KERN RIVER 3 HYDROELECTRIC SYSTEM, SANDBOX
Along the North Fork of the Kern River
Kernville Vicinity
Tulare County
California

HAER No. CA-2309-A

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

PHOTOGRAPHS

FIELD NOTES

National Park Service
Pacific West Region
909 First Avenue, Fifth Floor
Seattle, Washington 98104-1060

HISTORIC AMERICAN ENGINEERING RECORD

KERN RIVER 3 HYDROELECTRIC SYSTEM, SANDBOX
HAER No. CA-2309-A

Location: The sandbox is part of the Kern River 3 (KR3) Hydroelectric Historic District. The property is located downstream of the Fairview Diversion Dam, approximately 15 miles north of Kernville along Kern River Hwy 99 in Tulare County, California. The project is located on United States Forest Service, Sequoia National Forest (SNF) land within the Federal Energy Regulatory Commission (FERC) licensed project boundary 2290. The sandbox is located on the west side of the highway, on the east bank of the Kern River. The Southern California Edison Company (SCE) operates and controls access to the sandbox from the highway.

The approximate the center of the sandbox is located at UTM Zone 11N, easting 366650.221, northing 3978791, CGS_North American 1983.

Present Owner: Southern California Edison Company
P.O. Box 800
Rosemead, California 91770

Present Use: The sandbox is used as a settling basin on the KR3 system. It traps abrasive settlements suspended in the water that passes through the intake, and it passes the water without sediments downstream to the conduit, which conveys it to the power plant.

Significance: The sandbox is a contributing component of the KR3 Hydroelectric System, which is significant in the areas of commerce (National Register of Historic Places Criterion A), engineering and architecture (Criterion C), and potential for associated archaeological sites (Criterion D). The Period of Significance for the district is 1910 to 1930. In addition, the sandbox, which was constructed in approximately 1918-1919, appears to be individually significant in the area of engineering for its highly unusual design. It is exceptionally large, it lacks known precedents, and it is an ingenious solution to a specific problem.

Historian: Matthew Weintraub, Senior Preservation Planner
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Project Information: The Historic American Engineering Record (HAER) is a long-range program that documents and interprets historically significant engineering sites and structures throughout the United States. HAER is part of Heritage Documentation Programs (Richard O'Connor, Manager), a division of the National Park Service (NPS), United States Department of the Interior. The KR3 Hydroelectric System, Sandbox recording project was undertaken by GPA Consulting Inc. (GPA) for SCE in cooperation with Christy Avery, HAER Historian (NPS) as mitigation for SCE's Sandbox Upgrade Project. Archaeologist Crystal West, SCE, oversaw the project and provided access to the site. Architectural Historian Andrea Galvin, GPA, served as project leader. Preservation Planner Matthew Weintraub, GPA, served as the project historian. James Sanderson, GPA, produced the large format photographs. The field team consisted of Matthew Weintraub, GPA; James Sanderson, GPA; Michael Crippen, SCE; and Crystal West, SCE.

Part I. Historical Information

A. Physical History:

1. Date of Construction:
Construction related activities occurred as early as 1910 with road construction and establishment of a company work camp at the upper end of the planned KR3 system. Actual construction of the sandbox occurred in approximately 1918-1919.[1]

2. Engineer:
William A. Brackenridge, Vice-President and General Manager of SCE from 1909 to 1918 (later President and Senior Vice-President), was responsible for the design of the sandbox. Brackenridge provided overall supervision of KR3 system construction; Russell A. Ballard was Vice-President in charge of construction; and Harry W. Dennis was resident engineer.[2]

3. Builder/Contractor/Supplier:
The origins of construction materials for the sandbox, such as cement, sand, and gravel for concrete, and reinforcing steel rods, are not known. Materials such as cement and metal were shipped to the site from Los Angeles.[3]

4. Original Plans:
Two construction drawings of the sandbox were found in SCE electronic records. A drawing from 1915 showed an early design for the sandbox, of which only some elements were carried through to construction. Another drawing from 1925 showed the as-built condition of the sandbox.

As planned in the 1915 drawing, the sandbox was a single-chamber open structure approximately 400' long, with an irregular plan shape and curving walls. At its southeastern side, construction required excavation of the natural rock face, which partially contained the sandbox. In plan view, the outline of the structure resembled the shape of a gourd. From its origin just below the intake flume gate, the sandbox ballooned out to its widest point near the middle of the structure, approximately 100' across, before it constricted to approximately 30' near its outlet. A rotary fish screen was located in the constriction. Beyond that, the structure narrowed again into a flume. The floor at the downstream end of the sandbox (3621' in elevation) was 2' lower than at the upstream end (3623' in elevation), while the floor at the middle section of the sandbox was lower than the ends (mostly 3620' in elevation). Also the floor contained a total of six rectangular culverts, four of them within wide V-shaped channels, which ran

[1] Bob Powers, North Fork Country (Exeter, California: Bear State Books, 2003), 93-94, 100.
[2] Stephen D. Mikesell, "National Register of Historic Places Nomination, Kern River No. 3 Relicensing Project" (Walnut Creek, California: Entrix, Inc., 1989), 8-5, 8-6, 8-10.
[3] "Freighting with Motor Trucks on Kern River Project No. 3," Engineering News-Record 18 (1920): 868-869.

laterally across the sandbox. Each of the culverts was aligned with a drain gate located in the northwest wall of the structure.[4]

The 1925 as-built drawing of the sandbox showed a more sophisticated design than that proposed in 1915, although it retained some elements of the earlier plan. For instance, it was still approximately 400' long; it was tapered at both ends; it was 2' lower at the downstream end (3620' in elevation) than at the upstream end (3622' in elevation), and deeper in the middle than at the ends; and the northwest wall contained drain gates. However, rather than carving the structure out of natural rock adjacent to the dam, SCE constructed the sandbox some distance downstream. This was accomplished by extending the intake flume approximately 400' to the entrance of the sandbox. Also, SCE constructed the sandbox with a more regular plan shape than its earlier asymmetrical design. As constructed, it was mostly bottle-shaped with a widely flared entrance, straight parallel sidewalls approximately 60 feet apart, and a long-necked constriction at the downstream end that bent to the south and transitioned to a flume.[5]

The interior of the as-built sandbox demonstrated further innovation over its earlier design. The flared mouth of the sandbox was filled by a system of radiating, curving division walls with lateral bracing, which created multiple corridors of flow into the sandbox. In the floor, the previously proposed system of culverts and channels was absent. The floor was constructed with a broad bowl-shaped longitudinal section with its low point 2' lower than the upstream and downstream ends. The lowest part of the floor at the middle of the sandbox, at 3613' in elevation, corresponded to the pair of drain gates on the northwest side. Also, the sandbox was constructed with a wall dividing it into two chambers along its full length, each with its own inlet gate, fish screen, and outlet gate. The wall was laterally braced against the side walls, the tops of which were at 3633' in elevation.[6]

In 1922, a year after the KR3 system started operation, a Vice-President of the Pelton Water Wheel Company, which supplied the turbines to the KR3 power plant, described the KR3 sandbox as

> a double compartment, reinforced concrete, sand-settling basin, 400 feet long by 60 feet wide by 20 feet deep. This sand-box is constructed of such generous proportions in order to settle extremely fine particles, which because of their abrasive character, would greatly increase the wear in the turbines. The arrangement is such that one compartment may be drained of sediment while the other is in use. The usefulness of this settling basin has already been demonstrated.

[4] "Diversion Dam, Intake, Sand-box" (1915), Drawing #8139.
[5] "Exhibit L, Plan of Sandbox & Adjacent Flumes, Kern River Powerhouse #3 Project" (1925), Drawing #56475.
[6] "Exhibit L, Plan of Sandbox," Drawing #56475.

> At a point above the diversion dam, there is a natural settling basin which will catch the coarse sand for some time to come. After six months of operation the concrete sand-box was drained, and the slit found in the bottom was so fine that 45 per cent passed a 150-mesh screen, and 26 per cent passed a 200-mesh screen. Eventually, when the natural upstream basin is filled, the sandbox will catch all the sediment.[7]

5. Alterations and Additions:

The mechanisms for operating the inlet and outlet gates and the gates themselves have been replaced in the past, as indicated by the existing empty post holes in concrete mountings and the current hydraulic motive equipment. The materials that make up the inlet and outlet gates which consist of redwood square timbers held together by tie rods and structural steel framing/guiderails have generally been replaced with in-kind materials. In 1968 the original hand operated wheel actuators for the inlet and outlet gates were replaced with hydraulically (pressurized oil) operated motor actuators. In 2013, replacement of the sandbox gates with electric motor operated actuators was under consideration. Metal girders and wood timbers were installed as additional lateral reinforcement for several of the division walls at the entrance to the sandbox at an unknown date. A system of metal pipe railings and metal stairs was installed on top of and around the sandbox.

Two additional buildings are located in the area of the sandbox. One is a wood frame storage shed dating to 1921, identified as Building 128 and contributing to the system. It is sided in board and batten and includes a corrugated metal gabled roof and sliding door on the uphill side. It appears to be unmodified. A second structure, built in 1984 referred to as the "bubbler shack" is non-contributing to the system and is located on the downstream end of the sandbox where water enters the tunnel. It houses meters for gauging water levels in the tunnel.

B. Historical Context:

In 1914, William A. Brackenridge, Vice-President and General Manager of SCE, submitted a report recommending construction of the KR3 plant. Even so, the project for which he recommended approval was not fully designed. For example, Brackenridge initially proposed a second concrete diversion dam below the intake, which would act a settling basin for "the suspended matter, large quantities of sand and silt being at all times present in the water in the river." However, Brackenridge's initial design differed greatly from the sandbox that was actually constructed.[8]

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[7] Ely C. Hutchinson, "Kern River Number Three Plant of the Southern California Edison Company: With Special Reference to the Hydro-Electric Installation" (San Francisco: The Pelton Water Wheel Company, 1922), 6.
[8] Mikesell, "National Register," 8-7, 8-8, 8-16. Quotation is attributed to Brackenridge.

The settling basin was constructed at the upper end of the KR3 system. Several years before the start of construction, SCE made preparations for the site to serve as the highest point of operation in the system.

> . . . The earliest filing on the upper Kern, in 1900, was for 25,000 miner's inches just above Fairview by Henry Sinclair, then President of the Redlands Company. This later became the headworks site for Edison's Kern River No. 3 plant. . . .
>
> . . . Henry Sinclair's water rights for 25,000 miner's inches at Fairview had remained unused for years, although in 1906 Edison obtained a permit from the U. S. Department of Agriculture, signed by Thomas B. Sherwood, Acting Forester, to build a wagon road from the proposed Kern River No. 3 intake to the forks of the Kern. . . .
>
> Although the work had been in progress on the upper Kern ever since the first survey was made in 1901, not much progress had been made until after 1909, except for the token right of way to retain their rights. By the last part of 1910, the Edison Company had a rough wagon road upriver as far as what is now known as road's End. They had a camp set up at this spot that later became Camp 8, as it was the uppermost in a series of camps to be used in construction o f the Kern River No. 3 Hydroelectric Plant.[9]

Early construction activities at the KR3 site began in 1914 with work at the intake, setting up camps, and tunneling. Work continued into 1915.[10] However, during most of the period that the United States was involved in World War I, virtually no work occurred. When work resumed in earnest at KR3 in 1918, the intake and sandbox were completed first. Between 1919 and 1921, the tunnels and flumes, the powerhouse, the forebay and the penstocks were constructed, approximately in that order. Following completion of the power plant in 1921, SCE constructed a workers village near the KR3 powerhouse for its employees to live on site.[11]

At the time that KR3 was completed, it was referred to as "the most important forward step in hydroelectric practice in recent years."

> The hydraulic turbines and their auxiliaries are of particular interest, as they are operating under the highest head ever attempted with reaction turbine construction, and their design includes many novel features developed to meet special operating requirements.[12]

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[9] Power, North Fork Country, 90, 93.
[10] Power, North Fork Country, 98-99.
[11] Power, North Fork Country, 93-94, 96, 98-99
[12] Hutchinson, "Kern River Number Three," 6, 8.

Part II: Structural/Design Information

A. General Description:

The sandbox is a reinforced concrete open structure. It is 448' long and 82' feet wide along most of its length.[13] It is 20' deep at its center and 18' deep at it widest upstream and downstream points. The width and depth at the inlet gate, it is only 10' deep. It is 12' deep at the fish screens just before the outlet gates. At the inlet gate, it is only 10' deep, and it is 12' deep at the fish screens just before the outflow gates.[14] Its upstream end is flared and its downstream end constricts into a long neck.

The sandbox is divided lengthwise into two compartments by a vertical wall. Each compartment has its own wood inlet gate at the upstream end, metal fish screen at the downstream constriction, and wood outflow gate at the downstream end. Two cast iron drain gates with hydraulically operated actuators are located on the northwest (river side) of the sandbox and drain into the Kern River. The flared mouth of the sandbox contains curving division walls that radiate into the sandbox. The centerline wall and the curving division walls are laterally braced with post-and-beam that ties them to the sidewalls, resulting in a lattice of concrete reinforcement over the top of the open box. The tops of the sidewalls include a concrete lip around the exterior and a narrow platform on the northeast side over the drain gates. A concrete platform over the fish screens contains rails for a rolling crane (referred to as the "Trojan horse"), which stands on a berm adjacent to the sandbox. The surfaces of the exterior concrete sidewalls exhibit board form lines from the time that the sandbox was constructed.

1. Character:

The KR3 sandbox exhibits the historic character of an innovative settling basin from the early twentieth century. Its unique design incorporates principles of hydraulic flow, as evidenced by its long tapered shape, radiating division walls at the entrance, and sloped floor. These elements are largely intact and operating according to original specifications. Changes to the original structure that have occurred over time were largely limited to upgrades to manually operated gates and valves. These changes have not altered the underlying components or operation of the sandbox, and they have generally resulted in its improved functionality.

2. Condition of Fabric:

The sandbox is in overall good physical condition. The concrete sidewalls appear sound, with no major cracks or leaks. Previous repairs to sidewalls are evident by concrete patches and plugs. The concrete longitudinal center wall and the post-and-beam bracing also appear sound and well-maintained. However, the division walls at the mouth of the sandbox show signs of deterioration. Several sections of the walls are missing and others exhibit serious cracks, chipping, and damage at

[13] Mikesell, "National Register," 7-2
[14] "Exhibit L, Plan of Sandbox," Drawing #56475.

corners and edges. Additional lateral reinforcement and protective metal caps have been installed at the division walls as a preventative measure. However, it is likely that they will continue to deteriorate until a more comprehensive reinforcement solution is implemented. The gates and gate actuators are in excellent condition.

B. Construction:

According to a company drawing of SCE's construction program at the KR3 site from 1915, a total of eight construction camps were planned to support the project, most of which were located along the SCE company road that followed the course of the Kern River on its east bank. The highest of these, Camp 8, was located downstream from the headworks and sandbox site. Like most camps, it was three acres in size. In addition, two half-acre sites with facilities such as cement warehouses, blacksmith shops, and compressor houses were established along the road between Camp 8 and the headworks.[15]

> After the Edison road left Camp 7½, it went through what was later called Calkins Flat, around a sharp, rocky bend, and on upriver. Located on the little flat, which later became Road's End, was the Edison Company's Camp 8, the uppermost of their camps along the river. The Edison Company had a camp set up there since 1910. It served not only the men who worked on the upper tunnels but also the crew who constructed the intake.
>
> Construction of the intake started in 1914, but went rather slowly until 1918. At that time the rate of progress picked up, and the intake, with headgates for controlling the flow of water into the tunnel and traps for collecting and flushing sand out before it went into the tunnel system [i.e., the sandbox], was completed.[16]

Due to the remote location of KR3, the shipping of materials and equipment to the site during construction presented a challenge. While construction of hydro plants on the Kern River previously involved hauling by mule teams from the railhead, SCE sought a more modern solution to reach KR3, as reported in 1920.

> When the Southern California Edison Company early last year decided to rush construction on the hydro-electric development known as Kern River No. 3, the transportation problem presented itself first. The nearest railroad station was the little desert town of Caliente, 40 miles from construction headquarters, making the average haul to the several sites about 50 miles. The road was practically all up or down hill, the grades ranging up to 16 per cent. The construction contemplated called for

[15] "K. R. 3 System as Resurveyed in 1911" (1915), Drawing #51011.
[16] Power, North Fork Country, 100.

> supplies and materials amounting to 35,000 tons. The first question was whether it would be desirable to build a railroad. Surveys and estimates of cost were made but it was finally decided that it would be more economical to use motor trucks.[17]

SCE assembled a fleet of 95 trucks, including 43 company vehicles and 42 privately owned vehicles, to haul freight for KR3. Great attention was given to the organization of the workforce in order to minimize delays in loading and unloading. In Caliente, which served as the railhead where freight was unloaded, SCE set up a fully equipped truck maintenance garage. SCE also kept a warehouse in Caliente half full with cement in order to account for a fluctuating rail shipment schedule that could deliver either an abundance of cement or very little. A 50-mile long telephone line was installed along the road with stations approximately four miles apart to allow truck drivers to report.[18] SCE used Bulldog Mack trucks with hard rubber tires to haul materials.[19]

C. Operation:

The sandbox's primary function is to slow the flow of water as it enters and passes through its structure thus allowing sand and sediment to drop out of the water. This is accomplished by spreading out the flow from the narrow intake flume to the larger volume of the sandbox, which reduces its rate of passage. The dividing walls that radiate into the sandbox from its mouth augment the process. These curved walls divide the linear flow from the intake flume into separate channels that fan out to the full width of the sandbox. The long passage through the sandbox also slows and calms the moving water.

The decrease in flow rate within the sandbox allows suspended sediments, which are heavier than water, to settle to the sandbox floor before water exits the structure. The shallow bowl-shaped floor of the sandbox contains and concentrates the sediments towards it center, which is 2' lower at the middle than at the sides. The flow of water through the sandbox is constant because the lower end of the sandbox at the outlet gates is 2' lower than the upper end at the inlet gates. At the exit, the sandbox tapers to the width of the outflow flume. This serves to constrict the flow of water from the sandbox and increases the rate of flow into the conduit.

The sandbox is divided longitudinally into two compartments, each with its own inlet gate, outflow gate, and fish screen, which can be operated independently. Also, each compartment is separately connected to one of the sluice gates at the northwest side of the sandbox. Periodically, accumulated sediment is flushed back into the Kern River through the drain gates, which are located at the deepest part of the sandbox on the river side. This is accomplished by maintaining one chamber in operation while the flow to the other chamber is shut off at the inflow gate; it is emptied and flushed, and then put back in service.

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[17] "Freighting," 868.
[18] "Freighting," 868-869.
[19] Powers, North Fork Country, 90.

D. Site Information:

The sandbox is located on the east bank of the upper Kern River, immediately west of Mountain Highway 99. Steep rocky valley walls rise to either side of the river. The sandbox is located approximately 400 feet downstream from the KR3 diversion dam, intake, and control building. The site is relatively flat, with the southeast side of the sandbox abutting a roadside berm. Adjacent to the sandbox, a wood frame storage shed, building 128, is located on the berm. Downstream from the sandbox, the "bubblershack" houses gauging equipment, rebuilt in 1984 is located on top of the outlet flume.

Part III: Sources of Information

A. Primary Sources:

"Freighting with Motor Trucks on Kern River Project No. 3." Engineering News-Record 18 (1920): 868-869.

Hutchinson, Ely C. "Kern River Number Three Plant of the Southern California Edison Company: With Special Reference to the Hydro-Electric Installation." San Francisco: The Pelton Water Wheel Company, 1922.

Drawings provided by SCE:

"Diversion Dam, Intake, Sand-box." 1915. Drawing #8139.

"Exhibit L, Plan of Sandbox & Adjacent Flumes, Kern River Powerhouse #3 Project." 1925. Drawing #56475.

"K. R. 3 System as Resurveyed in 1911." 1915. Drawing #51011.

"K. R. 3 System as Resurveyed in 1916." 1916, revised 1919. Drawing #51056.

Secondary Sources:

Brodie, Natalie, and Roderick McLean. "Final Kern River 3 Hydroelectric Historic District Update." Carlsbad, California: LSA Associates, Inc., 2012.

Mikesell, Stephen D. "National Register of Historic Places Nomination, Kern River No. 3 Relicensing Project." Walnut Creek, California: Entrix, Inc., 1989. Prepared for SCE.

Myers, William A. Iron Men and Copper Wires: A Centennial History of the Southern California Edison Company. Glendale, California: Trans-Anglo Books, 1986.

Powers, Bob. North Fork Country. Exeter, California: Bear State Books, 2003.

Southern California Edison Company. Southern California Edison Hydro Generation Division (Draft). Rosemead, California: Southern California Edison Company, 1994.

Appendix A: Images

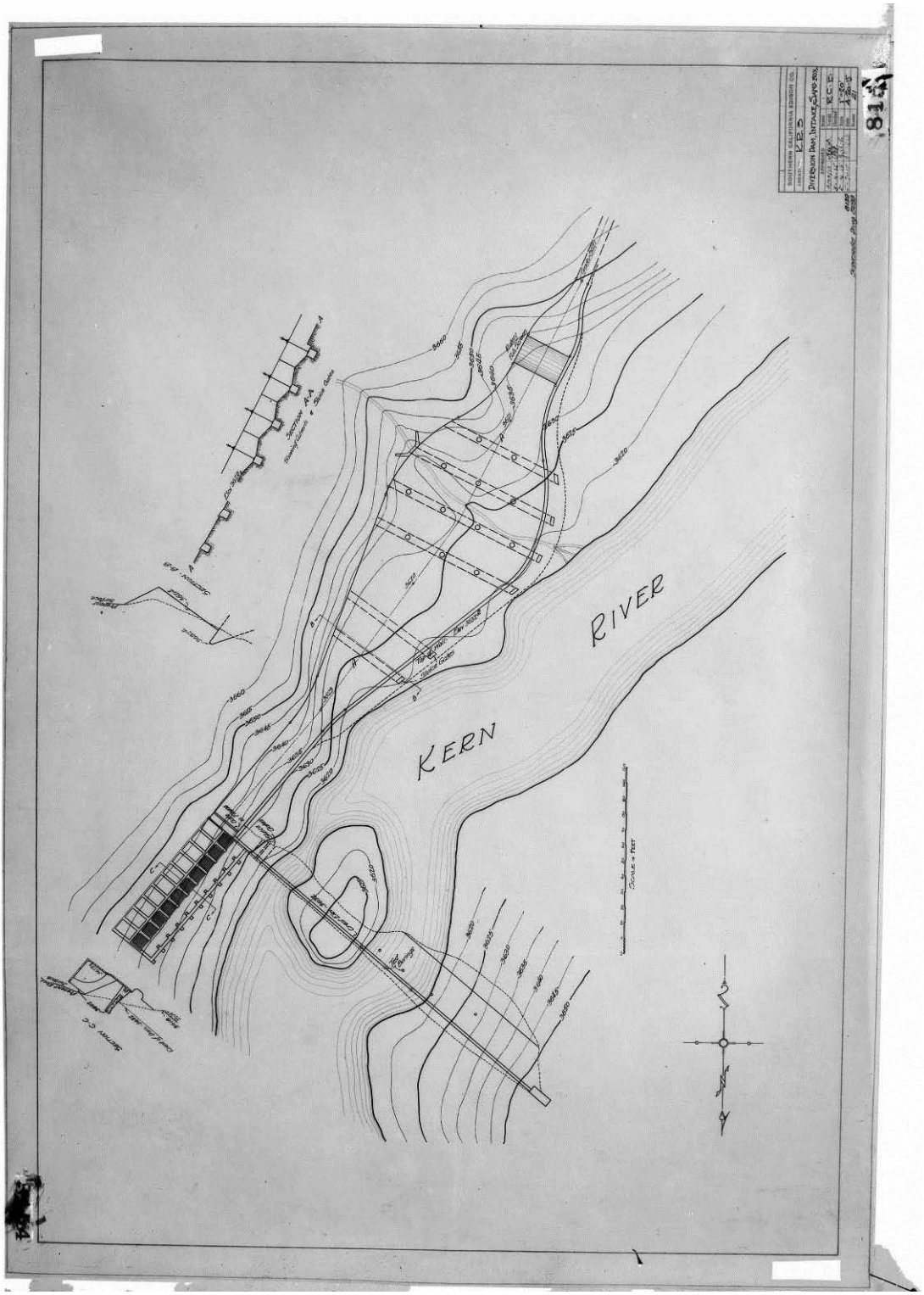

Figure 1: "Diversion Dam, Intake, Sand-box." 1915. Drawing #8139.

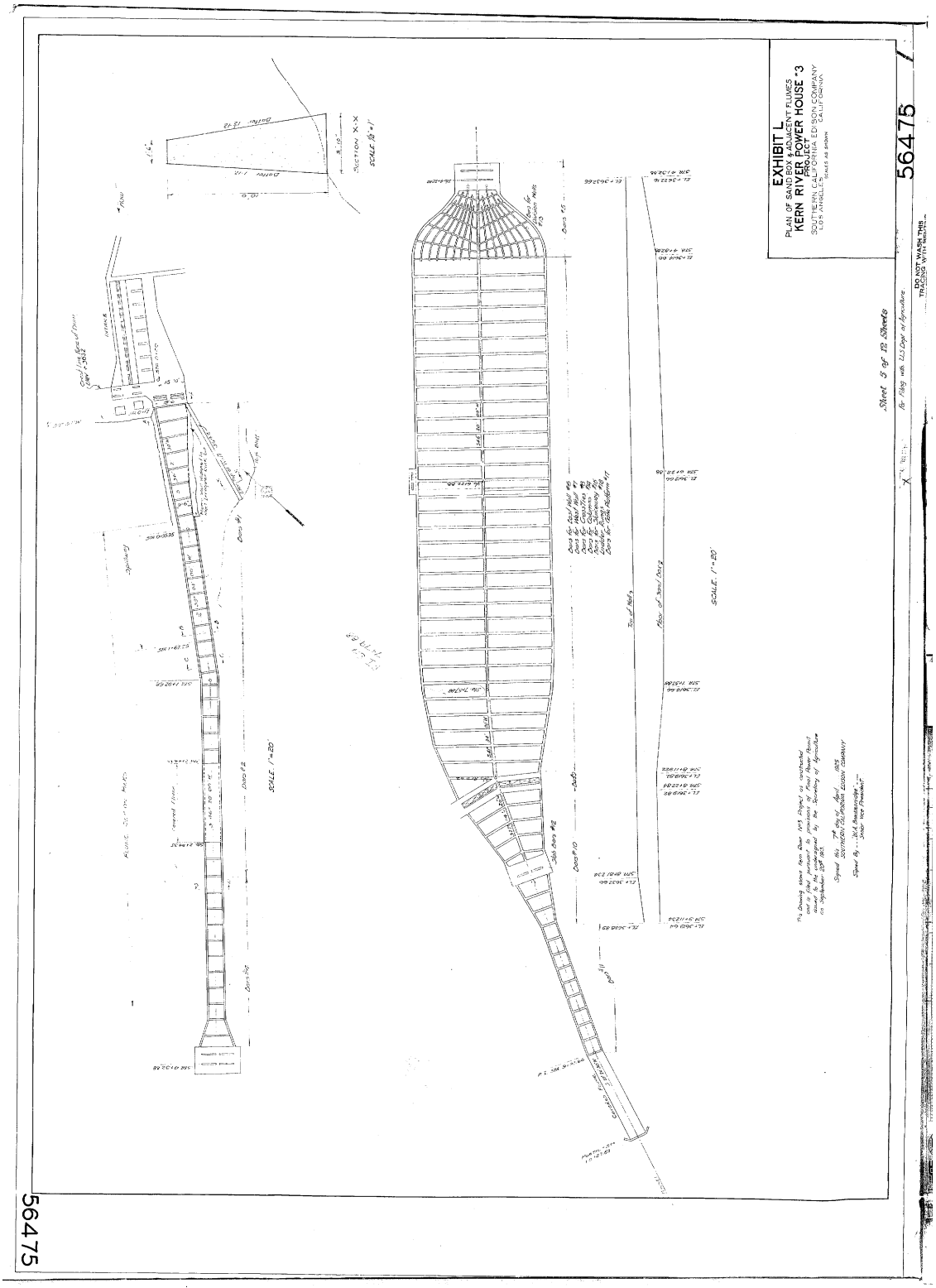

Figure 2: "Exhibit L, Plan of Sandbox & Adjacent Flumes, Kern River Powerhouse #3 Project." 1925. Drawing #56475.

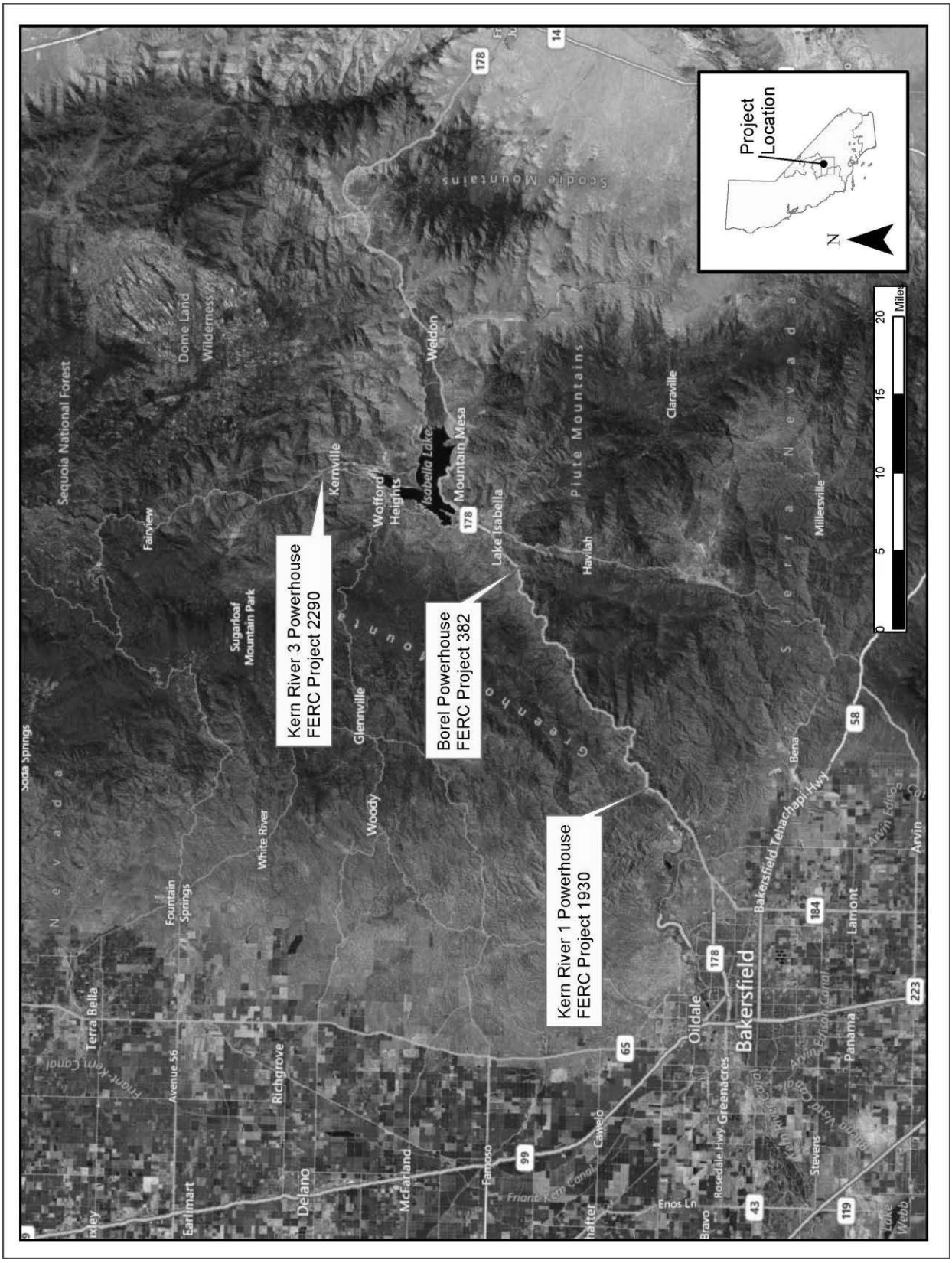

Figure 3: Project Location Map. Kern River 3 Powerhouse (FERC Project 2290).

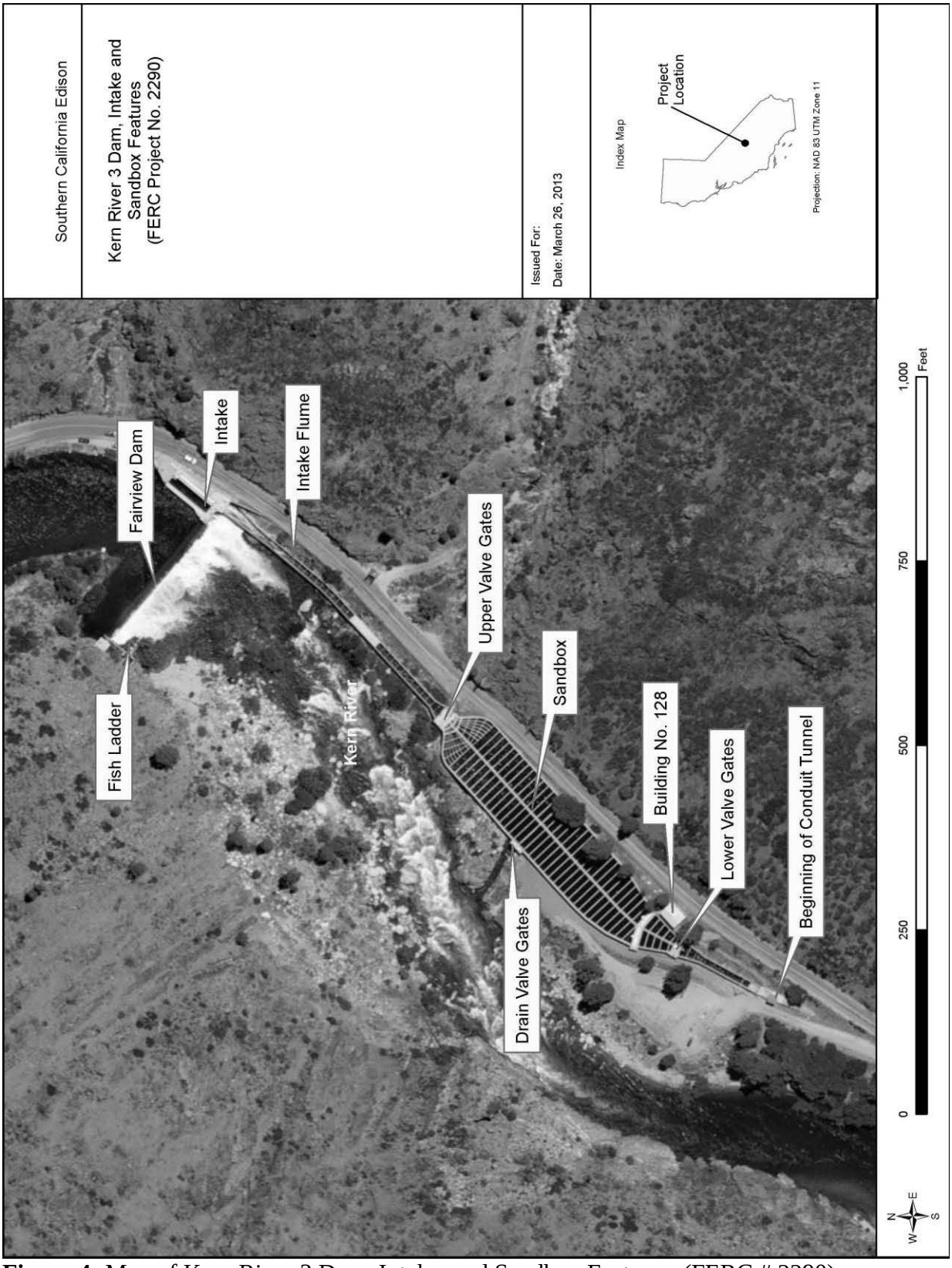

Figure 4: Map of Kern River 3 Dam, Intake, and Sandbox Features. (FERC # 2290).

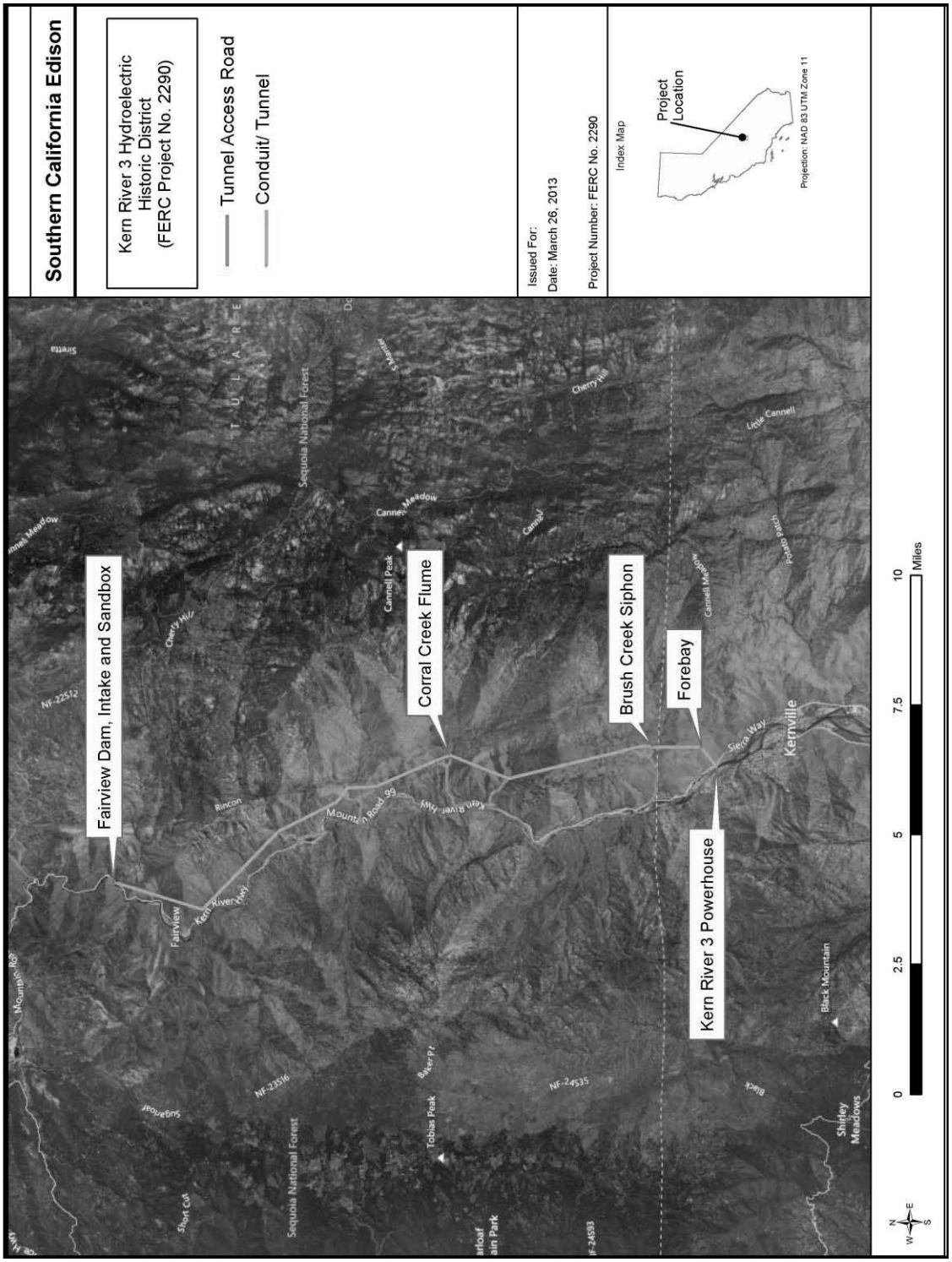

Figure 5: Overview map of the Kern River 3 Hydroelectric Historic District. March, 2013.