Meleagris gallopavo*). There is no designated habitat for game birds in the project area or FORGE area, although the FORGE area is adjacent to substantial habitat for the band-tailed pigeon (UDWR 2006, 2014b). Figure 3-13 depicts the distribution of game bird habitat in the analysis area.

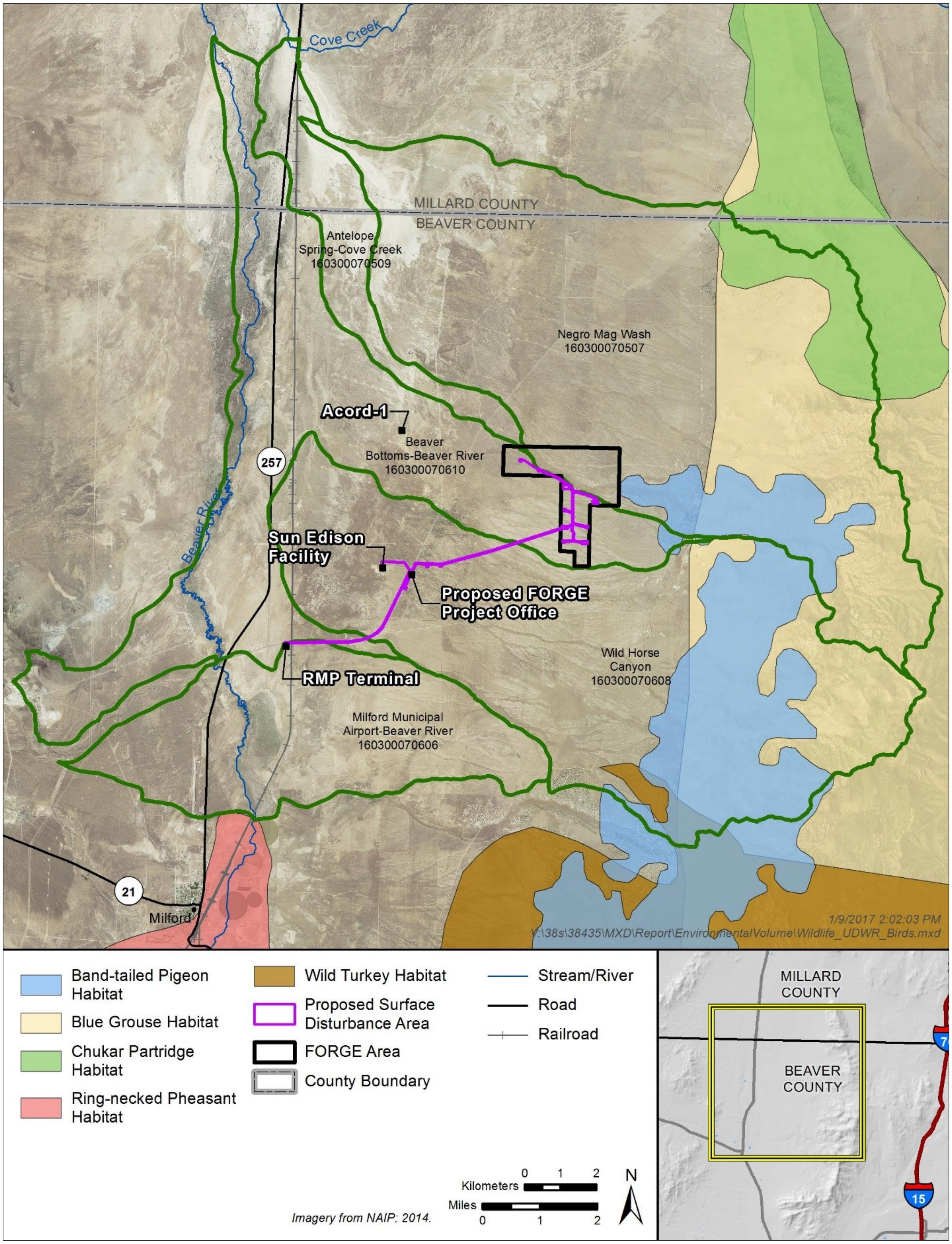

Figure 3-13. Game bird habitat distribution in the analysis area.

3.6.1.2.5. Special Status Wildlife Species

For the purpose of this EA, special-status wildlife species include federally listed endangered, threatened, and candidate species, and Utah state-listed sensitive species. Table 3-13 list special-status wildlife species for Beaver and Millard Counties and potential habitat for these species in the project area and analysis area. The presence of potential habitat for these species was determined by comparing individual species habitat requirements to the SWReGAP land cover types predicted to occur in the project area and analysis area. Quadrangle-level Utah Natural Heritage Program (UNHP) occurrences of Utah's federally and state-listed wildlife species were reviewed for the project and analysis areas. Records of occurrence are based on existing data in the UDWR's UNHP central database and should not be interpreted as a final statement regarding the occurrence of any species in or near the project or analysis areas.

Table 3-13. Potential Habitat for Special-Status Wildlife Species in Beaver and Millard Counties in the Project Area and Analysis Area

Species	Status	County	Potential Habitat Present	
			Analysis Area	Project Area
Birds				
American three-toed woodpecker (*Picoides dorsalis*)	State, SPC	Beaver and Millard	Y	N
American white pelican (*Pelecanus erythrorhynchos*)	State, SPC	Beaver and Millard	N	N
Bald eagle (*Haliaeetus leucocephalus*)	State, SPC	Beaver and Millard	Y	N
Bobolink (*Dolichonyx oryzivorus*)	State, SPC	Millard	N	N
Burrowing owl (*Athene cunicularia*)	State, SPC	Beaver and Millard	Y	Y
California condor (*Gymnogyps californianus*)	ESA, experimental population, nonessential	Beaver and Millard	N	N
Ferruginous hawk (*Buteo regalis*)	State, SPC	Beaver and Millard	Y	Y
Grasshopper sparrow (*Ammodramus savannarum*)	State, SPC	Millard	Y	Y
Greater sage-grouse (*Centrocercus urophasianus*)	State, SPC	Beaver and Millard	Y	N
Lewis's woodpecker (*Melanerpes lewis*)	State, SPC	Millard	Y	N
Long-billed curlew (*Numenius americanus*)	State, SPC	Beaver and Millard	Y	N
Northern goshawk (*Accipiter gentilis*)	State, CS	Beaver and Millard	Y	N
Short-eared owl (*Asio flammeus*)	State, SPC	Beaver and Millard	Y	Y
Yellow-billed cuckoo (*Coccyzus americanus*)	ESA-T	Beaver and Millard	N	N
Mammals				
Big free-tailed bat (*Nyctinomops macrotis*)	State, SPC	Beaver and Millard	Y	Y
Dark kangaroo mouse (*Microdipodops megacephalus*)	State, SPC	Beaver and Millard	Y	Y
Fringed myotis (*Myotis thysanodes*)	State, SPC	Beaver and Millard	Y	Y
Kit fox (*Vulpes macrotis*)	State, SPC	Beaver and Millard	Y	Y
Pygmy rabbit (*Brachylagus idahoensis*)	State, SPC	Beaver and Millard	Y	Y
Spotted bat (*Euderma maculatum*)	State, SPC	Beaver and Millard	Y	Y
Townsend's big-eared bat (*Corynorhinus townsendii*)	State, SPC	Beaver and Millard	Y	Y
Utah prairie-dog (*Cynomys parvidens*)	ESA-T	Beaver and Millard	N*	N*

Table 3-13. Potential Habitat for Special-Status Wildlife Species in Beaver and Millard Counties in the Project Area and Analysis Area

Species	Status	County	Potential Habitat Present	
			Analysis Area	Project Area
Fish				
Bonneville cutthroat trout (*Oncorhynchus clarkii utah*)	State, CS	Beaver and Millard	N	N
Least chub (*Lotichthys phlegethontis*)	State, CS	Beaver and Millard	N	N
Southern leatherside chub (*Lepidomeda aliciae*)	State, SPC	Beaver and Millard	N	N
Amphibians				
Columbia spotted frog (*Rana luteiventris*)	State, CS	Millard	Y	N
Western toad (*Bufo boreas*)	State, SPC	Beaver and Millard	Y	N
Mollusks				
Bifid duct pyrg (*Pyrgulopsis peculiaris*)	State, SPC	Millard	N	N
California floater (*Anodonta californiensis*)	State, SPC	Millard	N	N
Cloaked physa (*Physa megalochlamys*)	State, SPC	Millard	N	N
Hamlin Valley pyrg (*Pyrgulopsis hamlinensis*)	State, SPC	Beaver	N	N
Longitudinal gland pyrg (*Pyrgulopsis anguina*)	State, SPC	Millard	N	N
Sub-globose snake pyrg (*Pyrgulopsis saxatilis*)	State, SPC	Millard	N	N

Sources: (UDWR 2015c; USFWS 2016b)

* The analysis area is not located in a USFWS Utah prairie-dog recovery unit or within USFWS Utah prairie-dog buffers.

SPC: State wildlife species of concern

CS: Species receiving special management under a Conservation Agreement in order to preclude the need for federal listing.

ESA-T: Federally listed as threatened under the ESA

UDWR’s UNHP dataset for threatened, endangered, and sensitive species occurrences by quadrangle indicates that there are records of occurrence for burrowing owl, ferruginous hawk, kit fox, least chub, greater sage-grouse, Townsend’s big-eared bat, and long-billed curlew in the USGS 7.5-minute quadrangles intersected by the analysis area (Lime Mountain 1989, Read 1973, Pinnacle Pass 1973, Milford 1978, Ranch Canyon 1976, and Bearskin Mountain 1986), and occurrences for burrowing owl, ferruginous hawk, kit fox, least chub, long-billed curlew, and greater sage-grouse in the quadrangles intersected by the project area (Read 1973 and Ranch Canyon 1976) (UNHP 2015). USFWS determined that the project area is not located in a USFWS Utah prairie dog recovery unit or within USFWS Utah prairie dog buffers (USFWS 2016b).

Greater Sage-Grouse

According to UDWR geospatial data for Utah state sage-grouse management areas in Beaver and Millard Counties, there is opportunity area habitat for greater sage-grouse in the analysis area 2.3 miles south of the project area (UDWR 2014c). The Conservation Plan for Greater Sage-grouse in Utah defines opportunity areas as “those portions of a [sage-grouse management area] that currently do not contribute to the life cycle of sage-grouse but are areas where restoration or rehabilitation efforts can provide additional habitat when linked to existing sage-grouse populations” (UDWR 2013:9). There are no Utah state sage-grouse management areas or UDWR designated habitat for greater sage-grouse in the project area. Figure 3-14 depicts state sage-grouse management areas in the analysis area.

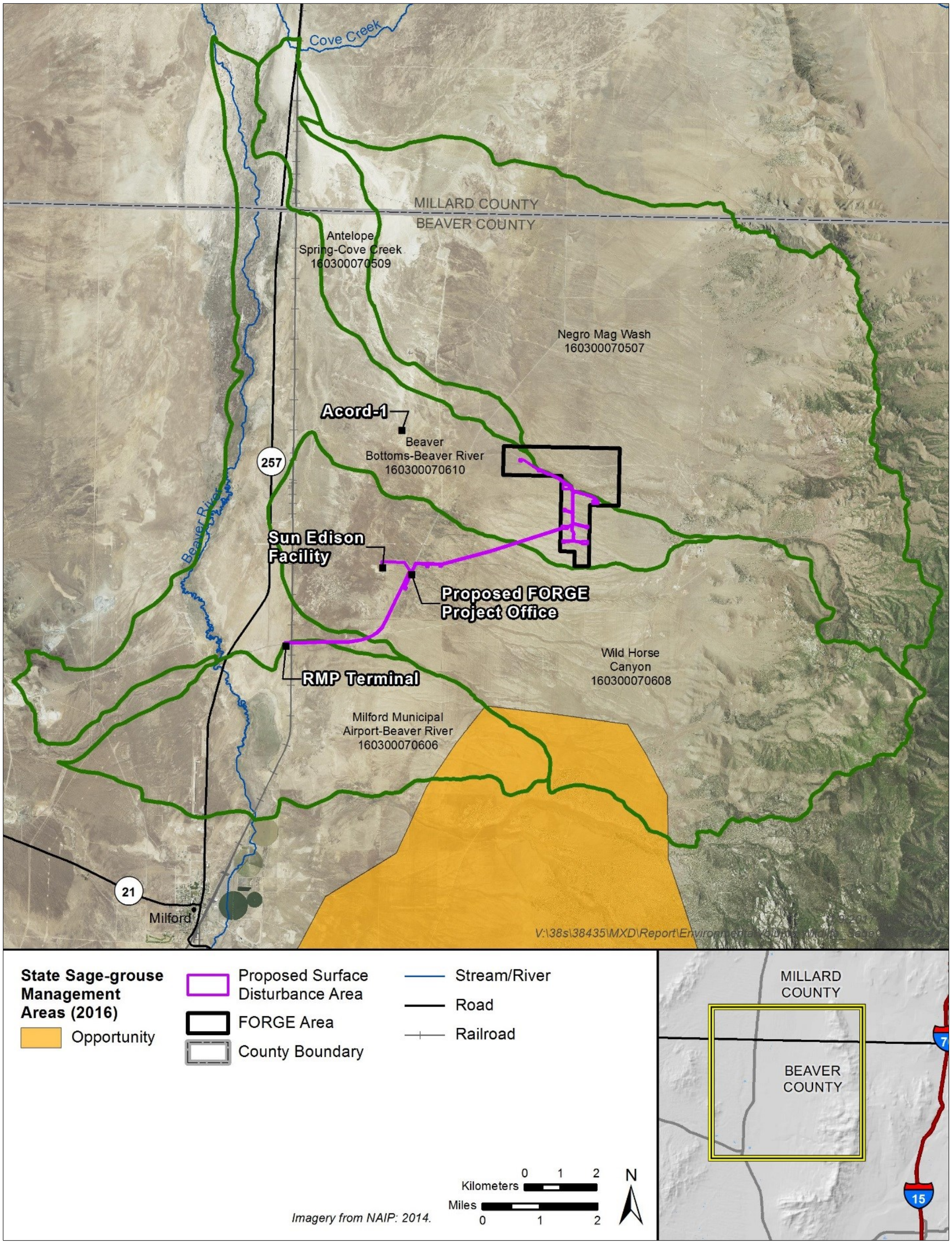

Figure 3-14. State sage-grouse management areas in the analysis area.

3.6.2. Environmental Consequences of the Proposed Project

3.6.2.1. VEGETATION

Impacts to vegetation were analyzed by reviewing acres of surface disturbance in specific SWReGAP land cover types, as well as the percentage of total acres affected, by land cover type, in the analysis area.

Surface disturbance would occur during geoscientific surveys, well drilling, access road improvement, construction of the office site, construction of the power and fiber optic lines, construction of the groundwater wellfields and associated water lines, installation of seismic monitoring drillholes, installation of survey monument stations, and installation of tiltmeter sites. Surface disturbance from construction activities would affect vegetation in the project area through direct removal. The land cover type that would experience the largest acreage of disturbance would be Inter-Mountain Basins Big Sagebrush Shrubland, because this is the most abundant land cover type in the project area and in the analysis area. Other land cover types that would experience disturbance from drilling and construction activities include Colorado Plateau Pinyon-Juniper Woodland, Great Basin Xeric Mixed Sagebrush Shrubland, Inter-Mountain Basins Greasewood Flat, Inter-Mountain Basins Mixed Salt Desert Scrub, Inter-Mountain Basins Semi-Desert Shrub Steppe, Invasive Annual and Biennial Forbland, Invasive Annual Grassland, and Invasive Perennial Grassland.

Indirect effects to vegetation could also occur from dust deposition from ground surfaces and equipment tailpipes as a result of vehicles driving on non-paved (dirt) roads and from construction activities. Dust deposition on leaves and other plant structures can cause plants to grow at slower rates and result in lower plant density over time. Leaf shaking by wind and leaching by rain can remove dust loads completely from plants at any time (Doley and Rossato 2010). Surface application of water to control fugitive dust would limit effects to vegetation. In addition, the gravelling of roads, well pads, and the office site would be used to minimize windblown dust from vehicle travel. The effects to vegetation from dust would be short term and temporary, and would be reduced after construction activities are completed.

The Proposed Project would result in a total of 124.9 acres of surface disturbance (or 0.14% of vegetation in the analysis area) using the G1 groundwater wellfield option and a total of 121.9 acres of surface disturbance (also 0.14% of vegetation in the analysis area) using the G2 groundwater wellfield option. Table 3-14 lists the acreages of vegetation by SWReGAP land cover type that the Proposed Project would affect through construction-related surface-disturbing activities.

Table 3-14. Acres of Land Cover Type Affected by Project Surface Disturbance

Land Cover Type	Disturbed Area (acres)	Percentage in Analysis Area
Colorado Plateau Pinyon-Juniper Woodland	12.9	0.1%
Great Basin Xeric Mixed Sagebrush Shrubland	8.0	0.5%
Inter-Mountain Basins Big Sagebrush Shrubland	58.2	0.2%
Inter-Mountain Basins Greasewood Flat	3.5	0.04%
Inter-Mountain Basins Mixed Salt Desert Scrub	16.1	0.2%
Inter-Mountain Basins Semi-Desert Shrub Steppe	14.7	0.1%
Invasive Annual and Biennial Forbland	0.3	0.1%
Invasive Annual Grassland	14.7	0.9%
Invasive Perennial Grassland	1.1	0.1%

Note: Surface disturbance caused by both groundwater wellfield options (G1 and G2) is included in the acreage calculations in this table. Acreage calculations in this table do not include 0.57 acre for 10 seismic monitoring drillholes or 0.39 acre for survey and tiltmeter sites, because their locations are unknown at this time.

3.6.2.2. SPECIAL STATUS PLANT SPECIES

All three of the special-status plant species listed as candidates in Beaver County and one species listed in Millard County were identified as having no potential to occur in the project area. Therefore, there would be no impacts to special-status plant species related to the Proposed Project.

3.6.2.3. NOXIOUS WEEDS

Construction and drilling activities could spread existing noxious weed populations in areas adjacent to the access routes by seed transport in fill materials and on vehicles. Vehicles traveling on roads, both paved and non-paved, are conduits for seed dispersal. In addition, noxious weeds often prefer disturbed sites such as areas cleared for facilities construction (Hobbs and Huenneke 1992). If noxious weeds are introduced or spread, they can invade and outcompete existing vegetation. During the life of the project and until the site is decommissioned and reclaimed, well pads and access roads would be monitored for noxious weeds. If found, the authorized state or federal agent would be notified, and the weeds would be treated following a program approved by the authorized state or federal agency to eliminate further spreading. Treatment would continue until the weeds have been eradicated. In addition, all equipment used for construction and drilling would be power washed before arrival in the FORGE area to remove any invasive, non-native weed seeds.

3.6.2.4. WETLANDS AND OTHER SENSITIVE AREAS

Geothermal exploration, development, and operation activities could affect wetlands and an intermittent stream in the project area through ground disturbance. Ground disturbance could remove portions of the wetland or cause disruption to surface water flow or surface contours, which could affect water levels and drainage patterns, increase sedimentation, and remove or damage vegetation that is part of the local functioning unit. Geothermal development could also impact these areas through a release of geothermal fluids or other pollutants. In addition, changes to groundwater caused by geothermal development could impact surface waters that are key parts of wetlands zones, if there is connectivity. Impacts to wetlands would be minimized through the application of best management practices (e.g., limiting ground disturbance, preventing the release of fluid or pollutants to the surrounding environment).

3.6.2.5. RECLAMATION

After 5 years of testing, the site would be decommissioned, and the well pad and any associated new access roads would be restored in conformance with landowner and permit agency requirements. All associated infrastructure such as the project office, tanks, and pipelines would be removed, and constructed roads would be re-vegetated if required by the landowner. Reclamation typically includes re-grading the affected surfaces to approximate pre-project contours, removing applied gravel, spreading topsoil removed during construction of well pads, and re-vegetating with native seed mixtures or other plants preferred by the landowners.

3.6.2.6. WILDLIFE

Impacts to wildlife were analyzed by reviewing the potential for loss and degradation of habitat, the potential for effects from human activity and noise, and the potential for effects on species' population health and viability.

Surface disturbance would occur during geoscientific surveys, well drilling, access road improvement, construction of the office site, construction of the power and fiber optic lines, construction of the groundwater wellfields and associated water lines, installation of seismic monitoring drillholes, installation of survey monument stations, and installation of tiltmeter sites. The impact of geothermal development on wildlife depends on the type and amount of wildlife and wildlife habitat at the site, as well as the amount of area that would be disturbed and the nature and location of the disturbance. According to the Geothermal Programmatic EIS (BLM and U.S. Forest Service 2008: Section 4.10.3), common impacts on wildlife resources from the four phases of geothermal development consist of the following:

- Exploration: The primary impacts from exploration activities would be habitat removal; the potential for direct injury and mortality from vehicles; noise; and the introduction of invasive species. These impacts are usually short term, with the exception of the introduction of invasive species.
- Drilling: Clearing and grading activities could result in direct injury or death of individuals not mobile enough to avoid construction operations, of wildlife that use burrows, or of wildlife that are defending nest sites. Individuals that move into adjacent habitats may experience increased competition for resources. Sump pits could present toxicity or entrapment hazards to wildlife.
- Utilization: Construction of a geothermal project and its associated facilities could impact wildlife through long-term loss, reduction, alteration, and fragmentation of habitat. Wildlife and wildlife habitat adjacent to disturbed areas could also be affected. Other impacts could include a reduction in habitat quality from the establishment of invasive species and noise; disturbance from regular grass mowing and brush cutting; increased potential for fires; and the prevention or disruption of the movements of terrestrial wildlife, particularly during migration.
- Reclamation and abandonment: Vehicle traffic and structure removal would cause noise and may damage wildlife habitat. There could be an increased potential for runoff and erosion during land disturbance as buildings and associated structures are removed. Reclamation of native vegetation would provide habitat for wildlife.

3.6.2.6.1. General Wildlife

Impacts to general wildlife species in the analysis area would consist of 121.9 to 124.9 acres of habitat loss (0.14% of the analysis area) depending on the groundwater wellfield option chosen. Surface disturbance could result in the direct loss of habitat elements such as groundcover and trees, which could cause a decrease in available forage and cover for certain species (e.g., birds) and an increase in predation on small mammal species. Effects on wildlife from human activity and noise during construction would consist of auditory and visual disturbances to individual wildlife present in the FORGE area, which could cause stress to individual animals (noise from drill rigs and construction activities can disturb wildlife in adjacent habitats up to 2,500 feet away [BLM and U.S. Forest Service 2008]). Some individuals would likely leave the immediate area, resulting in a temporary spatial redistribution of individuals or habitat-use patterns. Construction activity and noise would be direct impacts that would disappear at the completion of the project. However, some human activity and noise associated with the FORGE project operations would be present consistently for 5 years following construction. Vehicle use, including the 3-D seismic reflection survey, associated with the project would result in an increased risk of vehicle-animal collisions on project access roads and could cause stress, injury, or mortality to individual animals. Prudent speed limits would be observed to protect wildlife and reduce the risk of vehicle-animal collisions.

Geothermal well drilling would include the construction of reserve pits at each pad to contain drilling fluids. Reserve pits would present trapping hazards to wildlife. Big game and larger animals would be protected through the fencing of each reserve pit.

General wildlife species' population viability (rabbit, skunk, etc.) is unlikely to be affected because of the relatively small percentage of surface disturbance in the analysis area (0.14%) and the ability of individuals to move into adjacent habitat as needed to avoid the disturbance.

3.6.2.6.2. Migratory Birds

Impacts on migratory birds could include a loss of habitat in the project area from surface disturbance and vegetation removal. Habitat loss would be limited because of the small amount of project disturbance (121.9–124.9 acres, or 0.14% of the analysis area). Impacts could also include the displacement of individual birds, the abandonment of nests during breeding seasons because of human activity and noise, a temporary relocation of prey from the project area because of human activity and noise, and potential mortality from vehicular collisions. Human activity and noise would be short term during construction activities, occurring sporadically, but would continue to occur until the completion of Phase 3 of the project (a total of five years). Similar habitat for displaced prey or individual birds would be available in adjacent areas.

One burrowing owl nest is located in the project area. If construction occurs during the raptor nesting season, nests would be first checked for signs of nesting activity. If any nests are occupied, appropriate seasonal and spatial protection buffers would be applied. If construction occurs during the bird breeding season, bird nest clearance surveys would be completed. Therefore, the potential for effects on individuals and on overall species' population health and viability would be minimal because pre-construction surveys for migratory birds would indicate their presence. In addition, the reseeding of disturbed areas with native seed would minimize some long-term migratory bird impacts by restoring vegetation.

3.6.2.6.3. Game Species

Impacts to game species and black bear would be the same as those described for general wildlife above, along with the more specific impacts discussed in the following paragraph. All surface disturbances would occur in year-long, crucial habitat for pronghorn. Project activities would create 121.9 to 124.9 acres of disturbance in the 86,344-acre analysis area for pronghorn; approximately 0.18%–0.19% of the total year-long crucial pronghorn habitat in the analysis area would be permanently removed. The small quantity of disturbance in crucial pronghorn habitat when compared with the total amount of crucial habitat available for this species in the analysis area (66,687.6 acres) would not likely affect the overall health of the habitat.

No surface disturbances would occur in designated habitat for mule deer, Rocky Mountain elk, or black bear, or in game bird habitat in the analysis area. Project development could impede movement of game species and create habitat fragmentation. Human activity and noise would cause some individual game species to move farther away in the analysis area, resulting in a temporary spatial redistribution of individuals or habitat-use patterns. Added stress could occur from physiological excitement as a result of the noise and human activity and could result in a change in food intake due to disruptions and extra exertion to escape disruptions. Added stress could also result in the depletion of energy stores in individual animals at the expense of growth and reproduction, and could limit an animal's ability to respond to adverse conditions such as bad weather or hunting. In addition, overall habitat changes could cause individuals to select suboptimal habitat. However, impacts to mule deer, Rocky Mountain elk, black bear, and game birds would be less than impacts to pronghorn because these game species have no habitat in the FORGE area or project area. Project development is not likely to lead to declines in game species population numbers or carrying capacities.

3.6.2.6.4. Special-Status Species

Impacts to special-status species would be the same as those described for common wildlife above, along with the more specific impacts discussed in the following paragraph.

Aside from burrowing owl, none of the species listed in Table 3-13 have a high potential to occur in the project area. Potential habitat for federally listed species (California condor, Utah prairie-dog, and yellow-billed cuckoo) does not occur in the project area, FORGE area, or analysis area. There is potential habitat for 11 special-status species in the project area: burrowing owl, ferruginous hawk, grasshopper sparrow, short-eared owl, dark kangaroo mouse, kit fox, pygmy rabbit, big free-tailed bat, fringed myotis, spotted bat, and Townsend's big-eared bat. There is potential habitat for 19 special-status species in the analysis area: American three-toed woodpecker, bald eagle (winter only), burrowing owl, ferruginous hawk, grasshopper sparrow, greater sage-grouse, Lewis's woodpecker, long-billed curlew, northern goshawk, short-eared owl (primarily winter), dark kangaroo mouse, kit fox, pygmy rabbit, big free-tailed bat, fringed myotis, spotted bat, Townsend's big-eared bat, Columbia spotted frog, and western toad.

There are 2,924 acres of UDWR-designated opportunity area habitat for greater sage-grouse in the Bald Hills Sage-Grouse Management Area, located 2.3 miles south of the project area. Because of the high mobility of greater sage-grouse, the project area would likely only be used by the species while it is in transit between higher quality habitat patches. In addition, the project area is not inside a State of Utah sage-grouse management area (areas that encompass greater than 90% of the Utah aggregate population).

Pre-construction surveys for migratory birds and raptor nests would limit impacts to special-status species that are migratory birds (bald eagle, burrowing owl, ferruginous hawk, grasshopper sparrow, Lewis's woodpecker, long-billed curlew, and short-eared owl). Based on the moderate (rather than high) occurrence potential and pre-construction surveys for migratory birds and raptor nests, project impacts to the 11 special-status species would not affect the overall population health or viability of any species.

Surface disturbance from construction and drilling activities would result in a loss of some potential habitat for the 11 special-status species with potential habitat in the project area. Acres of land cover types and percentages of the analysis area that would be impacted are presented in Table 3-14 and include both the G1 and G2 groundwater wellfield options. Surface disturbance would impact nine different land cover types in the project area. Based on the less than 1% land cover loss for each land cover type, impacts to the 11 special-status species would not affect the overall population health or viability of any species.

3.6.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location and the FORGE area would remain undeveloped; therefore, no new impacts to vegetation or wildlife resources would occur. Ongoing activities in the analysis area or new projects in the FORGE area could cause impacts to vegetation or wildlife resources.

3.7. Socioeconomic Conditions

The analysis area for impacts on socioeconomic conditions is Beaver County, Utah. Analysis at the county level for this project is appropriate because the communities that are closest to the FORGE area and that have the population, facilities, and services to meet the needs of the project are located in Beaver County. Therefore, most of the project's impacts on employment, population, and other socioeconomic factors would occur in Beaver County. Additionally, socioeconomic data are typically collected by government agencies, including the U.S. Census Bureau, at the county level.

3.7.1. Affected Environment

3.7.1.1. POPULATION AND DEMOGRAPHICS

Beaver County is classified as a rural county by the U.S. Census Bureau. From 1970 to 2015, the population of the county expanded from 3,798 to 6,354 people (Figure 3-15; Economic Profile System [EPS] 2016a). Between 2000 and 2014, the population changed from 6,005 to 6,514, representing an increase of approximately 8.5%. During this same period, the population of the United States increased approximately 11.6% (EPS 2016b). The three closest cities to the project area are all within Beaver County. These include Beaver City (approximately 40 miles from the project area, 2010 population 3,112), Minersville Town (approximately 23 miles from the project area, 2010 population 907), and Milford City (approximately 9 miles from the project area, 2010 population 1,409) (U.S. Census Bureau 2010a, 2010b, 2010c).

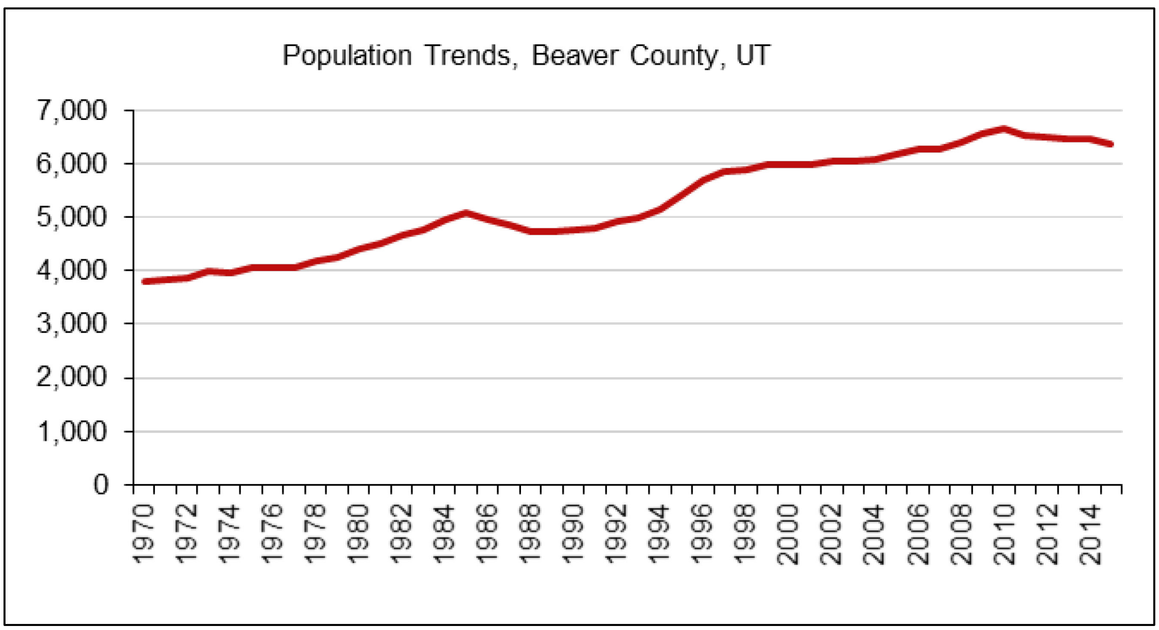

Figure 3-15. Population trends in Beaver County from 1970 to 2014 (EPS 2016a).

Between 2000 and 2015, population change in Beaver County was driven by annual births exceeding deaths. The county experiences a net out-migration (i.e., more people move out of the county than into it on an annual basis) (EPS 2016a). Figure 3-16 illustrates the average annual components of population change for the county between 2000 and 2015.

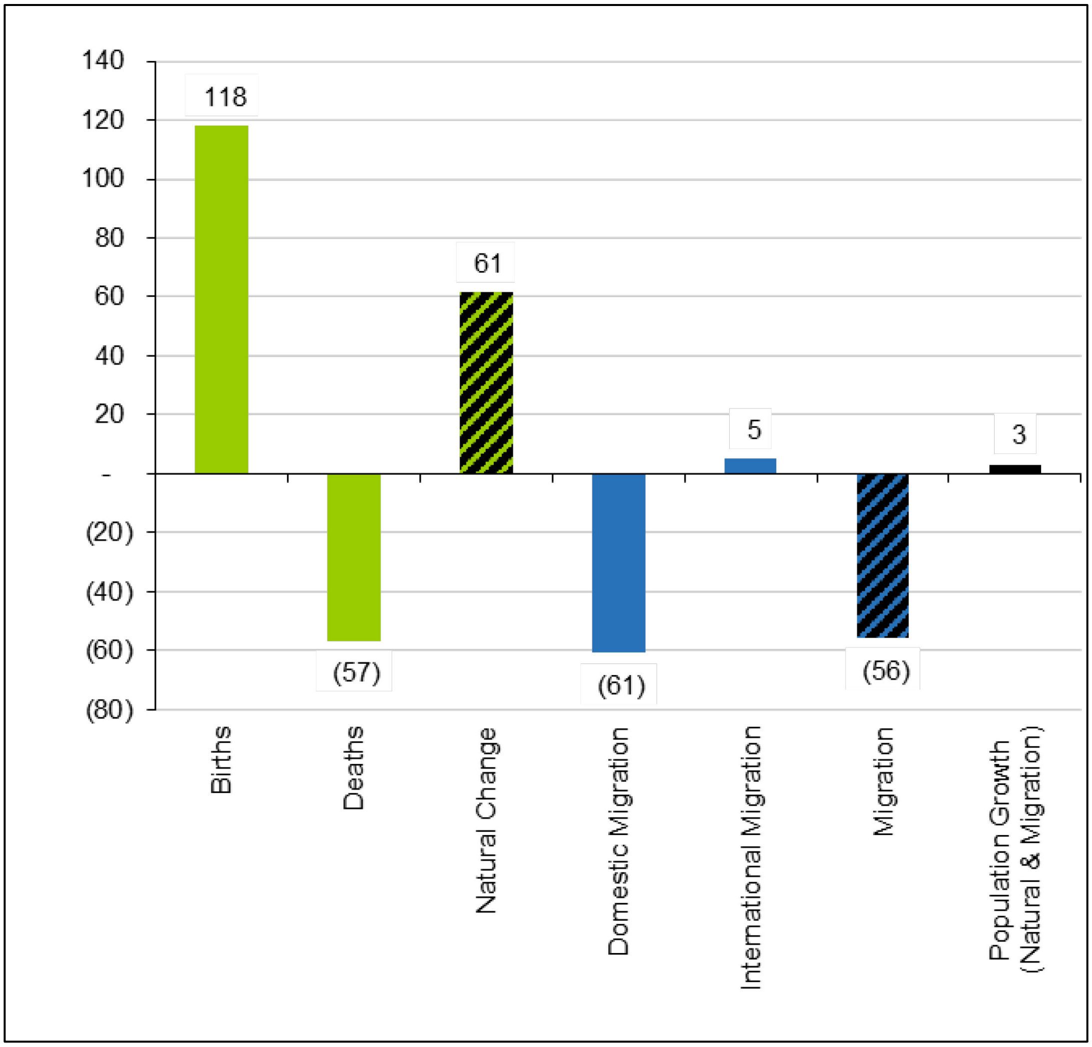

Figure 3-16. Average annual components of population change in Beaver County, Utah, from 2000 to 2015 (EPS 2016a).

3.7.1.2. HOUSING, COMMUNITY FACILITIES, AND SERVICES

There are 2,908 permanent housing units in Beaver County, Utah. Of these units, 2,265 (77.9%) are occupied and 643 (22.1%) are unoccupied. Of the unoccupied units, 74 (2.5%) are for rent; 57 (2.0%) are for sale; and 327 (11.2%) are for seasonal, recreational, or occasional use (U.S. Census Bureau 2010d). There are 480 hotel and motel rooms in Beaver County (BLM 2008). There are approximately 80 hotel rooms available in Milford (Hudson Inn and Oak Tree Inn 2017), with the remaining rooms largely concentrated in Beaver City. There are also recreational vehicle parks in Beaver City and Minersville. The Beaver County Sheriff's Office, located in Beaver City, is responsible for law enforcement, maintaining the county jail, animal control, and search and rescue services. Rural community hospitals are located in both Beaver City and Milford City. There are five public schools in Beaver County, located in Beaver City, Milford City, and Minersville. The county also provides waste management services and operates three community parks in the area.

3.7.1.3. EMPLOYMENT AND ECONOMIC CONDITIONS

From 1970 to 2015, employment in Beaver County grew from 1,711 to 4,047 jobs (Figure 3-17; EPS 2016a). In 2015, the annual unemployment rate in Beaver County was 3.7%, whereas the annual unemployment rate in the United States was 5.3% (EPS 2016c). The average earnings per job in Beaver County was $39,670 ($58,228 in the United States), and the per capita income $34,983 ($48,112 in the United States) (EPS 2016c).

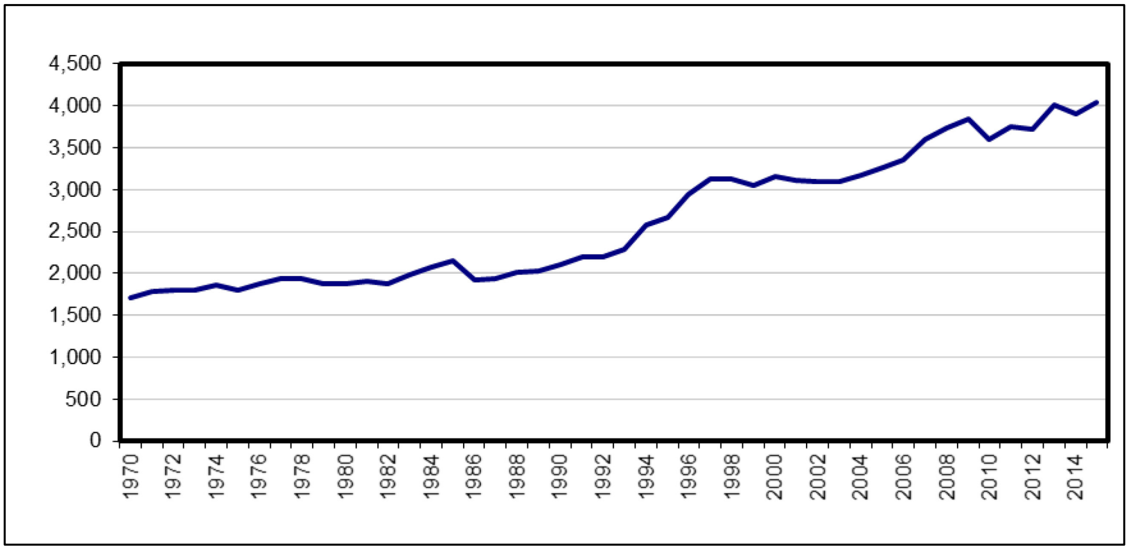

Figure 3-17. Employment trends in Beaver County, Utah, from 1970 to 2014 (EPS 2016a).

Table 3-15 presents an employment breakdown by industry in Beaver County in 2015 (EPS 2016a). In comparison to the employment breakdown by industry for the United States, Beaver County has significantly less employment in services-related industries (72.5% in the United States compared to 38.5% in Beaver County), more employment in government (12.7% in the United States compared to 18.8% in Beaver County), more employment in the mining industry (0.3% in the United States compared to 2.9% in Beaver County), and more employment in agriculture (1.4% in the United States compared to 14.9% in Beaver County) (EPS 2016c).

Table 3-15. Employment Breakdown by Industry in Beaver County in 2015

Industry	Jobs (number)	Total Jobs (%)
Non-Services Related	1,043	25.8%
Farm	602	14.9%
Forestry, fishing, and agriculture services	–	–
Mining (including fossil fuels)	118	2.9%
Construction	159	3.9%
Manufacturing	164	4.1%

Table 3-15. Employment Breakdown by Industry in Beaver County in 2015

Industry	Jobs (number)	Total Jobs (%)
Services Related	1,559	38.5%
Utilities	57	1.4%
Wholesale trade	37	0.9%
Retail trade	457	11.3%
Transportation and warehousing	210	5.2%
Information	12	0.3%
Finance and insurance	134	3.3%
Real estate and rental and leasing	167	4.1%
Professional and technical services	55	1.4%
Management of companies and enterprises	5	0.1%
Administrative and waste services	89	2.2%
Educational services	20	0.5%
Health care and social assistance	107	2.6%
Arts, entertainment, and recreation	–	–
Accommodation and food services	–	–
Other services, except public administration	209	5.2%
Government	762	18.8%
Total	**4,047**	**100.0%**

Source: EPS (2016a).

Excluding the public sector, Circle Four Farms is the largest employer in Beaver County (BLM 2008a). An important source of new construction and utility jobs in Beaver County in recent years has been the construction and operation of the Milford Wind Farm. The Milford Wind Farm is Utah's largest wind energy project with a total capacity of 306 megawatts. The project was developed in two phases. The first phase was completed in November 2009 and supported more than 225 development and construction jobs (BLM 2008a). The second phase was completed in May 2011 (First Wind [now SunEdison] 2014).

3.7.1.4. TAXES

Counties and communities rely on revenues from property taxes, sales and use taxes, and other miscellaneous taxes to fund essential services.

Property taxes levied at the county level include taxes on residential, commercial, and industrial property; agricultural land and buildings; mobile homes; motor vehicles; and other personal property (Utah State Tax Commission 2015). A statewide tax is levied to finance schools through the Uniform School Fund. Property assessed by the state includes utilities (airlines, other transportation, power, telephone, and pipeline and gas utilities) and natural resources (oil and gas extraction, metal mines, coal mines, sand and gravel, and non-metal mines). The largest state-assessed company in Beaver County is SunEdison (the Milford Wind Farm) (Utah State Tax Commission 2015). A large share of the tax revenues for Beaver County is derived from utilities, with small contributions from personal property and natural resources (Table 3-16). SunEdison accounts for more than 75% of the utility tax revenue in the county (Utah State Tax Commission 2015).

Table 3-16. Summary of Property Taxes Charged Against Each Class of Property in Beaver County in 2015

Property Class	Amount ($)
Real property	$3,758,273
Personal property	$708,655
Utilities	$6,075,354
Natural resources	$739,687
Total	**$11,281,969**

Source: Utah State Tax Commission (2015)

The Utah sales tax applies to retail sales of meals, admissions to places of amusement, intrastate communication and passenger services, gas and heat utility services, commercial electric, hotel and motel accommodations, and certain other services. The Utah use tax is imposed on taxable transactions involving tangible personal property purchased outside Utah that the purchaser stores, uses, or consumes within the state.

Beaver County imposes an option sales and use tax and a restaurant tax on all prepared foods and beverages sold for immediate consumption. Beaver County also imposes a rural hospital tax to support public hospitals and clinics. In addition to the sales tax charged on accommodations in hotels, motels, inns, and campgrounds, Beaver County imposes a transient room tax, as does Milford City.

3.7.2. Environmental Consequences of the Proposed Project

Socioeconomic effects of the project can be attributed primarily to changes in the local economy related to the construction and operation of the FORGE project. Economic activity attributable to the project includes an increase in local employment; purchase of materials and services from local sources; and expenditures in the local economy by non-local workers for items such as accommodations, food, and recreation. Project-related effects associated with the construction and decommissioning of the project would be relatively short lived, whereas those associated with operations would last longer. Because the project would be completed and decommissioned after 5 years, long term lasting impacts on the local economy are not anticipated.

Project-specific estimates of the number of workers who would be required to temporarily relocate to the area for the construction and operation of the FORGE project are not available. As described in section 2.3.2, well drilling operations would be conducted by a crew of nine to 15 workers. Based on a review of similar construction and geothermal development projects, it is assumed that up to 30 workers during the peak activity month would be required and that an average of five workers would be required during the operation of the project.

3.7.2.1. POPULATION AND DEMOGRAPHICS

To the degree that the local labor force cannot provide suitably skilled workers to fill the demand of the project, workers would enter the area from elsewhere. Assuming that up to 30 workers would relocate to the FORGE area during the peak activity month, this could result in an approximately 0.5% increase of total residents in Beaver County.

3.7.2.2. HOUSING, COMMUNITY FACILITIES, AND SERVICES

When a local area is unable to provide adequate numbers of workers with the requisite skills for construction and other projects similar to the FORGE project, it is common practice for workers from other locations to temporarily relocate to communities close to a project site. This is especially the case for projects of relatively short duration, and for projects in rural areas with relatively small labor and employment pools.

Because the duration of the construction and well drilling activities is relatively short (approximately 1 year), it is likely that most non-local workers would reside in temporary housing, including project-specific man camps or hotels, motels, recreational vehicles, campers and to a lesser extent, rental housing units such as apartments and single-family homes within commuting distance of the FORGE area. As described in section 2.3.2, well drilling would be conducted 24 hours per day, 7 days per week, by a crew of nine to 15 workers. A temporary man camp would be located at the pad to accommodate workers. Researchers, visitors, and other skilled construction staff would stay in Milford or other adjacent communities. It is assumed that these workers would not be accompanied by family members.

The duration of operation for the FORGE project is estimated to be 5 years. It is anticipated that the local labor force cannot provide suitably skilled workers for the specialized tasks associated with operating the project. Because the duration of the operation phase of the project is limited and the number of similar jobs for skilled workers in Beaver County is relatively low, it is likely that most workers would not relocate to the area permanently. Therefore, non-local workers would need to either relocate to the area or reside in man camps or hotels, motels, recreational vehicles, campers, and to a lesser extent, rental housing units such as apartments and single-family homes within commuting distance of the FORGE area. It is assumed that these workers would not be accompanied by family members.

Non-local workers would temporally reside in communities close to the FORGE area or at a man camp located at the project site. Assuming a one-way commute time of approximately 1 hour, the communities with hotels, motels, and campgrounds that could accommodate these non-local workers are Milford, Minersville, and Beaver. There are approximately 480 hotel or motel rooms in Beaver County (BLM 2008a), including 80 hotel rooms available in Milford (Hudson Inn and Oak Tree Inn 2017). Because Milford is substantially closer to the FORGE area than Beaver, it is assumed that that community would be preferentially selected by temporary workers. The availability of temporary housing and hotel rooms in Milford and Beaver County should exceed the demand created by the project.

In the absence of sizeable increases in the number of residents as a result of project construction, impacts to community facilities and services are not expected.

3.7.2.3. EMPLOYMENT AND ECONOMIC CONDITIONS

Assuming that up to 30 workers would relocate to the FORGE area during the peak activity month, the project could result in a temporary increase of approximately 0.7% of the total jobs and 18.9% of the total construction jobs in Beaver County.

Many of the well drilling and operation tasks require skilled workers with specialized expertise, and many of these skilled workers would not be available locally. Therefore, a large proportion of the workers for tasks such as well drilling, power line construction, and geothermal facility operation would likely temporarily relocate from areas outside Beaver County. Workers for standard construction activities (e.g., road building, pad leveling, concrete production, and project office construction) would likely be available in the local communities. Wages for skilled workers with specialized expertise are typically higher than those of standard construction wages. Therefore, it is anticipated that a larger proportion of direct employment wages would go to workers from outside Beaver County.

Employment and wages in addition to that directly associated with construction and operation activities can be anticipated in the region as a result of project implementation. This "secondary" employment is related to additional employment in local businesses providing 1) materials, goods, and services necessary for project implementation; 2) accommodations, meals, and recreation opportunities for temporary residents; and 3) other items for personal consumption by resident workers.

Providing additional materials, e.g., concrete and aggregate, could require local suppliers to add jobs during the construction period. Likewise, providing for food and lodging and other goods and services for temporary and permanent workers during the construction period could also increase employment in local businesses.

Collectively, the stimulus attributable to project-related procurements and personal consumption expenditures by local and non-local construction workers would have a beneficial impact on the local economy. In the short term during construction, the economic stimulus could reduce unemployment, increase income and earnings, and increase revenues accruing to the state and local jurisdictions from sales, use, and other taxes.

3.7.2.4. TAXES

Property taxes are based on 100% of the FMV of the property and would, in most cases, be computed by the county assessor. There are three general approaches for determining FMV: cost approach, sales comparison approach, and income approach. The Proposed Project is currently in the preliminary environmental review stage and is not anticipated to generate revenue; therefore, an income approach is not possible. Additionally, the number of similar developments available for comparison purposes is very limited. It is most likely that the state would use the "cost approach," which relies on cost projections available in advance of actual construction and operation of the facility. It is not possible at this time to forecast the estimated FMV of the facilities. Based on the size of the project in comparison to other local facilities (e.g., Milford Wind Farm), it is anticipated that the construction and operation of the project would make a minor but beneficial contribution to the tax base of Beaver County.

Sales tax is normally collected on all retail sales made within the state. Products purchased outside the state for final consumption within the state are subject to use taxes at rates equivalent to the sales tax in the jurisdiction where the product is consumed. Temporary resident workers would require local services such as accommodations, recreation, and entertainment and would purchase items such as meals and gasoline locally. Such services and commodities would generate sales tax revenues. It is not possible to forecast tax revenues likely to accrue to specific counties and municipalities because the exact location of projected temporary residents is not known. However, it is anticipated that the construction and operation of the project would make a minor but beneficial contribution to the sales tax revenue in Beaver County.

3.7.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped; therefore, no new impacts to socioeconomic conditions would occur. Minor, beneficial contributions to sales tax revenue and the tax base of Beaver County would not be realized.

3.8. Historic and Cultural Resources

Cultural resources are defined as the physical evidence or location of past human activity, such as a site, an object, a landscape, or a structure. Archaeological sites and historic built environments (such as buildings) are two of the most common types of cultural resources. Archaeological resources can be either prehistoric or historic in age (i.e., dating to either before or after Euro-American settlement), and they can include artifacts (portable objects of human manufacture); features such as fire pits, houses, or other types of structures; rock art; and archaeological sites where any of the above may be found. Cultural resources can also include places that are important to the heritage of contemporary peoples (e.g., traditional cultural properties).

Cultural resources are protected primarily through the NHPA of 1966 and the regulations implementing Section 106 of that act (36 CFR 800), the Archaeological and Historic Preservation Act of 1974, and the Archaeological Resources Protection Act of 1979. Section 106 of the NHPA requires federal agencies to consider the effects of their actions on cultural resources that are listed on or eligible for the NRHP. Such cultural resources are known as "historic properties." Criteria for NRHP eligibility are provided in 36 CFR 60.4, and Section 101(d)(6)(A) of the NHPA states that properties of traditional religious and cultural importance to a tribe may be determined to be eligible for the NRHP.

The federal and state management agencies for the lands in the FORGE area—the BLM and SITLA, respectively—have determined that the project may affect cultural resources. A cultural resources inventory was conducted in November 2016 on 585.5 acres of the FORGE area (SWCA Environmental Consultants [SWCA] 2017a). An addendum to the inventory was conducted in July 2017 (SWCA 2017b). The addendum included a cultural resources inventory of an additional 177.0 acres of the FORGE area (the proposed transmission line from the office site to the Rocky Mountain Power terminus, the proposed fiber optic line from the office site to the Sun Edison Facility, and the Acord-1 well site). The inventory and addendum provide the data used to discuss both the affected environment and the analysis of potential environmental impacts to cultural resources in the FORGE area.

3.8.1. Affected Environment

3.8.1.1. INVENTORY

SWCA conducted an intensive-level Class III inventory in 2016 of most of the FORGE area, specifically in areas located outside of any previously surveyed areas (Figure 3-18) (SWCA 2017a). There was a small portion of the project area that had been previously surveyed within the last 10 years, and the BLM did not require this area to be re-surveyed. The Class III inventory resulted in the assessment of 16 sites. Twelve previously recorded sites (42BE52, 42BE88, 42BE236, 42BE238, 42BE248, 42BE270, 42BE1400, 42BE1411, 42BE1414, 42BE2198, 42BE3276, and 42BE3885) were revisited, and updated documentation of these sites was prepared. Four newly identified sites (42BE4620, 42BE4621, 42BE4622, and 42BE4623) were also documented. The agency review of the report on this inventory is pending, but the results of the inventory are discussed here.

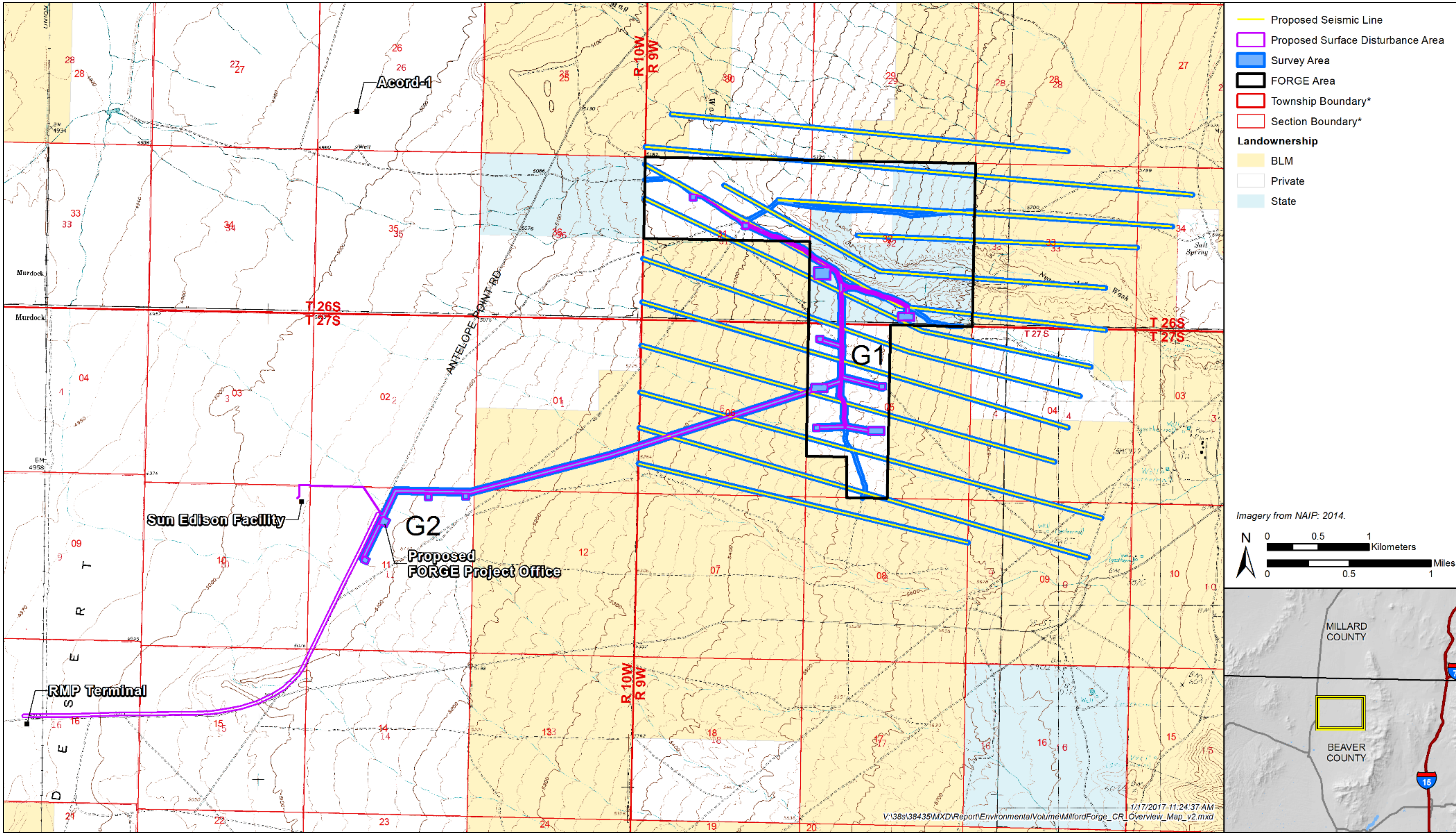

Figure 3-18. Class III inventory survey area.

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Before the field survey, a file search was conducted to identify any previously recorded cultural resources projects and previously documented archaeological sites and buildings within 1.0 mile of the Class III survey area. The file search results indicated that 46 cultural resources projects and 264 previously documented archaeological sites (SWCA 2017a) were located within 1.0 mile of the survey area. Nineteen of these previous projects and 12 previously recorded sites intersected the survey area (SWCA 2017a). The goals of these previous project inventories were to locate, record, and evaluate all cultural resources within the respective inventory areas and identify those cultural resources that are eligible for the NRHP (i.e., historic properties).

General Land Office (GLO) plat maps and several geographic information systems (GIS) layers were also examined for potential cultural resources that may be present in or near the Class III survey area. These layers include NRHP properties, Utah historic trails, Utah historic districts, Utah mining districts, historical topographic maps, and other historical aerial imagery. Results of the literature review are described in the inventory report (SWCA 2017a).

Based on the results of the inventory, there are 12 previously recorded archaeological sites within the inventory area and four newly recorded archaeological sites. Of the 12 previously recorded sites, seven were merged under the single site number (42BE52) before the Class III inventory. This effectively means that there were six previously recorded sites, including the portions of 42BE52, located within the survey area. The sites assessed for the project include prehistoric artifact and lithic scatters (including the Negro Mag and Wildhorse Canyon obsidian source), a historic road, and historic debris scatters. In general, the prehistoric lithic scatters could not be assigned to a specific time period, including the portion of 42BE52 that was updated in 2016. No diagnostic artifacts or features were noted at any of the prehistoric sites. The historic road (with no associated artifacts) dates to at least 1913, whereas the remaining historic debris scatters all fall within the general historic period. Artifacts identified at the prehistoric sites consist mainly of translucent banded and black opaque obsidian lithic debitage, whereas the artifacts identified at the historic sites consist mainly of tin cans (hinged tobacco, sanitary, hole-in-cap, and hole-in-top) and glass fragments (SWCA 2017a).

Of the six previously recorded archeological sites and four newly recorded archaeological sites assessed for the project, one is listed on the NRHP (42BE52) and one (42BE2198) is determined eligible for the NRHP by the SHPO (SWCA 2017a). The remaining eight sites have been recommended ineligible for the NRHP because they do not meet any of the criteria for evaluation.

Site 42BE52, also known as the Negro Mag and Wildhorse Canyon obsidian source, is the result of numerous, previously recorded archaeological sites being merged into one. It is listed on the NRHP because it meets NRHP Criterion D and is likely to “have, or have had, information to contribute to our understanding of human history or prehistory” (36 CFR 1–199). The site has been subjected to several updates and revisits since it was originally recorded in 1964 and listed in 1976, with the most recent updates and revisits conducted for the Sigurd to Red Butte Transmission Line project in 2015 and for the Proposed Project in 2016. Because of the nature and sensitivity of cultural resources in the region and specifically because of the presence of the Negro Mag and Wildhorse Canyon obsidian sources and lithic landscape, special attention should be paid, and possibly additional protection and treatment measures implemented, in regard to the management of cultural resources before any federal undertaking or development. The second site, 42BE2198, is a historic road that is identified on 1913 GLO maps as the road from “Milford to Roosevelt Hot Springs”, and is eligible under Criterion A for its contribution to the development of the Milford region or “community” (36 CFR 1–199) (SWCA 2017a).

Additional cultural resources details can be found in the inventory report (SWCA 2017a).

3.8.1.2. ADDENDUM

When the inventory was conducted in 2016, some elements of the FORGE project had not yet been finalized. As a result, some portions of the FORGE area were not inventoried for cultural resources. An addendum to the inventory was conducted in July 2017 to cover these areas (SWCA 2017b), which consist of the proposed transmission line from the office site to the Rocky Mountain Power terminus, the proposed fiber optic line from the office site to the Sun Edison Facility, and the Acord-1 well site (Figure 3-19).

Before the field survey, a file search was conducted to identify any previously recorded cultural resources projects and previously documented archaeological sites within 1.0 mile of the Class III survey area. The file search results indicated that 16 cultural resources projects and 17 previously documented archaeological sites were located within 1.0 mile of the survey area (SWCA 2017b). Fourteen of these previous projects and four previously recorded sites intersect the survey area (SWCA 2017b). GLO plat maps and several GIS layers were also examined for potential cultural resources that may be present in or near the survey area. Results of the literature review are described in the addendum.

Three isolated cultural resources (all IOs) were identified during the field survey and newly recorded. Including the IOs, eight sites were assessed and one (42BE50) was determined not to be located near the survey area boundary. Therefore, seven sites were newly recorded, revisited and/or fully updated. Of the seven sites, four are prehistoric lithic scatters, one is a historic road segment, one is a multicomponent historic and prehistoric artifact scatter, and one is a large obsidian source. Of these seven sites, one is listed on the NRHP (42BE52) and one is determined eligible for the NRHP (42BE3184) (SWCA 2017b). The remaining five sites have been recommended ineligible for the NRHP because they do not meet any of the criteria for evaluation.

Site 42BE52 is a large lithic source that has been listed on the NRHP because of its quality of spatial integrity, as well as its ability to address questions about lithic procurement and use. Site 42BE3184 is a historic road segment identified on a GLO plat map (the road intersects the survey area), and is part of a series of similar segments that extends south-southwest and north-northeast across the Beaver Bottoms to the foot of the Mineral Mountains. The site was recommended eligible under Criteria A and D based on significant research potential along other unrecorded segments and based on its potential to contribute to the body of knowledge concerning early transportation corridors in the area (Weymouth 2008).

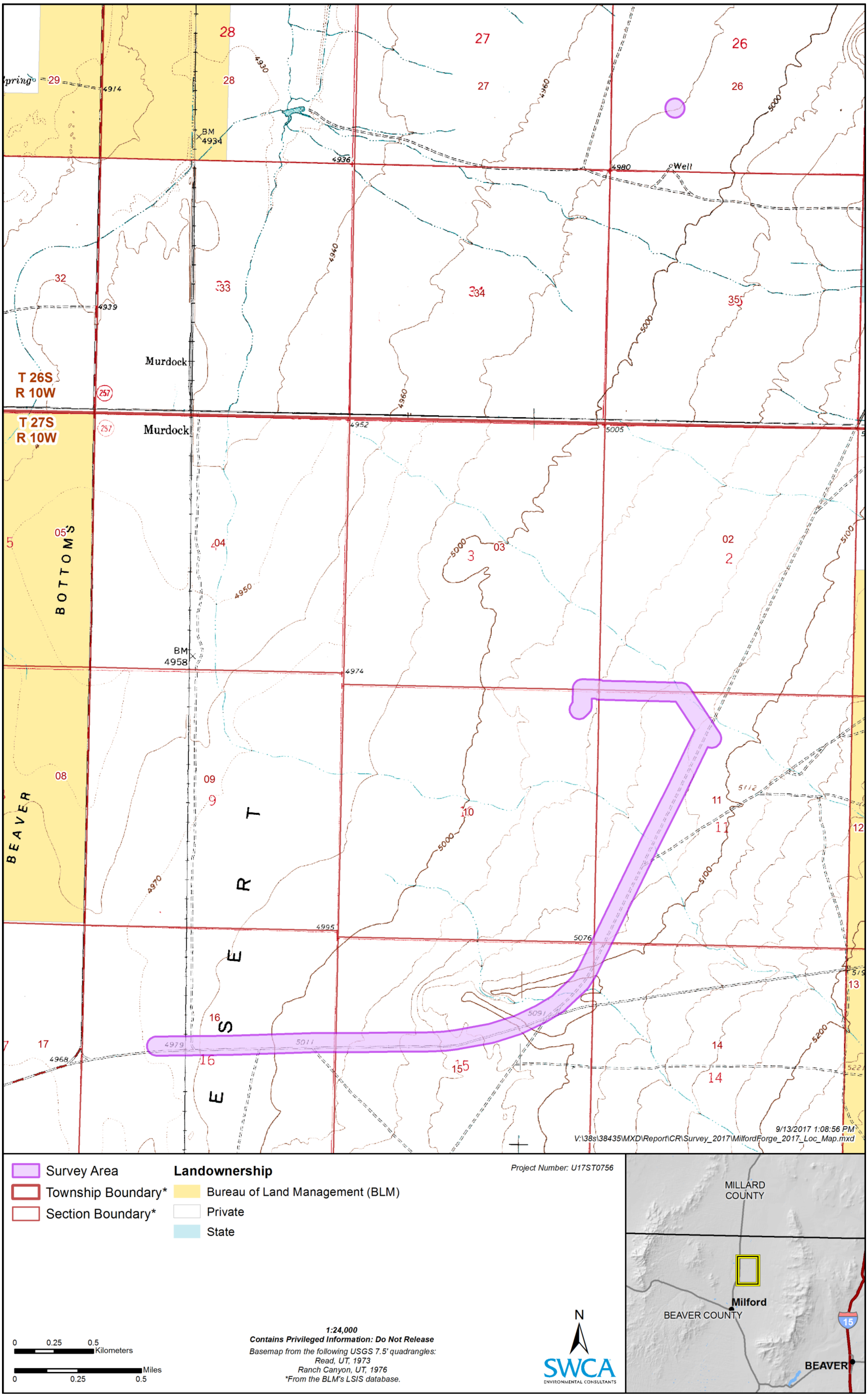

Figure 3-19. Addendum survey area.

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3.8.1.3. NATIVE AMERICAN CONSULTATION

Section 101(d)(6)(B) of the NHPA requires consultation with federally recognized Native American tribes that attach religious and cultural significance to historic properties, including archaeological sites. This consultation is ultimately the responsibility of the federal agency overseeing the undertaking. When federally recognized tribes speak of "government-to-government" consultation, they are often referring to consultation between a designated tribal representative and a designated representative of the federal government. The BLM and DOE must make a reasonable and good faith effort to identify such Native American tribes and invite them to be consulting parties. If such Native American tribes have not been invited by the agency to consult, the tribes may request in writing to be consulting parties and must be considered as such by the agency (Advisory Council of Historic Preservation [ACHP] 2012).

NHPA Section 106 regulations state that the agency official shall acknowledge that Native American tribes possess special expertise in assessing the NRHP eligibility of historic properties, including archaeological sites, that may possess religious and cultural significance to them (36 CFR 800.4(c)(1)). Therefore, the agency should consult with Native American tribes to carry out identification efforts and to evaluate the NRHP eligibility of identified properties for proposed undertakings located off tribal lands. The agency should provide Native American tribes with the same information that is provided to the SHPO during consultation, including information on buildings and other standing structures that may be affected by the proposed undertaking. A federal agency should not assume to possess the expertise to determine what is of significance to a particular tribe unless it has been advised by that tribe (ACHP 2012).

Tribal consultation for the project will be conducted by both the DOE and BLM.

3.8.2. Environmental Consequences of the Proposed Project

3.8.2.1. GENERAL IMPACTS

Geothermal exploration, development, and operational activities for the demonstration of new technologies in harnessing geothermal energy could affect cultural resources. Common impacts to cultural resources from the geothermal development would likely consist of the following:

- Exploration: The development of new roads or access routes, the improvement of existing access roads for surveying or exploratory wells, as well as overland travel between project components could lead to increased disturbances of cultural resources or the landscape of cultural resources, and also increased illegal collecting or vandalism. The drilling of wells could directly and permanently impact any cultural resources that are present.
- Drilling: Ground disturbance would directly impact any cultural resources or historic landscapes of cultural resources that are present. Impacts would be permanent and long term.
- Utilization: Ground disturbance from groundwater wells, main wells, power, fiber optic lines, and pipelines would directly and permanently impact any cultural resources or historic landscapes of cultural resources that are present.
- Decommission: Ground disturbance from the removal of the groundwater and main wells, the power, fiber optic and seismic lines, and pipelines could directly and permanently impact any cultural resources that are present.

In summary, actions that cause surface and subsurface physical disturbance could result in the damage, destruction, or inadvertent discovery of cultural resources. Any damage or destruction of cultural resources would be long term. The magnitude and extent of the impacts would depend on the current state of the cultural resources and their eligibility for the NRHP. Indirect impacts would include the loss of research potential and interpretation possibilities.

3.8.2.2. SPECIFIC IMPACTS (INVENTORY)

Of the 10 archeological sites assessed in the inventory, one is listed on the NRHP and the one has been determined eligible for the NRHP by SHPO. Both of the eligible sites (42BE52 and 42BE2198) are located within the FORGE area and could be affected by the Proposed Project (SWCA 2017a).

3.8.2.2.1. Site 42BE52

Site 42BE52 is an extremely large obsidian source with an associated artifact scatter. For Phase 2B of the Proposed Project—site characterization—portions of 42BE52 would be impacted by activities associated with the improvement and construction of access roads, the surveying of seismic lines, and the drilling of the deep scientific well. The access roads would result in 4.8 acres of surface disturbance, the seismic lines would result in 43.7 acres of surface disturbance, and the deep scientific well would result in 4.2 acres of surface disturbance within the archaeological site boundary. For Phase 2C of the Proposed Project—site preparation—portions of 42BE52 would be impacted by activities associated with the improvement of access roads, the seismic lines (and other monitoring equipment), groundwater wells, the water pipeline, and the power line. The improvement and construction of access roads would result in 4.8 acres of surface disturbance, the surveying of seismic lines would result in 43.7 acres of surface disturbance, the drilling of groundwater wells would result in 6.1 acres of surface disturbance, and the power line corridor would result in 15.5 acres of surface disturbance within the archaeological site boundary. There would be no new surface disturbance for the water pipeline and utility corridor; it would be located in an already existing power line corridor. For Phase 3 of the Proposed Project—site operation—portions of 42BE52 may be impacted by activities associated with the general use and maintenance of the overall FORGE area, which would include the access roads and seismic lines (and other monitoring equipment) and the groundwater wells. General monitoring and maintenance activities associated with the water pipeline, the fiber optics line, and the power line may also occur. The acreages impacted by these project components would be the same as those outlined above.

It is recommended that anticipated impacts to 42BE52 would not modify the characteristics of the site that make it eligible for the NRHP; therefore, the project would not adversely affect 42BE52. The SHPO concurred with this determination in a letter dated November 6, 2017. A copy of the SHPO concurrence letter is included in Appendix C.

3.8.2.2.2. Site 42BE2198

Site 42BE2198 is a historic road. For Phase 2B and Phase 2C, only small portions of 42BE2198 would be impacted by the improvement of and construction of the access roads and the assessment and surveying of seismic lines. The access road improvements and the surveying of seismic lines would result in 0.06 acres of surface disturbance within the historic site. For Phase 3, portions of 42BE2198 may be impacted by general use and maintenance of the overall FORGE area, with the acreages of the historic site impacted by project components the same as those outlined above.

It is recommended that anticipated impacts to 42BE2198 would not modify the characteristics of the site that make it eligible for the NRHP; therefore, the project would not adversely affect 42BE2198. The SHPO concurred with this determination in a letter dated November 6, 2017. A copy of the SHPO concurrence letter is included in Appendix C.

3.8.2.3. SPECIFIC IMPACTS (ADDENDUM)

Of the seven sites documented in the addendum, one is listed on the NRHP (42BE52) and one is determined eligible for the NRHP (42BE3184) (SWCA 2017b). Both of the eligible sites intersect the FORGE area.

3.8.2.3.1. Site 42BE52

The previously recorded site boundary was found to extend into the survey area, but the precise boundary is difficult to discern given its enormous and ephemeral nature. The area where the boundary is supposed to extend into the survey area (based on the previous recording) was intensively investigated, and was found to not contain any more or less obsidian material than is found in the surrounding landscape, suggesting that 1) the site does not extend into the survey area after all, or 2) the site extends into the survey area but no additional information or materials are discernible. Because construction or other project surface disturbance would not occur in or near any artifact concentrations or features that contribute to the site's NRHP eligibility, it was determined that the site would not be adversely affected by any of the project phases (SWCA 2017b). The SHPO concurred with this determination in a letter dated November 6, 2017. A copy of the SHPO concurrence letter is included in Appendix C.

3.8.2.3.2. 42BE3184

SWCA investigated the portion of the historic road segment where it intersects with the survey area, and found that it still closely follows the existing linear site boundary. The road is also still in use as an off-highway two-track roadway for trucks and ATVs. The existing eligibility nomination remains unchanged. No ground disturbing activities for the Proposed Project would occur at this location. Therefore, it was determined that the site would not be adversely affected by any phase of the project (SWCA 2017b). The SHPO concurred with this determination in a letter dated November 6, 2017. A copy of the SHPO concurrence letter is included in Appendix C.

3.8.2.4. NATIVE AMERICAN CONSULTATION

Potential impacts to Native American religious concerns could result if tribal interests or traditional cultural resources are located on lands disturbed by the Proposed Project. Impacts could occur from vandalism; unauthorized collection from ancestral sites; alteration of cultural landscapes; noise; loss of tribal treaty rights; and interference with traditional religious or cultural practices such as resource gathering, use of sacred sites, or hunting. In addition, the qualities essential to areas considered sacred could be permanently lost. Impacts on setting, important viewsheds, and cultural landscapes can extend far beyond the project area. The context and intensity of impacts would depend on the resources that are present and whether the resources can be avoided. Impacts may be minimized or avoided through consultations and environmental review.

The FORGE area may contain previously unidentified historic properties and/or resources protected under the NHPA, American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act, Executive Order 13007, or other statutes and executive orders. The BLM and DOE will not approve any ground-disturbing activities that may affect any such properties or resources until it completes its obligations under applicable requirements of the NHPA and other authorities. The BLM may require modification to exploration or development proposals to protect such properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized, or mitigated.

3.8.2.5. SUMMARY

Based on the results of the inventory and addendum, and SHPO's concurrence, this undertaking would not have an adverse effect on 42BE52, 42BE2198, 42BE52, and 42BE3184.

If the BLM Cedar City Field Office, DOE (in any future EAs), or SHPO determine at a later date that the Proposed Project would adversely impact one or more of these sites, then a plan to minimize or mitigate the adverse effect could be required before a notice to proceed for construction of the project is issued. If Proposed Project activities change from what is currently proposed to something more intensive or destructive, such as new road development, a historic properties treatment plan (HPTP) may be required to minimize or mitigate the adverse effects to these archaeological sites.

Protection measures for cultural resources in the project area would include identifying allowable travel areas; identifying areas to be avoided during construction, maintenance, and operation; and preventing site looting through periodic monitoring by the BLM and SITLA, with environmental training provided to all project employees. All of these measures would be used to prevent adverse effects to known or unknown historic properties. Potential treatment measures would include site mapping and documentation, archaeological testing and possible block excavation in the disturbance corridor, artifact collection, and interpretation of treatment results as they apply to research questions developed for prehistoric sites in the area, depending on the nature of the resource.

3.8.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped; therefore, no new impacts to cultural resources would occur. Ongoing activities in the analysis area or new projects in the FORGE area could cause impacts to cultural resources.

3.9. Visual Resources

Visual resources consist of landform (e.g., topography and soils), vegetation, bodies of waters (e.g, lakes, streams, and rivers), and human-made structures (e.g., roads, buildings, and modifications of the land, vegetation, and water). These elements of the landscape can be described in terms of their form, line, color, and texture. Typically, areas with the most scenic variety and most harmonious composition have the greatest scenic value (BLM 1986).

The analysis area for impacts to visual resources comprises lands in and surrounding the project area and FORGE area out to and including the background zone (5+ miles away). This analysis area includes the foreground-to-middleground zone, which consists of areas seen from highways, rivers, or other viewing locations that are less than 3 to 5 miles away. This area was chosen because it consists of lands where potential alteration of the landscape from the FORGE project may be discerned.

3.9.1. Affected Environment

3.9.1.1. VISUAL RESOURCE MANAGEMENT

Although the FORGE area is primarily on state and private lands, it is appropriate to consider how the BLM manages visual resources because of the quantity of BLM land located in the general area. The BLM manages public lands for multiple uses, but is required to ensure that scenic values are considered before allowing projects with potential negative visual impacts. This is accomplished through the BLM's Visual Resource Management (VRM) system, which involves inventorying scenic values, establishing management objectives for those values, and evaluating proposed activities to determine conformance with management objectives. The VRM system classifies land based on visual appeal, public concern for scenic quality, and visibility from travel routes or other key observation points. It is based on the premise that different levels of scenic values require different levels of management.

Visual values are identified through the VRM inventory process. The inventory consists of a scenic quality evaluation, sensitivity level analysis, and a delineation of distance zones. Based on the inventory, BLM-administered lands are then assigned one of four visual resource inventory management classes: VRM Class I, II, III, or IV. VRM Classes I and II are the most restrictive with regard to proposed modifications and their level of contrast to the visual landscape, and VRM Classes III and IV are more lenient with regard to proposed modifications (BLM 1986).

The BLM Cedar City Field Office completed an updated visual resource inventory of its planning area (which includes the project area) in 2010 (BLM 2010). BLM lands adjacent to the project area are designated as Class IV. The Mineral Mountains to the east are designated as Class II. The management objective of Class IV allows high levels of visual contrast to the characteristic landscape. Proposed elements may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location; minimal disturbance; and repetition of the basic visual elements of form, line, color, and texture (BLM 2010). The BLM Cedar City Field Office is currently preparing an EIS for a new resource management plan (RMP) for its planning area. Through this RMP update process, the visual resource inventory classes identified in the 2010 inventory will be evaluated and assigned as VRM classes in the new RMP.

3.9.1.2. VISUAL SETTING

The landscape in the visual resources analysis area is a broad, open, relatively flat valley that extends north and south, paralleling the Mineral Mountains. The visual character of the landscape in the FORGE area is generally open with unencumbered views to surrounding lands. The valley is covered in numerous, uniform, low grasses and small, rounded shrubs of tan to light brown, creating a stippled effect. As it extends east to the Mineral Mountains, the valley slopes upward to the mountain foothills, and vegetation includes light green and gray sagebrush and pinyon-juniper communities. The Beaver River corridor adds a contrasting sinuous line on the land from the presence of water and additional vegetation.

The existing visual quality of the FORGE area is influenced by the presence of human development and activities, including the Blundell Geothermal Plant just east of the project area (with blocky, solid rectangular buildings; horizontal, cylindrical pipelines; and muted brown and silver colors), the Milford Wind Farm adjacent to the project area on the northeast (with strong, parallel, white, vertical lines), the SunEdison facility west of the project area (with a solid, rectangular building and ordered, thick, multi-colored elements on the ground from equipment storage), Milford to the southwest (with strong horizontal road elements; various-shaped complex, ordered, bold structures; and subtle to vivid colors), major and minor power and gas pipeline utility corridors, a Union Pacific rail line, paved and dirt roads, State Route 257, and fencing. Roads, utility corridors, the railroad line, and fences add regular, continuous, straight lines to the landscape that can be seen from a distance and visually fragment the land. Utility poles and fences also add vertical elements and create implied lines on the landscape. The dominant visual features from the FORGE area are the gray-brown Mineral Mountains in the background, which have both softly rounded and pointed edges, and the wind farm in the foreground, consisting of strong, vertical, bright white lines. Predominant natural colors include the tans, yellows, and browns of vegetation (some of which may turn green in the spring), and the gray-brown of the mountains.

3.9.2. Environmental Consequences of the Proposed Project

The project would be constructed on approximately 121.9 to 124.9 acres of land, depending on the wellfield option chosen. The Proposed Project would result in changes to the existing landscape through surface disturbance; removal of vegetation; temporary placement of drill rigs; installation of a power line and fiber optic line; construction of an office building and associated parking (along with a fence); and creation of a groundwater wellfield, seismic monitoring drillholes, survey monument stations, and tiltmeter sites. The implementation of the project would not exceed management objectives for VRM Class IV on adjacent BLM lands, given the substantial existing visual modifications to the landscape from structures such as the Blundell Geothermal Plant, SunEdison facility, and wind turbines; utility lines and corridors; railroad line; roads; fencing; and development that is part of the city of Milford. Proposed project activities would likely attract attention, and would, in some cases, dominate the view (e.g., the office building), but would be consistent with surrounding development. Vegetation removal and surface disturbance would create some visual contrast and would be noticeable as patches across the landscape. Drill rigs would be visible and would create noticeable vertical elements; however, their presence would be short term. The proposed power line would create a strong vertical contrast on the landscape, but would be consistent with existing lines created by other utility corridors. Reclamation would reduce visual contrasts over time. In general, the project would repeat the same vertical and horizontal lines that already exist on the landscape; it is expected to be consistent with the existing scenic quality.

3.9.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped; therefore, no new impacts to visual resources would occur.

3.10. Health and Safety Factors

3.10.1. Affected Environment

3.10.1.1. EMISSIONS

The analysis area for impacts to public health and safety from air quality concerns is Beaver County, Utah. This area was chosen because it is a typical spatial boundary used to determine compliance with the NAAQS established in the CAA. A county is often selected to be the geographic area evaluated or designated as meeting or not meeting NAAQS. Beaver County is 2,586 square miles, or 1,655,040 acres (Utah State Library 2016).

The EPA has established NAAQS to limit the amount of air pollutants considered harmful to public health and the environment. Beaver County is currently in attainment with the NAAQS for all criteria pollutants (section 3.3) (EPA 2016i); UDAQ 2013).

3.10.1.2. NOISE

Noise is defined as unwanted sound. There are several different ways to measure noise, depending on the source of the noise, the receiver, and the reason for the noise measurement. A-weighted decibels (dB(A)) are often used in most noise ordinances and standards and correlate to overall loudness as perceived by the human ear. Beaver County does not currently have any noise ordinances. The analysis area for noise is a 2-mile radius around the project area. This area was chosen because 2 miles is the maximum distance that Proposed Project activities are expected to have an impact on ambient noise levels.

For a typical rural environment, background noise is expected to be approximately 40 dB(A) during the day and 30 dB(A) at night (Harris 1979). However, there are several other noise-generating industrial facilities in the analysis area that likely increase the ambient background noise above typical rural levels. These industrial facilities include the Blundell Geothermal Plant approximately 2.5 miles east of the project area and the Milford Wind Farm, which covers a large area but has wind turbines sites as close as 0.5 mile north of the G1 groundwater wellfield. At a distance of 500 meters, a wind turbine produces noise levels at approximately 40 dB(A) (General Electric 2017).

The nearest sensitive receptors, including residences and other public areas and facilities, are located approximately 7 miles away in Milford.

3.10.1.3. EFFLUENTS

Because the lack of surface water in the project area, there are no existing effluents.

3.10.2. Environmental Consequences of the Proposed Project

3.10.2.1. EMISSIONS

Section 3.3.2 describes in detail the effects of the Proposed Project on air quality and existing emissions. This section focuses on potential human health effects from emissions associated with project activities.

3.10.2.1.1. Fugitive Dust Emissions from Surface Disturbance

Fugitive dust produced from project construction activities would increase local concentrations of PM in the short term. An increased PM concentration has been shown to have adverse effects on human health.

However, increases in fugitive dust would be limited to areas directly adjacent to construction activities where equipment or vehicles are being used. Additionally, fugitive dust would be controlled through the use of water and gravelling of roads. Therefore, the FORGE project is not anticipated to result in measurable increases in PM or fugitive dust in most of the analysis area, including inhabited areas where impacts on human health may occur.

3.10.2.1.2. Vehicle and Equipment Combustion Emissions

Equipment and vehicles used in all three phases of the project would emit criteria and HAP pollutants through fuel combustion, including NO_x, CO, SO_x, PM, CO_2, and some HAPs such as benzene, xylene, and acetaldehyde. These pollutants have been shown to have adverse effects on human health. However, Beaver County does not currently exceed federal standards for criteria or HAP pollutants, and vehicles and combustion engines used for the project would comply with state and federal regulations. Any increases in criteria and HAP pollutants are anticipated to be localized and would have short-term effects on local air quality that would end at the completion of construction activities. Measurable increases in criteria and HAP pollutants in inhabited areas where impacts on human health may occur are not anticipated.

3.10.2.1.3. Hydrogen Sulfide

Depending on the chemical composition of the geothermal resource, H_2S emissions could occur during well testing. H_2S is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Repeated exposure can result in health effects occurring at levels that were previously tolerated without any effect.

Low concentrations of H_2S irritate the eyes, nose, throat, and respiratory system (e.g., burning/tearing of eyes, cough, shortness of breath). Asthmatics may experience breathing difficulties. The effects can be delayed for several hours, or sometimes several days, when working in low-level concentrations. Repeated or prolonged exposures may cause eye inflammation, headache, fatigue, irritability, insomnia, digestive disturbances, and weight loss. Moderate concentrations of H_2S can cause more severe eye and respiratory irritation (including coughing, difficulty breathing, and accumulation of fluid in the lungs), headache, dizziness, nausea, vomiting, staggering, and excitability. High concentrations of H_2S can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma, and death. Effects can occur within a few breaths, and possibly a single breath.

Emission of H_2S would be minimized through the use of properly weighted drilling mud, which should keep the well from flowing during drilling. No H_2S emissions would occur during operations because the wells would function as part of a closed system. During decommissioning, the wells would be permanently plugged to prevent any future emissions.

3.10.2.2. NOISE

Ambient noise levels near the FORGE area are expected to be approximately 40 dB(A). Noise levels are anticipated to be somewhat higher in nearby towns, including Milford.

Noise associated with the project would occur throughout the site characterization, site preparation, and site operation phases. Project-generated noise is anticipated to be the greatest during the site characterization and site preparation phases, when noise associated with drilling and construction activities would occur. Construction noise can reach levels of 95 dB(A). Geothermal drilling can cause noise ranging from 80 to 115 dB(A) (Patsa and Zarrouk 2012). Prolonged exposure to noise at this level can be hazardous to human health. Employees present during the drilling phase would use proper personal protective equipment to avoid damages to hearing and health. The nearest residences and sensitive receptors to the FORGE area are approximately 7 miles away in the town of Milford. With 7 miles of distance, 100 dB(A) at the FORGE area would be reduced to approximately 19 dB(A) (The Engineering ToolBox 2017). This is below the typical background noise levels for a rural environment; therefore, no impacts to sensitive receptors are anticipated. Because of the FORGE project's distance from Milford and the proximity of the Milford Wind Farm and Blundell Geothermal Plant, as well as other sources of industrial noise within the city limits (e.g., Union Pacific Railway), it is not anticipated to raise ambient noise levels within city limits under typical conditions.

The level of noise generated during construction and well drilling operations would not continue throughout the 5 years of the project. During most of the operational phase of the project, noise generation would primarily occur as a result of fluids and steam moving through pipes and from any pumping facilities associated with extraction and injection of geothermal fluids. The noise associated with these activities is anticipated to be substantially less than the noise associated with drilling and construction. This noise would also decrease with increasing distance from the project area. Therefore, there are no noise impacts anticipated at sensitive receptors during the operational phase of the project.

3.10.2.3. EFFLUENTS

There would be no impacts due to lack of effluents in the project area.

3.10.3. Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the DOE would not fund the Proposed Project, and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped; therefore, no new impacts to health and safety factors would occur.

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CHAPTER 4. CUMULATIVE IMPACTS

4.1. Introduction

As defined in 40 CFR 1508.7 of the Council on Environmental Quality's regulations for implementing NEPA, a *cumulative impact* is an impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (RFFAs), regardless of which agency (federal or non-federal) or person undertakes such actions. Cumulative impacts may result from individually minor but collectively significant actions occurring over a period of time.

4.2. Analysis Areas

The geographic extent of cumulative impacts may vary by the type of resource and resource issues and by the type of potential impact. The time frames, or temporal boundaries, for those impacts may also vary by resource and resource issue. Spatial and temporal cumulative impact analysis areas (CIAAs) have been developed for each resource and are listed in Table 4-1. A temporal boundary was chosen because it represents a reasonable timeframe within which to predict RFFAs.

Table 4-1. Cumulative Impact Analysis Areas by Resource

Resource	CIAA	Rationale	Total CIAA Acreage	Temporal Boundary
Land Use	1.0-mile buffer around the periphery of the project area	This area was chosen because it captures the existing land uses most likely to be affected by the Proposed Project.	14,746	10–20 years
Atmospheric Conditions and Air Quality	Beaver County	This area was chosen for air quality because it is a typical spatial boundary used to determine compliance with NAAQS. (The CIAA for atmospheric conditions is the globe because atmospheric conditions are global.)	1,655,040	10–20 years
Hydrologic Conditions and Water Quality	Antelope Spring-Cove Creek, Beaver Bottoms-Beaver River, Milford Municipal Airport-Beaver River, Negro Mag Wash, and Wild Horse Canyon subwatersheds	This area was chosen because it provides a clear topographical boundary against which to measure potential hydrological and water quality impacts.	86,344	10–20 years
Geologic and Soil Conditions	Antelope Spring-Cove Creek, Beaver Bottoms-Beaver River, Milford Municipal Airport-Beaver River, Negro Mag Wash, and Wild Horse Canyon subwatersheds	This area was chosen because it provides a distinct, natural topographic boundary in which to analyze potential impacts to geologic and soil conditions.	86,344	10–20 years

Table 4-1. Cumulative Impact Analysis Areas by Resource

Resource	CIAA	Rationale	Total CIAA Acreage	Temporal Boundary
Vegetation and Wildlife Resources	Antelope Spring-Cove Creek, Beaver Bottoms-Beaver River, Milford Municipal Airport-Beaver River, Negro Mag Wash, and Wild Horse Canyon subwatersheds	This area was chosen because the subwatersheds represent a defined, continuous area linked by common watercourses on which wildlife depend. In addition, vegetative connectivity is linked to watersheds.	86,344	10–20 years
Socioeconomic Conditions	Beaver County	This area was chosen because the economic and demographic effects of the project could be experienced by the surrounding communities in Beaver County.	1,655,040	10–20 years
Historic and Cultural Resources	Antelope Spring-Cove Creek, Beaver Bottoms-Beaver River, Milford Municipal Airport-Beaver River, Negro Mag Wash, and Wild Horse Canyon subwatersheds	This area was chosen because 1) much human cultural and behavioral variation is conditioned by the natural environment and 2) impacts to cultural resources in one part of a given ecological area can affect our understanding of the interrelationships between sites in that ecological area as a whole.	86,344	10–20 years
Visual Resources	6.0-mile buffer around the periphery of the project area	This area was chosen because it consists of lands where potential alteration of the landscape from the Proposed Project may be discerned and because it includes the visual background zone.	133,455	10–20 years
Health and Safety Factors	Beaver County	This area was chosen because it is a typical spatial boundary used to determine compliance with NAAQS, which were established to protect human health and the environment.	1,655,040	10–20 years

4.3. Past, Present, and Reasonably Foreseeable Future Actions

4.3.1. Past and Present Actions Summary

Past and present actions in all CIAAs identified in Table 4-1 include development of energy generation facilities (e.g., geothermal, solar, and wind facilities), pipelines, oil and gas facilities, roads and highways, railways, utility corridors and transmission lines, residences, agricultural development and production (including a pig farm and dairy farming), and towns and small cities (e.g., Milford) with associated support systems and infrastructure.

SWReGAP-identified land cover classes in the CIAAs indicate that past and present actions have caused the conversion of natural vegetation communities to developed uses such as agriculture and mines or quarries.

4.3.2. Reasonably Foreseeable Future Actions

RFFAs are decisions, funding, or formal proposals that are either existing or are highly probable, based on known opportunities or trends. Anticipated RFFAs for the CIAAs identified above include the expansion of an existing pig farm (Smithfield hog farm expansion) and the development of additional energy generation projects. Based on development activity occurring in the area over the last 20 years, new municipal, agricultural, and residential development could also occur in the CIAAs. *Note: SWCA is still in the process of obtaining additional information on the Smithfield hog farm expansion to include in section 4.4.*

4.4. Cumulative Impacts by Resource

Cumulative impacts organized by resource issue category are described below. The cumulative impact analysis by resource issue category includes SWReGAP-identified disturbed land cover classes, where appropriate, because they reflect the past and present loss of natural vegetation. General categories of past and present actions in the CIAAs are listed in section 4.3.1. RFFAs in the CIAAs are described in section 4.3.2.

A choice of the No Action Alternative would not contribute incrementally to the impacts of past actions, present actions, and RFFAs because, under the No Action Alternative, the DOE would not fund the Proposed Project and the FORGE initiative would not go forward at the Utah site. No additional research would occur at this location, and the FORGE area would remain undeveloped. As a result, a No Action Alternative cumulative impacts analysis is not included.

4.4.1. Land Use

Existing leases and ROWs on BLM-administered lands in the land use CIAA include six geothermal, two ROW/pipeline/other energy facilities, one ROW/oil and gas pipeline/oil and gas facility, and a geothermal participating area and geothermal unit agreement.

The Proposed Project would add cumulatively to the acreage of previously authorized projects and reasonably foreseeable future projects in the land use CIAA by converting undeveloped land to a geothermal project. New surface disturbance under the Proposed Project would cover up to 130.5 acres (including both groundwater wellfield options, seismic monitoring drillholes, and tiltmeter sites), or 0.9% of the land use CIAA. However, the Proposed Project is compatible with the current zoning (see section 3.2.1). In addition, the Proposed Project would be consistent with the existing leases and ROWs in the FORGE area and surrounding lands.

4.4.2. Atmospheric Conditions and Air Quality

Most emissions from past and present actions in the atmospheric conditions and air quality CIAA likely come from energy development; mining, quarrying, and related processing activities, vehicles on roads, dairy farming, and pig farming. Some emissions also occur from towns and small cities, businesses, residences, and other agricultural production in the CIAA. Most reasonably foreseeable future emissions are expected to come from energy development, mining and quarrying, mobile sources, and farming.

The Proposed Project would add cumulatively to the air pollutant emissions in the atmospheric conditions and air quality CIAA by contributing fugitive dust emissions from surface disturbance, combustion emissions from the use of vehicles and equipment, and potentially H_2S and other emissions during well drilling and testing. Fugitive dust emissions would be short term, occurring only during surface disturbance activities for construction and drilling. Local concentrations of PM would increase near the dust-generating activities, and visibility could be temporarily reduced in the local airshed. This would be a short-term incremental impact. New surface disturbance under the Proposed Project would cover up to 130.5 acres (including both groundwater wellfield options, seismic monitoring drillholes, and tiltmeter sites), or 0.008% of the air quality CIAA. Combustion emissions from vehicles and equipment would be sporadic but would last for the life of the project. H_2S and other emissions from well drilling and testing would be short term and would occur only during the well drilling and testing activities.

Based on the analysis in section 3.3.2, project emissions would not incrementally affect pollutant levels enough to change the current attainment status of Beaver County. Fugitive dust emissions would be controlled through the application of water. The gravelling of roads, well pads, and the office site would be used to avoid windblown dust from vehicle travel. The reseeding of disturbed areas such as well pads would also minimize long-term fugitive dust emissions. Emissions of H_2S and other pollutants would be minimized through the use of properly weighted drilling mud and blowout prevention equipment.

With regard to climate change, combustion emissions from project vehicles and equipment and steam emissions from well testing would include GHGs such as CO_2, N_2O, and methane. However, these incremental contributions to climate change would likely be offset by the Proposed Project's research and development of new EGS, which, when implemented, would provide carbon-free sources of energy.

4.4.3. Hydrologic Conditions and Water Quality

Past, present, and reasonably foreseeable projects can affect surface water resources through increased surface and sediment runoff and changes to water chemistry from anthropogenically derived contaminants. The Proposed Project could add cumulatively to such impacts. Cumulative impacts to wetlands could also occur from increased surface and sediment runoff and water quality degradation. This could result in the loss of proper functioning condition for individual wetlands. Numerous poorly functioning or non-functioning wetlands can add up to a large cumulative impact over time.

Past and present land-disturbing activities in the hydrologic conditions and water quality CIAA can be estimated through acres of land with disturbed SWReGAP land cover classes. Table 4-2 summarizes the estimated total past and present surface disturbance in the CIAA.

Table 4-2. Acres of Estimated Past and Present Surface Disturbance in the Hydrologic Conditions and Water Quality CIAA

Type of Disturbance	Total Past, Present, and Reasonably Foreseeable	Percent of CIAA
Agriculture	5.8	0.01%
Developed, Open Space – Low Intensity	381.4	0.4%
Developed, Medium – High Intensity	75.1	0.1%
Recently Mined/Quarried	192.0	0.2%
Total	**654.3**	**0.8%**

Note: This table also applies to the geologic and soil conditions, vegetation and wildlife resources, and historic and cultural resources CIAAs.

Past and present disturbance would likely affect surface water resources more than the Proposed Project would, based on the total acreages of disturbance (i.e., 654.3 acres of past and present impacts in the hydrologic conditions and water quality CIAA versus up to 130.5 acres from the Proposed Project). In addition, the Proposed Project would implement environmental protection measures for surface water including the installation of appropriately sized culverts as needed at surface water line crossings, the development and implementation of a SWPPP to prevent excess sediment from discharging to surface waters, interim reclamation of areas no longer needed, final soil stabilization, the use of berms around any hazardous material storage areas, and the development and implementation of an SPCC. These protection measures would limit incremental cumulative impacts to surface waters and wetlands from the Proposed Project.

An incremental cumulative impact to groundwater quality from the Proposed Project is unlikely because of the following environmental protection measures: storing produced fluids in lined reserve pits to prevent seepage to groundwater, developing a grouting and casing program for the construction of all wells to prevent the degradation of groundwater quality, setting surface and other casings with cement to prevent the migration of produced fluids and contamination of non-geothermal aquifers, using blowout prevention equipment, preparing and adhering to an SPCC, using lined berms around fuel tanks at the well pads, and storing water and barite at the well site to prevent uncontrolled well flow if needed.

Drilling, well testing, construction, and geothermal production all require water consumption. New water consumption when combined with other water use projects (e.g., municipal wells and agriculture) would have a cumulative impact. Because energy facilities often concentrate in areas abundant in a particular energy resource, there is more potential to contribute to cumulative depletion of groundwater. Actual water consumption by energy facilities can be somewhat mitigated through water efficiency and water reuse (BLM 2008b). Typically, the state engineer assigns water rights and manages groundwater resources. Any added use of groundwater in areas where water demand is approaching the available supply would contribute to cumulative groundwater impacts. As discussed in section 3.4.2, if all 2,500 acre-feet of total allotted water rights were used by the Proposed Project, it would consist of 0.006% of the total groundwater in the basin, which is a very small depletion and incremental impact.

4.4.4. Geologic and Soil Conditions

Any land-disturbing activity that causes surface and subsurface physical disturbance could result in changes to surface and near-surface geology in the geologic and soil conditions CIAA. Cumulative impacts from such disturbance would depend on the amount, placement, depth, and type of surface disturbance. Cumulative geologic impacts of geothermal operations can include induced seismicity because of changes in reservoir pore pressure. In the geologic and soil conditions CIAA, such impacts would result from past actions, present actions, and RFFAs associated with mineral extraction and other energy development, agricultural development, or other low-intensity to high-intensity development.

Any land-disturbing activity that removes native vegetation and topsoil from the CIAA may cumulatively and incrementally affect soil resources. Cumulative impacts would depend on the amount, placement, and type of surface disturbance; the type (complex) of soil; and soil characteristics. Specific impacts to soils include removal of vegetation, exposure of soil, mixing of soil horizons (layers), soil compaction, loss of productivity, and increased susceptibility to wind and water erosion.

Past and present land-disturbing activities in the geologic and soil conditions CIAA can be estimated through acres of land with disturbed SWReGAP land cover classes. Disturbed or altered land cover classes indicate impacts to surface geology and soils through erosion, compaction, and topsoil degradation. Table 4-2 summarizes the estimated total past and present surface disturbance in the geologic and soil conditions CIAA. New surface disturbance under the Proposed Project would cover up to 130.5 acres (including groundwater wellfield options, seismic monitoring drillholes, and tiltmeter sites), or 0.2% of the CIAA. This constitutes a 19.9% addition to the past and present total surface disturbance shown in Table 4-2 (654.3 acres). However, the environmental protection measures discussed in section 2.3.7, such as the development of a SWPPP and the reseeding of disturbed areas, would limit long-term, incremental cumulative impacts to surface geology and soils.

4.4.5. Vegetation and Wildlife Resources

The removal of native vegetation and topsoil through surface disturbance may cumulatively and incrementally affect vegetation communities by fragmentation and increased competition with noxious and invasive weeds in the vegetation and wildlife resources CIAA. In addition, surface disturbance may cause soil compaction, increased erosion, and fugitive dust that can cumulatively affect vegetation through decreases in plant productivity and species composition.

Past actions, present actions, and RFFAs could cumulatively remove wildlife habitat, contribute to wildlife fragmentation, disrupt seasonal patterns or migration routes, displace individual wildlife species, increase collisions between wildlife and vehicles, and potentially contribute to the harassment of animals in the vegetation and wildlife resources CIAA. These impacts could affect all wildlife, including big game, special-status wildlife species, and migratory birds. In general, special-status wildlife species would be more susceptible to cumulative impacts if they have sensitivity to disturbance, declining population numbers, and habitat losses. The severity of the cumulative impacts would depend on factors such as the sensitivity of the species affected, seasonal intensity of use, type of project activity, and physical parameters (e.g., topography, forage, and cover availability).

Cumulative changes to vegetation and wildlife habitat can be estimated through quantities of surface disturbance. As with the hydrologic conditions and water quality CIAA, surface disturbance under the Proposed Project would cover up to 130.5 acres, or 0.2%, of the vegetation and wildlife resources CIAA. This constitutes a 19.9% addition to the past and present total surface disturbance shown in Table 4-2 (654.3 acres). However, the reseeding of disturbed areas would limit cumulative impacts to vegetation. Incremental cumulative impacts from the spread of noxious weeds or invasive plants would be limited by environmental protection measures such as the power washing of equipment before it enters the project area and the monitoring of well pads and access road for weeds. The implementation of the wildlife protection measures listed in section 2.3.5 (e.g., the fencing of reserve pits and migratory bird and raptor clearance surveys) would reduce incremental cumulative impacts to wildlife.

4.4.6. Socioeconomic Conditions

Cumulative impacts to socioeconomic conditions may be beneficial or adverse. Potential cumulative impacts from past actions, present actions, and RFFAs in the socioeconomics CIAA include changes in population, employment, and housing demands; effects on the local economy through the purchase and use of goods and services; changes to lifestyle and cultural values; and demands on government services, school districts, and local infrastructure.

Socioeconomic effects from the Proposed Project would primarily be changes in the local economy including an increase in local employment; purchase of materials and services from local sources; and expenditures in the local economy by non-local workers for items such as accommodations, food, and recreation. Project-related effects associated with the construction and decommissioning of the project would be relatively short lived, whereas those associated with operations would last for the 5-year life of the project. Because the project would be decommissioned after 5 years, long-term lasting impacts on the local economy are not anticipated.

The Proposed Project could result in an approximately 0.5% increase of total residents in Beaver County over its 5-year life (see section 3.7.2). The availability of temporary housing and hotel rooms in Milford and Beaver Counties should exceed the demand created by the project. Because there would not be a sizeable increase in the number of residents as a result of project construction, impacts to community facilities and services are not expected. The Proposed Project could also result in a temporary increase of approximately 0.7% of the total jobs and 18.9% of the total construction jobs in Beaver County.

Collectively, the stimulus attributable to project-related procurements and personal consumption expenditures by local and non-local construction workers would have a beneficial impact on the local economy. In the short term during construction, the economic stimulus could reduce unemployment and increase income and earnings. Based on the size of the project in comparison to other local facilities (e.g., Milford Wind Farm), it is anticipated that the construction and operation of the project would make a minor but beneficial contribution to the tax base and sales tax revenue of Beaver County.

Based on this analysis, the Proposed Project would have a temporary, beneficial impact on socioeconomic conditions in Beaver County, and these would either add incrementally to other beneficial cumulative impacts or offset adverse cumulative impacts from other projects in the socioeconomic conditions CIAA.

4.4.7. Historic and Cultural Resources

Cultural resources tend to degrade over time from natural forces; however, many survive for hundreds or thousands of years. Any land-disturbing activity can disturb or potentially damage cultural resources. Cumulative impacts to cultural resources in the CIAA would primarily result from past actions, present actions, and RFFAs associated with mineral extraction and energy development, agricultural development, or other low-intensity to high-intensity development. Cumulative impacts would depend on the amount, placement, and type of surface disturbance. Additionally, the development of new roads and improved vehicle access throughout the CIAA could increase the potential for vandalism and theft of cultural resources.

Cumulative impacts to cultural resources may be beneficial or adverse. If previously unknown cultural resources are found during activities in the CIAA, they may contribute cumulatively to an increase in the knowledge of cultural properties in the area by expanding the overall number of known cultural resources in the area and by providing additional regional history and prehistory data.

Development on federal lands is generally subject to Section 106 of the NHPA, which requires the identification of cultural resources in the area of potential effects for these undertakings. Adherence to Section 106 allows for the consideration of alternatives to avoid or mitigate impacts.

The Proposed Project would not add cumulatively to current impacts to known cultural resources, based on the FORGE area inventory and addendum determinations and SHPO concurrence. The surface disturbance from the Proposed Project could increase the potential for destruction or damage to unknown or unidentified cultural resources in the CIAA. As with the hydrologic conditions and water quality CIAA, surface disturbance under the Proposed Project would cover up to 130.5 acres, or 0.2%, of the historic and cultural resources CIAA. This constitutes a 19.9% addition to the past and present total surface disturbance shown in Table 4-2 (654.3 acres). This addition would only apply to the discovery of unknown or unidentified cultural resources, and does not include any RFFAs because quantitative data for these projects are not available. Therefore, 19.9% is likely a high estimate.

4.4.8. Visual Resources

The approximately 130.5 acres of new surface disturbance from the Proposed Project would add cumulatively to the existing and future visual resources impacts in the visual resources CIAA in the short term. However, views in the CIAA are already influenced by the presence of human development and activities, including the Blundell Geothermal Plant just east of the project area, the Milford Wind Farm adjacent to the project area on the northeast, the SunEdison facility west of the project area, Milford to the southwest, major and minor power and gas pipeline utility corridors, a Union Pacific rail line, paved and dirt roads, State Route 257, and fencing. The implementation of the project would not exceed management objectives for VRM Class IV on adjacent BLM lands, given the substantial existing visual modifications to the landscape from structures. Though the Proposed Project would add cumulatively to the amount of developed acreage in the visual resources CIAA, its appearance would be consistent with that of adjacent facilities, repeating some of the same basic vertical and horizontal lines. In addition, the project would be decommissioned and removed after 5 years, leaving little or no long-term incremental impacts to visual resources.

4.4.9. Health and Safety Factors

Although the Proposed Project would add incrementally to air pollutant emissions in the health and safety CIAA, the increases are not expected to be measureable with the implementation of applicable environmental protection measures. Any incremental impact in the CIAA would be short term and would not increase emissions enough to change the current attainment status of Beaver County. There would be no long-term cumulative impacts to health and safety with regards to air pollution from the Proposed Project.

Based on the analysis in section 3.9.3, the nearest noise sensitive receptors to the FORGE area are located approximately 7 miles away in Milford. Noise generated by the Proposed Project would be reduced to below background noise levels for a rural environment by the time it reaches Milford. Because of the FORGE project's distance from Milford and the proximity of the Milford Wind Farm and Blundell Geothermal Plant, as well as other sources of industrial noise within the city limits (e.g., Union Pacific Railway), it is not anticipated to raise ambient noise levels within city limits under typical conditions. Therefore, there would be no incremental cumulative impact to health and safety with regards to noise in the CIAA.

CHAPTER 5. LIST OF PREPARERS

5.1. Introduction

This chapter provides information on the consultation and coordination that occurred during the NEPA process. The results of consultation efforts are described below in Section 5.2.

5.2. Persons, Agencies, and Organizations Consulted

Persons, agencies, and organizations consulted for the EA are provided in Table 5.1. A list of stakeholders that were sent copies of the EA is included as Appendix E.

Table 5.1. Persons, Agencies, and Organizations Consulted for this Environment Assessment

Name	Purpose and Authorities for Consultation or Coordination	Findings and Conclusions
Utah State Historic Preservation Office	Consultation for undertakings, as required by 54 USC 300101 et seq.	On November 6, 2017, the SHPO concurred with the DOE's determination dated October 20, 2017. The concurrence letter can be found in Appendix C.
Paiute Indian Tribe of Utah	Consultation as required by the American Indian Religious Freedom Act of 1978 (42 USC 1531) and 54 USC 300101 et seq.	On May 11, 2016, the Paiute Indian Tribe of Utah reviewed the BLM's Vibroseis EA (Appendix A) and had no objection to that project moving forward, but asked to be informed of any changes or updates to that project. Consultation with the Paiute Indian Tribe of Utah is ongoing for this project.
U.S. Fish and Wildlife Service	Section 7 of the Endangered Species Act	On November 22, 2017, the U.S Fish and Wildlife Service concurred with the DOE's "no effect" determination dated November 22, 2017. The concurrence letter can be found in Appendix D.

During preparation of the EA, DOE notified the public of the Proposed Action by posting on the DOE Office of NEPA Policy and Compliance webpage on August 16, 2017.

5.3. List of Preparers

Tables 5.2 and 5.3 identify DOE staff and consultants used in the preparation of the EA.

Table 5.2. Department of Energy Preparers of this Environment Assessment

Name	Title	Responsible for the Following Section(s) of the EA
Pierina Fayish	NEPA Compliance Officer	Review of EA
Robert Vagnetti	National Energy Technology Laboratory Project Manager	Review of EA
William Vandermeer	Project Officer Geothermal Technologies Office	Review of EA

Table 5.3. SWCA Environmental Consultants Preparers of this Environmental Assessment

Name	Position	Role
Tom Hale, M.S.	Senior NEPA project manager	NEPA oversight
Gretchen Semerad, M.S.	NEPA specialist	All EA sections
Christine Michalczuk, M.A., RPA	Archaeologist	Cultural resources and Native American religious concerns
Rachel Johnson, B.S.	GIS specialist	Maps and GIS analysis
Linda Burfitt B.S. and Kari Chalker M.A.	Technical editor	Technical editing
Debbi Smith	Production coordinator	Formatting

CHAPTER 6. REFERENCES

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