

Appendix A

Project Facilities and Maps

Appendix A1

Project Facilities

Table A1-1. Summary of General Information, Project Facilities, and Features

General Information	
Owner and Operator	Pacific Gas and Electric Company
FERC Project Number	96
Current License Term	50 years (through November 30, 2022) ^a
Commenced Commercial Operation	1920
County	Fresno and Madera counties
Hydrologic Drainage Basin	Upper San Joaquin River basin
Watersheds	San Joaquin River watershed
Water Rights	Four individual licensed water rights for a combined total of: <ul style="list-style-type: none"> • 1,775 cfs diversion and 3,200 acre-feet storage for hydropower generation at K1 and K2 Powerhouses • 4,600 cfs for hydropower generation and incidental domestic uses at K2 Powerhouse
Dams and Reservoirs	
Dams:	Kerckhoff Dam
Reservoirs:	Kerckhoff Reservoir
Intakes and Water Conveyance System	
Intake Structures:	
	K1 Intake Structure
	K2 Intake Structure
Tunnels and Surge Chambers:	
	K1 Tunnel
	K1 Surge Chamber ^b
	K2 Tunnel
	K2 Surge Tank/Chamber
	K2 Discharge Tunnel
Penstocks: ^c	
	K1 Penstock No. 1 ^b
	K1 Penstock No. 3 ^b
	K2 Penstock
Access Tunnels and Adits	
	Adit 1 to K1 Tunnel ^b
	Adit 2 to K1 Tunnel ^b
	North Adit to K1 Tunnel (instream flow release)
	Portal door and access tunnel to K2 Powerhouse
	K2 Penstock construction access tunnel (plugged)
Powerhouses and Switchyards	
	K1 Powerhouse (above ground)
	K2 Powerhouse (underground)
	K1 Switchyard
	K2 Switchyard (and Communication Building)

Project Compliance Gages
J-1 gage – Kerckhoff Reservoir
J-2 gage – San Joaquin River below Kerckhoff Dam
J-7 water temperature gage ^d
Project Communications and Electric Distribution
Fiber optics and 12-kV pole line between the K2 Switchyard and non-Project substation near K1 Headworks
K1 6.6-kV overhead line
Helicopter Landing Zones
HLZ at J-1
HLZ at J-2
HLZ at J-2 low-flow measurement site
HLZ at J-7 ^e
HLZ at Smalley Cove
HLZ near K2 Powerhouse
Ancillary and Support Facilities
Runoff piping above K2 Intake Structure
Boat dock adjacent to A.G. Wishon Powerhouse
Boat dock near tunnel intakes on Kerckhoff Reservoir
Wood storage building on slope above intake structures
Metal storage building between boat dock and K2 Intake Structure
K1 Headworks ^b
Control house near K1 Powerhouse ^b
Communication Building near K1 Powerhouse ^f
Warehouse near K1 Powerhouse
Laydown storage area near K1 Powerhouse
Flood wall at K1 Powerhouse
K2 Tunnel vent
Staging area near K2 Tunnel portal
Public and Worker Safety Features
Log boom on Kerckhoff Reservoir
Boat barrier on Kerckhoff Reservoir
Fencing around the K1 Powerhouse, the K2 Powerhouse, both switchyards, and all headworks; each end of dam crest; and across the path between the boat dock and the trash rake conveyor system at the dam
Boat barrier at K2 Tailrace
Project Roads^g
Access Road 1 (from Access Road 2 to Adit 1)
Access Road 2 (Smalley Road to Adit 2)
Access Road 3 (Access Road 6 – BLM Shared to K1 Powerhouse [Lower])
Access Road 4 (Access Road 3 to K1 Powerhouse [Upper])
Access Road 5 (Access Road 6 – BLM Shared to Laydown Storage Area)
Access Road 5 to 7 Connector (Access Road 5 to Access Road 7)
Access Road 6A (segment from Access Road 6 – BLM Shared to K2 Discharge Tunnel)
Access Road 6B (segment from Access Road 6A to K2 Powerhouse Access Tunnel)
Access Road 6C (segment from Access Road 6 – BLM Shared to K1 Surge Chamber)

Access Road 7 (Access Road 6C to K1 Powerhouse Headworks)
Access Road 8 (Access Road 6 – BLM Shared to K2 Surge Tank/Chamber)
Access Road 9 (Access Road 10 to K2 Penstock Construction Access Tunnel)
Access Road 10 (Access Road 6 to K2 Switchyard)
Smalley Cove Recreation Area Road
Project Trails^g
Trail to J-2 (Kerckhoff Dam to J-2 Gage)
Access path from dock to dam
Access path to North Adit from dam (Kerckhoff Dam to North Adit)
Trail from J-7 HLZ to San Joaquin River (HLZ to J-7 gage) ^e
Project Recreation Facilities
Smalley Cove Recreation Area

Notes: cfs – cubic feet per second
 HLZ – helicopter landing zone
 K1 – Kerckhoff 1
 K2 – Kerckhoff 2

- a The 50-year term for the date of expiration is from expiration of the original license on October 5, 1976.
- b Under the Proposed Action, the facilities would no longer be Project works, but would remain within the FERC Project Boundary as facilities used to maintain the Project, as described in the K1 retirement plan.
- c K1 Penstock No. 2 was abandoned in place and removed from the Project license in 2013.
- d Since 2015, PG&E has been monitoring water temperature at the Gage J-2 location downstream of Kerckhoff Dam, in addition to Gage J-7. In 2020, PG&E relocated the J-7 water temperature gage from its historical location approximately 1/3 mile upstream of the K1 Powerhouse to the K1 Powerhouse (J-7@K1 site) with concurrence from the California Department of Fish and Wildlife.
- e This feature is not included in the Proposed Action.
- f In the Draft License Application, this structure was referred to as the K1 Hoist House.
- g Project roads and trails are shown on Map A2-2a through Map A2-2e. Text in parentheses describes where access roads begin and end as depicted in Maps A2-2a through Map A2-2e.

Table A1-2. Project Facilities and Other Relevant Details

Kerckhoff Dam	
Dam location	San Joaquin River
Constructed	1920
Drainage area	1,481 square miles
Dam type	Concrete arch structure (constant angle arch, variable radius dam)
Elevation datum	North American Datum 1983
Hazard classification	Low
Height of dam height above streambed	<ul style="list-style-type: none"> • 91 feet from base of dam to spillway crest • 114.5 feet from base of dam to top of dam
Dam crest length	507 feet at elevation of 994.5 feet above msl
Dam thickness	36 feet (maximum)
Elevation of dam crest	994.5 feet above msl
Low-level outlet capacity	3,900 cfs
Low-level outlet pipes	Three 72-inch-diameter pipes
Required minimum flow below Kerckhoff Dam	<ul style="list-style-type: none"> • 25 cfs (Normal water years) • 15 cfs (Dry water years)
Spillway	
Spillway elevation	Spillway crest at gates at elevation 971.3 feet above msl
Type	14 radial gates: 14.3 feet high by 20 feet long
Spillway length	280 feet
Gate operation	<ul style="list-style-type: none"> • Radial Gates 1–9: Manually operated (normally operated during storms/high-flow conditions) • Radial Gates 10–14: Automatically operated
Capacity	43,700 cfs
Flood/spill of record	1997
Radial gate control	Automatically controlled gate hoist
Kerckhoff Reservoir	
Normal maximum water surface elevation	985.0 feet above msl
Normal operating range	4.5 feet (980.0 to 984.5 feet above msl)
Reservoir length	Approximately 3.0 miles ^a
Shoreline length	Approximately 10.3 miles ^a
Original gross storage	4,252 acre-feet
Usable capacity (at normal maximum water surface elevation)	2,434 acre-feet
Surface area (at normal maximum water surface elevation)	175 acres (985.0 feet above msl)

K1 Powerhouse and Associated Facilities	
K1 Intake Structure	<ul style="list-style-type: none"> Reinforced concrete structure with two 8.5-foot x 21.4-foot fixed-wheel gates, with trash racks Elevation invert 942.0 feet
Tunnel	<ul style="list-style-type: none"> 16,913-foot-long tunnel Approximately 17-foot x 17-foot rectangular tunnel cross section near the intake Capacity of 1,700 cfs
Surge chamber	Simple
Penstocks ^b	<ul style="list-style-type: none"> K1 Penstock No. 1: 913 feet long K1 Penstock No. 3: 946 feet long
Tailrace	Powerhouse discharges directly to the San Joaquin River
K1 Powerhouse	
Location	Located 8 miles downstream from Kerckhoff Dam ^c
Date of commission	August 15, 1920
Structure	Reinforced concrete
Construction material	Reinforced concrete with natural rock walls below ground
Approximate size	45 feet x 99 feet (main floor)
Authorized installed capacity	22,720 kW
Normal operating capacity	25,200 kW
Turbine	
Number of units	Two
Type	Vertical reaction-type Francis turbine
Manufacturer	Allis-Chalmers
Rated output	15,000 hp each at 360 RPM
Licensed nameplate capacity	15,000 hp
K1 Powerhouse (continued)	
Static head	350 feet
Maximum flow	1,500 cfs (design) 1,156 cfs (actual)
Generator	
Number and Type	<ul style="list-style-type: none"> Three-phase 60-cycle, 0.8 power factor, 6,600-volt revolving field Two units
Manufacturer	Allis-Chalmers
Authorized installed capacity	Each unit: 11,360 kW (14,200 kVA) for a total of 22,720 kW
Normal operating capacity	Each unit: 12,600 kW for a total of 25,200 kW
Voltage	6,600 volt
Average annual energy	176 million kWh
K2 Powerhouse and Associated Facilities	
K2 Intake Structure	<ul style="list-style-type: none"> Reinforced concrete structure equipped with two 10.6-foot x 24.6-foot fixed-wheel gates, with trash racks Elevation invert 934.0 feet

Tunnel	21,632 feet long with a 24-foot diameter
Surge tank/chamber	Simple
Penstock	One 1,013-foot-long penstock
Tailrace	Concrete discharge channel with 40-foot-wide base and 4 to 1 side slopes
Discharge tunnel to tailrace	717 feet long with a 25-foot diameter
K2 Powerhouse	
Location	Underground powerhouse located 9.8 miles downstream of Kerckhoff Dam ^c
Date of commission	May 6, 1983
Structure	Underground, in a circular rock chamber
Construction material	Excavated rock chamber
Approximate size	85 feet in diameter, 124 feet high
Authorized installed capacity	140,000 kW
Normal operating capacity	155,000 kW
Turbine	
Number of units	One
Type	Vertical shaft, Francis type
Manufacturer	Hitachi
Rated output	190,000 hp at 180 RPM
Normal maximum gross head	421 feet
Maximum hydraulic capacity	5,100 cfs
Generator	
Number and type	One unit, 3-phase, 60 hertz, 0.90 power factor
Manufacturer	General Electric
Authorized installed capacity	140,000 kW (155,000 kVA)
Normal operating capacity	155,000 kW
Voltage	13,800 volts
Average Annual Energy	290 million kWh

Notes: cfs – cubic feet per second
HLZ – helicopter landing zone
hp – horsepower
kV – kilovolt
kVA – kilovolt ampere
kW – kilowatt
kWh – kilowatt-hour
msl – mean sea level
RPM – revolutions per minute

- a** Mileage is at normal maximum water surface elevation (985.0 feet above msl) and reflects latest information based on geographic information system analysis.
- b** K1 Penstock No. 2 was abandoned in place and removed from the Project license in 2013.
- c** Mileage reflects latest information based on geographic information system analysis.

Appendix A2

Maps, June 2023

APPENDIX A-2 MAPS — ACCESSIBLE SUMMARY FOR FERC FILING

This narrative summary is provided ahead of the map figures to give readers and listeners a structured understanding of the information presented, ensuring that the intent, organization, and content of the maps are accessible regardless of the user's ability to visually interpret complex cartographic documents.

Appendix A-2 contains map figures prepared in support of the Kerckhoff Hydroelectric Project (FERC Project No.96) Final License Application (March 2023). The maps visually depict the location, extent, and configuration of existing project facilities and features, as well as surrounding land ownership and recreation areas within the project vicinity.

Because the figures include dense symbology, overlapping labels, and multiple infrastructure elements displayed simultaneously, this written summary is provided as an overview and interpretive aid for accessibility and clarity. The summary is intended to help the viewer or listener understand the maps before or while reviewing the figures, and it serves as a functional equivalent description consistent with Section 508 requirements.

Map A2-1: Overview of Major Project Facilities and Land Ownership

Map A2-1 presents a regional-scale overview of the Kerckhoff Hydroelectric Project along the San Joaquin River. It illustrates the general project setting and identifies major components, including:

- Kerckhoff Dam and Kerckhoff Reservoir
- Kerckhoff 1 Powerhouse (above ground) and Kerckhoff 2 Powerhouse (underground)
- Associated tunnels, adits, penstocks, powerlines, and project access roads
- Nearby non-project facilities, such as A.G.Wishon Powerhouse and San Joaquin No. 1A Powerhouse

The map also shows surrounding recreation and jurisdictional areas, including Sierra National Forest, San Joaquin River Gorge Recreation Area, Millerton Lake State Recreation Area, and Smalley Cove Recreation Area. Land ownership and management are identified for PG&E, the Bureau of Land Management, Bureau of Reclamation, U.S. Forest Service, the State of California, and private lands.

Maps A2-2a through A2-2e: Project Facilities and Features (Sheets 1–5 of 5)

Together, Maps A2-2a through A2-2e provide a series of detailed, large-scale views of the Kerckhoff Project facilities. Each sheet covers a different portion of the project area while using consistent legends and symbols.

Common Elements Shown Across All Sheets

Across the five sheets, the maps identify:

- Project facilities such as dams, powerhouses, tunnels, intakes, penstocks, surge chambers, switchyards, communication buildings, and gages
- Water conveyance features, including tunnels, adits, instream flow pipes, and runoff piping
- Electrical and communication infrastructure, including fiber optics and 12-kilovolt pole lines
- Transportation and access features, such as paved and unpaved project roads, shared BLM and U.S. Forest Service roads, locked gates, boat docks, and trails
- Recreation features, including Smalley Cove Recreation Area, trails, boat barriers, log booms, and designated access points
- Helicopter Landing Zones (HLZs) used for inspections, construction, maintenance, and emergency access
- FERC project boundary, shown relative to lakes, rivers, streams, and adjacent lands

Land ownership and management jurisdictions are consistently depicted on all sheets.

Map A2-2a (Sheet 1 of 5)

This sheet provides an index-style overview showing the spatial relationship between Redinger Lake, Corrine Lake, Kerckhoff Reservoir, Millerton Lake, and the San Joaquin River Project Bypass Reach. It establishes the location of the downstream detailed sheets and highlights the primary project area.

Map A2-2b (Sheet 2 of 5)

Map A2-2b focuses on the Smalley Cove Recreation Area and adjacent river corridor. It shows:

- Recreation facilities and access roads
- Boat docks and barriers
- HLZs, including those near Smalley Cove and the J-2 low-flow site
- The proximity of non-project facilities such as A.G. Wishon Powerhouse

Map A2-2c (Sheet 3 of 5)

This sheet centers on Kerckhoff Dam and the areas immediately surrounding it. It depicts:

- Intake structures for Kerckhoff 1 and Kerckhoff 2
- Tunnel portals, adits, access paths, and gaging cableways
- Storage areas and dam-related access routes
- HLZs near key operational features

Map A2-2d (Sheet 4 of 5)

Map A2-2d illustrates the area around Kerckhoff 1 Powerhouse and its support infrastructure. Features include:

- Powerhouse structures, switchyard, surge chamber, and headworks
- Warehouses, control houses, flood walls, and laydown areas
- A network of access roads, including shared BLM roads
- Communication and power lines supporting the facility

Map A2-2e (Sheet 5 of 5)

This sheet focuses on the Kerckhoff 2 Powerhouse area. It shows:

- The underground powerhouse, discharge tunnel, surge tank, and switchyard
- Construction and operational access tunnels
- Staging areas and multiple access roads
- HLZs associated with Kerckhoff 2 facilities
- Connections to nearby trails and Millerton Lake

Overall Intent of Appendix A-2

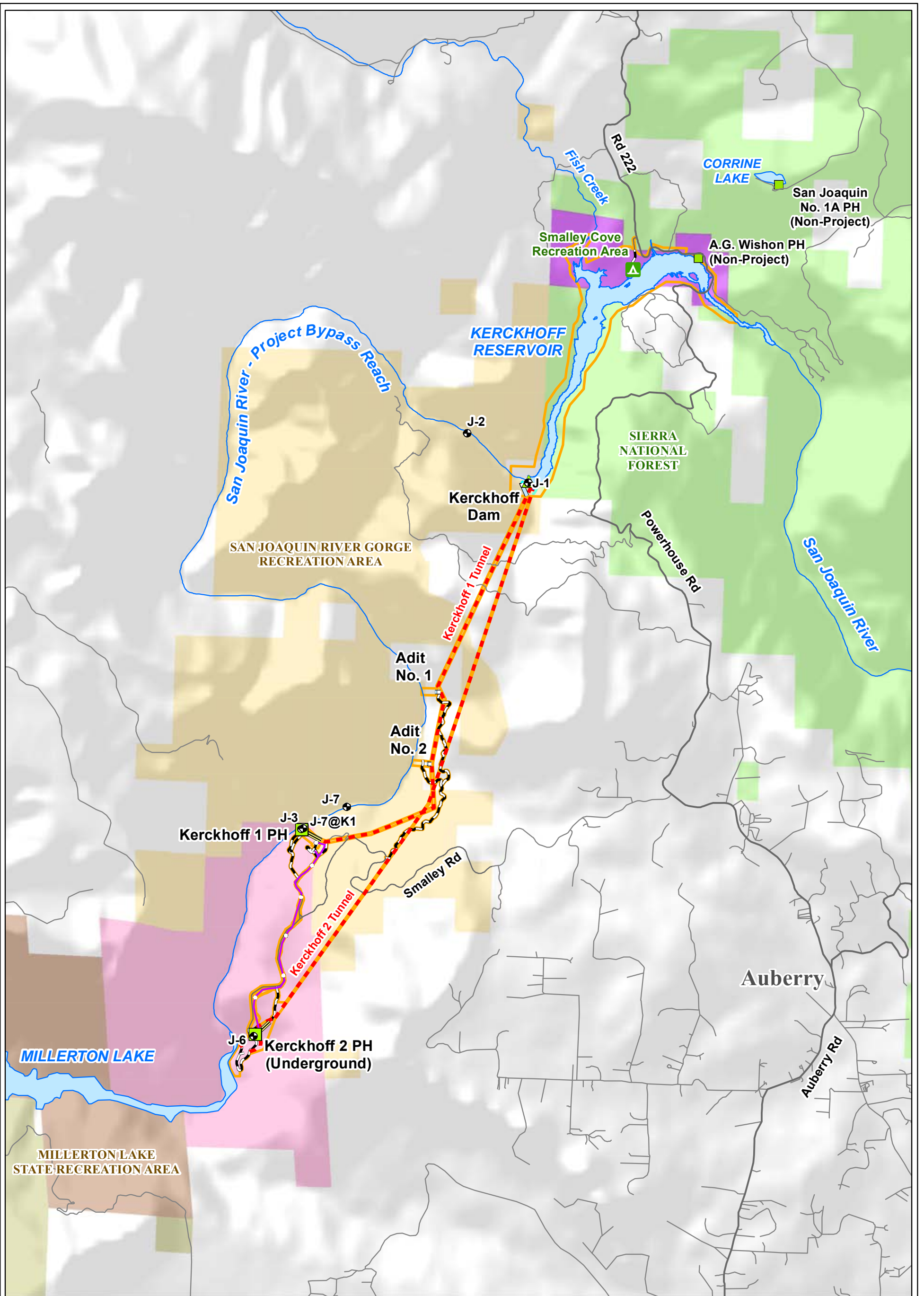
Taken together, the maps in Appendix A-2 provide a comprehensive visual description of the existing Kerckhoff Hydroelectric Project facilities, their relationship to the surrounding landscape, and their operation within the San Joaquin River corridor.



Maps



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PG&E Project Facilities

- Powerhouse
- ▲ Dam
- - - Water Conduit
- Penstock
- 12kV and Fiber Optics Line
- Project Road
- ▲ Recreation Area
- FERC Project Boundary

Other Features

- Other Road
- Watercourse
- Water Body
- Gage

Land Ownership*

- Bureau of Land Management (BLM)
- Bureau of Reclamation lands including those under BLM management
- Bureau of Reclamation lands under State of California management
- State of California
- U.S. Forest Service
- PG&E
- Private (Blank)

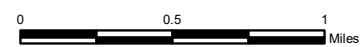
*SOURCE: BLM, 2020



PG&E Kerckhoff Project (FERC No. 96)

Map A2-1

Overview of Major Project Facilities and Land Ownership



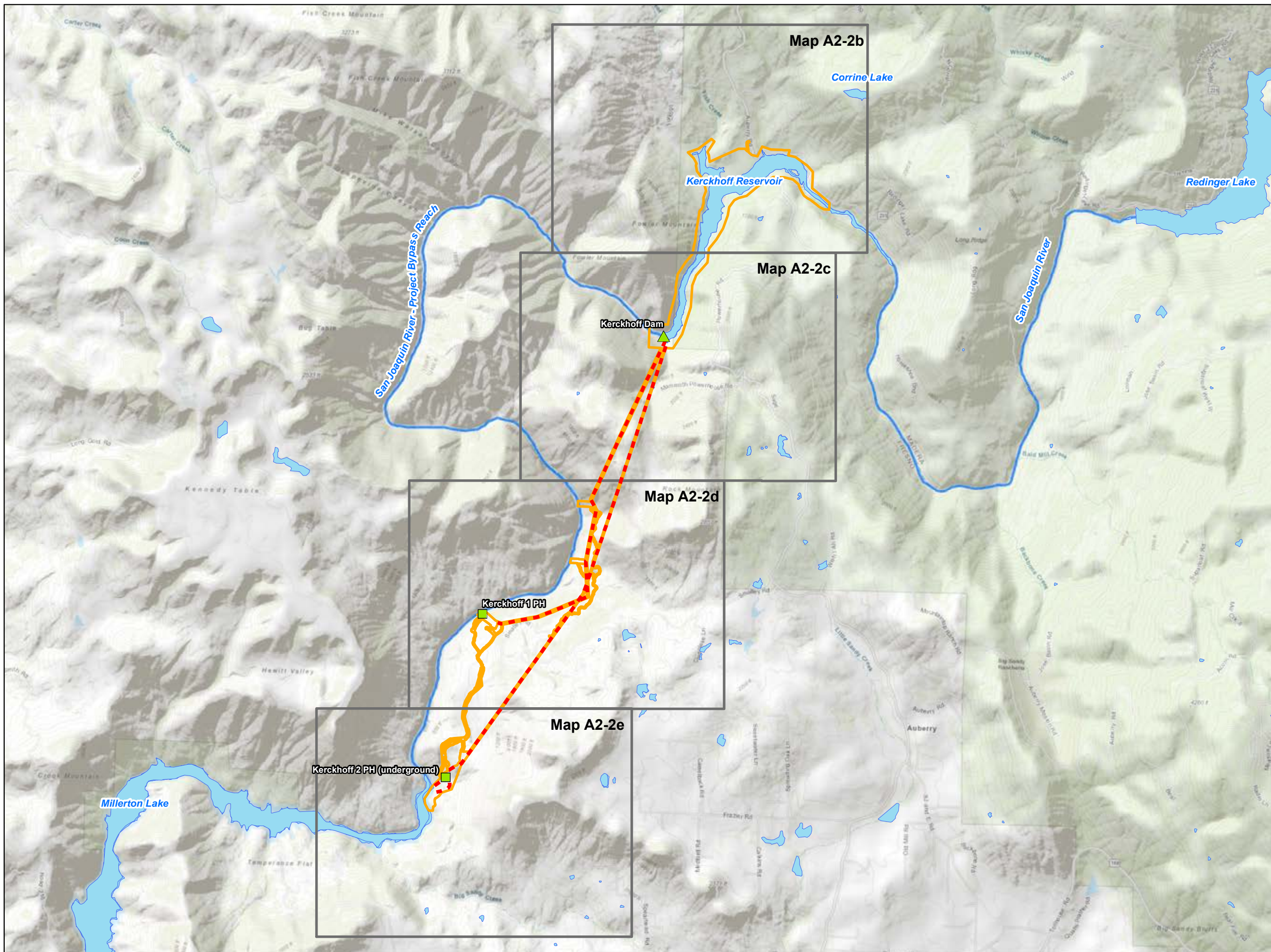
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Datum: NAD 83



10/13/2020



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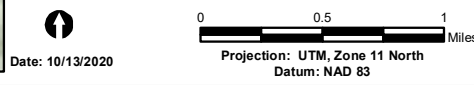


- PG&E Project Facilities**
- ▲ Dam
 - Powerhouse
 - Tunnel
 - FERC Project Boundary
- Other Features**
- Lake/Reservoir
 - River/Stream



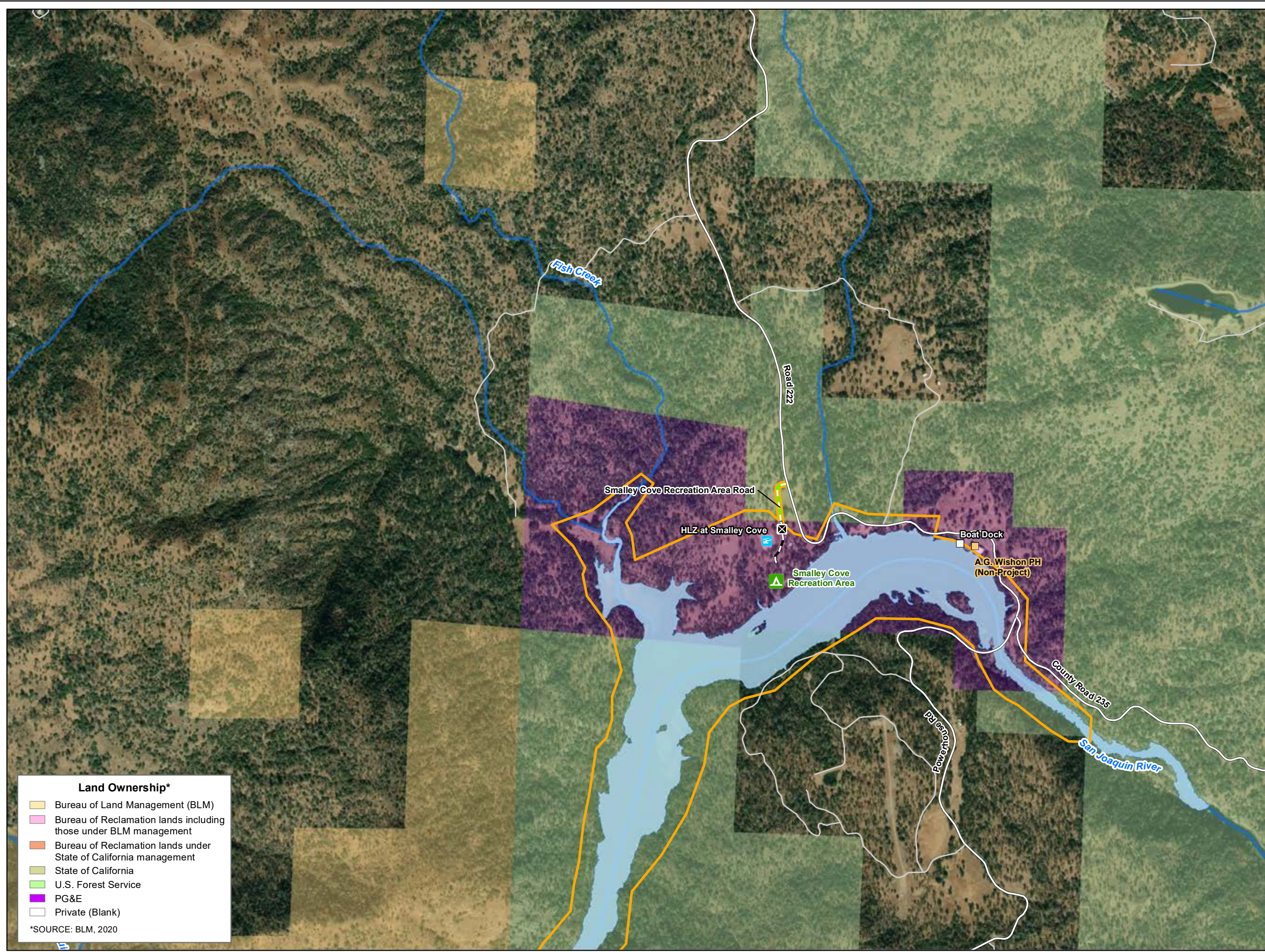
PG&E Kerckhoff Project (FERC No. 96)

Map A2-2a
Project Facilities and Features
(Sheet 1 of 5)



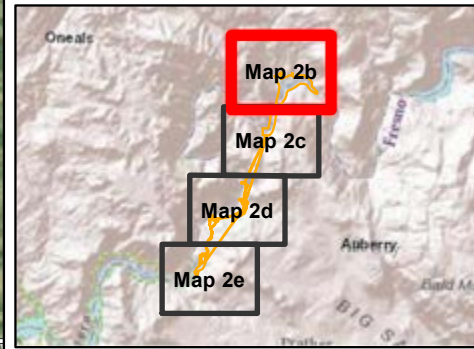


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- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Helicopter Landing Zone (HLZ)
 - Building
 - Ancillary and Other Facilities
 - Tunnel
 - Penstock
 - Adit
 - Instream Flow Pipe
 - Runoff Piping
 - Fiber Optics & 12kV Pole Line
 - 6.6 kV Line
 - Boat Barrier
 - Log Boom
 - Project Trail
 - Fence
 - FERC Project Boundary
- Project Recreation Facilities**
- Smalley Cove Recreation Area
- Transportation System Features**
- Locked Access Gate
 - Project Road
 - BLM Shared
 - USFS Shared
 - Non-Project Public Access Road
 - Other Road
- Other Features**
- Lake/Reservoir
 - River/Stream
- Non-Project Facilities**
- A.G. Wishon Powerhouse

- Land Ownership***
- Bureau of Land Management (BLM)
 - Bureau of Reclamation lands including those under BLM management
 - Bureau of Reclamation lands under State of California management
 - State of California
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM, 2020



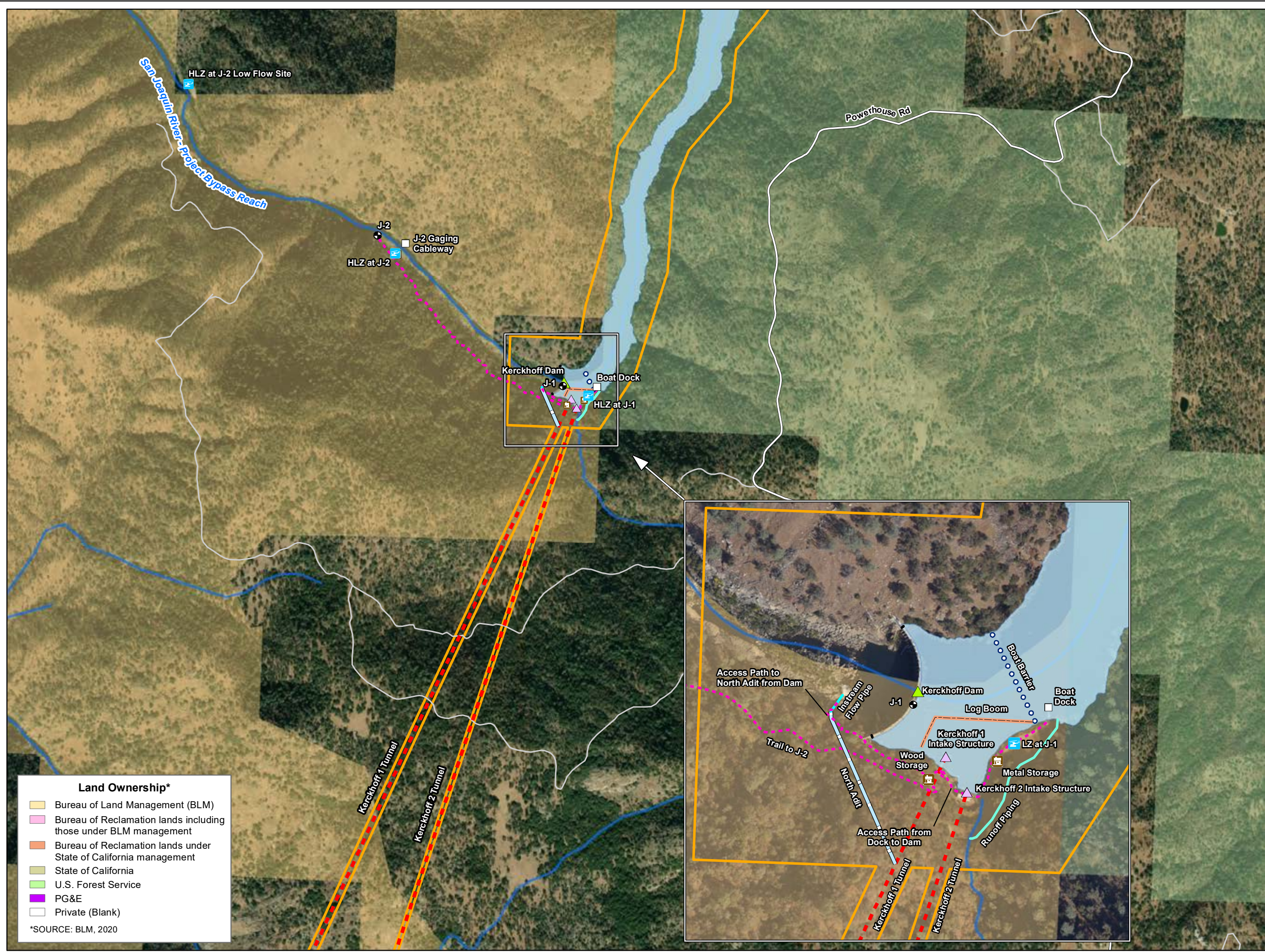
PG&E Kerckhoff Project (FERC No. 96)

Map A2-2b
Project Facilities and Features
(Sheet 2 of 5)



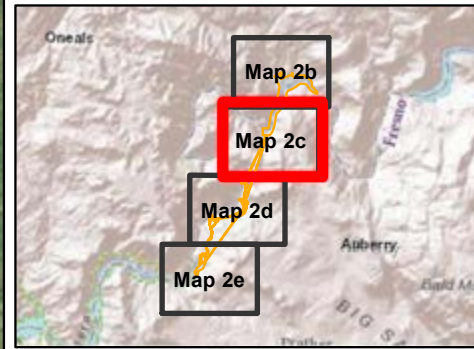


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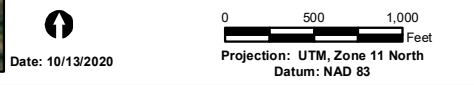
- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Helicopter Landing Zone (HLZ)
 - Building
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 - Tunnel
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 - River/Stream
- Non-Project Facilities**
- A.G. Wishon Powerhouse

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 - Bureau of Reclamation lands under State of California management
 - State of California
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM, 2020



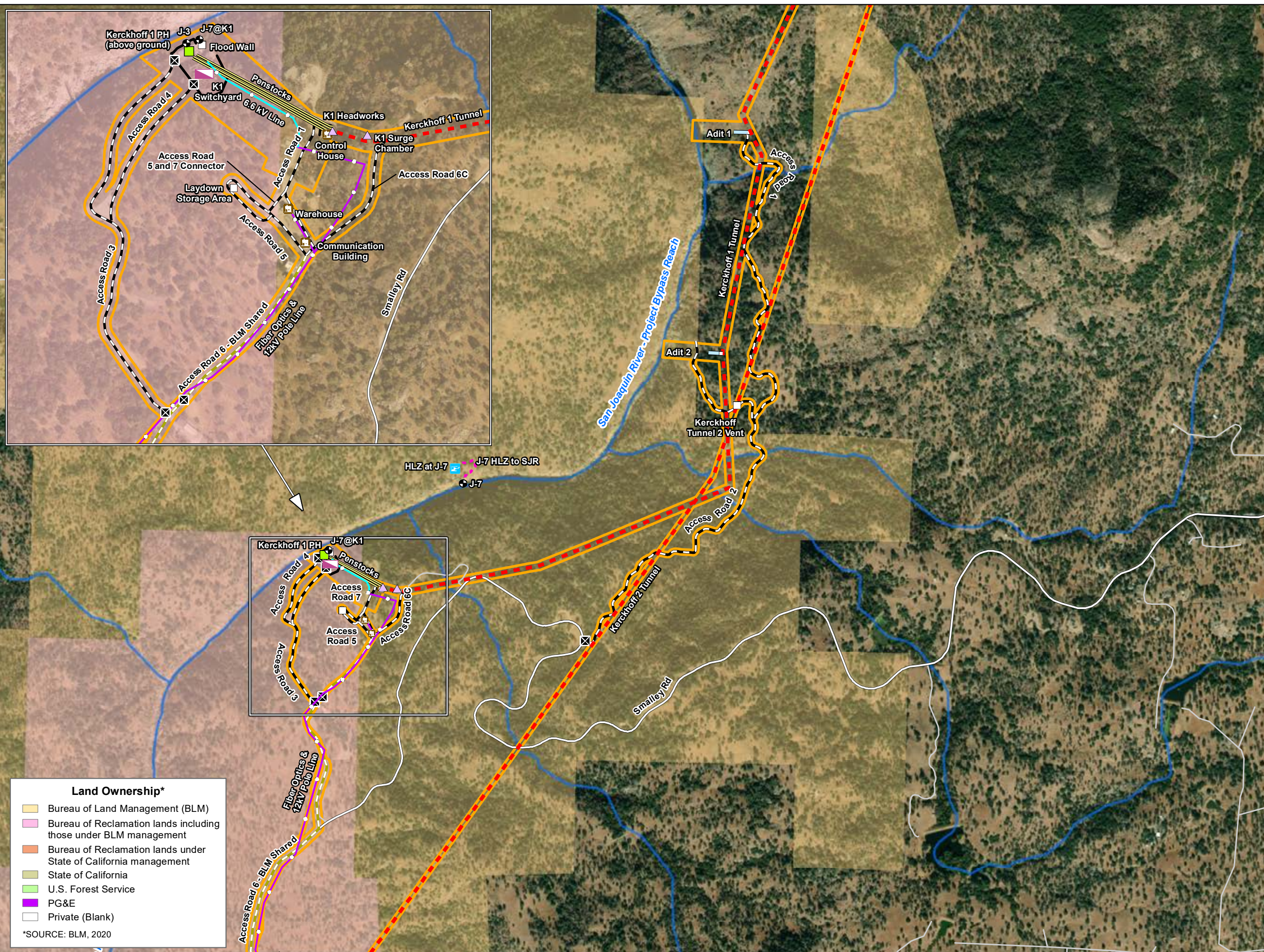
PG&E Kerckhoff Project (FERC No. 96)

Map A2-2c
Project Facilities and Features
(Sheet 3 of 5)



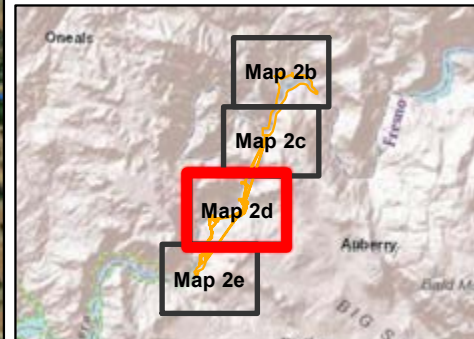


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- PG&E Project Facilities**
- ▲ Dam
 - Powerhouse
 - Switchyard
 - ▲ Water Conveyance Feature
 - Gage
 - Helicopter Landing Zone (HLZ)
 - Building
 - Ancillary and Other Facilities
 - - - Tunnel
 - Penstock
 - Adit
 - Instream Flow Pipe
 - Runoff Piping
 - Fiber Optics & 12kV Pole Line
 - 6.6 kV Line
 - ○ Boat Barrier
 - Log Boom
 - - - Project Trail
 - Fence
 - FERC Project Boundary
- Project Recreation Facilities**
- ▲ Smalley Cove Recreation Area
- Transportation System Features**
- Locked Access Gate
 - Project Road
 - BLM Shared
 - USFS Shared
 - Non-Project Public Access Road
 - Other Road
- Other Features**
- Lake/Reservoir
 - River/Stream
- Non-Project Facilities**
- A.G. Wishon Powerhouse

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- *SOURCE: BLM, 2020



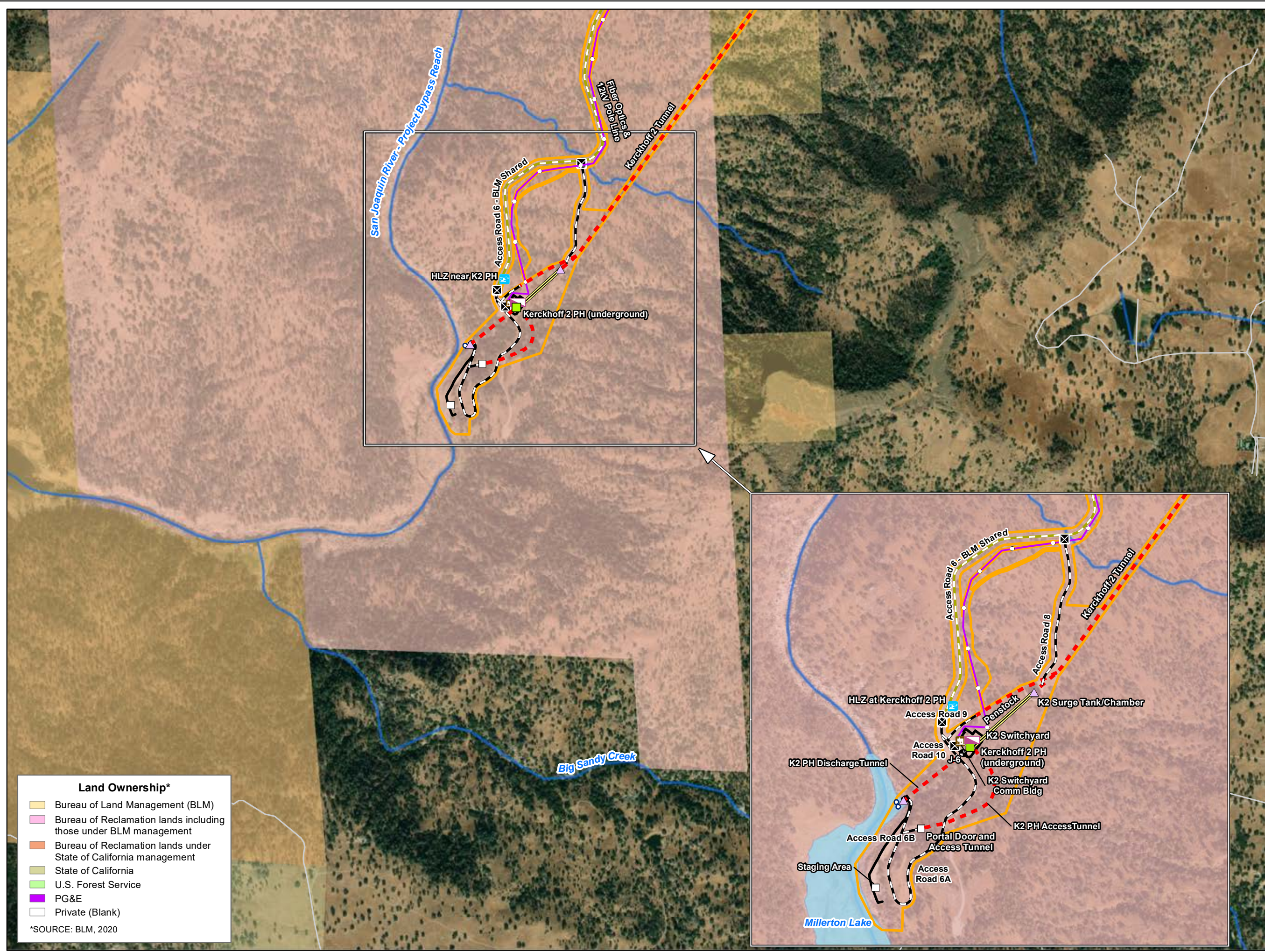
PG&E Kerckhoff Project (FERC No. 96)

Map A2-2d
Project Facilities and Features
(Sheet 4 of 5)



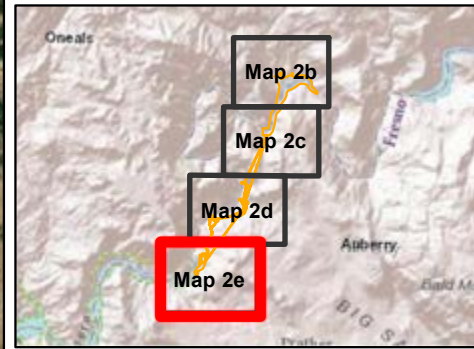


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- PG&E Project Facilities**
- ▲ Dam
 - Powerhouse
 - Switchyard
 - ▲ Water Conveyance Feature
 - Gage
 - Helicopter Landing Zone (HLZ)
 - Building
 - Ancillary and Other Facilities
 - - - Tunnel
 - Penstock
 - Adit
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 - USFS Shared
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 - Other Road
- Other Features**
- Lake/Reservoir
 - River/Stream
- Non-Project Facilities**
- A.G. Wishon Powerhouse

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 - Bureau of Reclamation lands under State of California management
 - State of California
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM, 2020



Pacific Gas and Electric Company

PG&E Kerckhoff Project (FERC No. 96)

Map A2-2e

Project Facilities and Features
(Sheet 5 of 5)

0 500 1,000 Feet

Date: 10/13/2020 Projection: UTM, Zone 11 North Datum: NAD 83

Appendix A3

Maps

APPENDIX A-3 MAPS — ACCESSIBLE SUMMARY

This written summary is provided in advance of the Appendix A-3 map figures as an overview and orientation aid. The maps in Appendix A-3 contain a high level of technical detail and visual information that may be difficult to interpret when viewed without full visual context or when accessed using assistive technology.

The purpose of this summary is to:

Explain what the maps collectively show before the reader views them

Identify the types of facilities, boundary changes, and land jurisdictions depicted

Provide a plain-language narrative equivalent to the visual information in the maps

Help viewers or listeners understand the intent, scale, and organization of the map series

This summary does not replace the maps. Instead, it is intended to support understanding by describing the overall structure and purpose of Appendix A-3 prior to reviewing the individual figures. Readers may reference this overview before, during, or after viewing the maps to better interpret the information presented.

Appendix A-3 contains a series of maps prepared in support of proposed Federal Energy Regulatory Commission (FERC) boundary modifications and related project features for the **PG&E Kerckhoff Hydroelectric Project (FERC No. 96)**. The maps collectively illustrate:

- Existing project facilities and infrastructure
- Proposed additions to, and reductions of, the FERC project boundary
- Land ownership and management jurisdictions
- Recreation features and proposed improvements
- Locations of support infrastructure such as gages, access roads, tunnels, and helicopter landing zones

Because the maps are visually complex and include numerous symbols, labels, and overprinted features, this narrative summary is provided as a **functional equivalent description** for accessibility and interpretability.

Map A3-1: Overview of Major Project Facilities and Land Jurisdictions

This overview map presents the full extent of the Kerckhoff Project area along the **San Joaquin River**, including:

- Kerckhoff Dam, Kerckhoff Reservoir, Kerckhoff 1 Powerhouse, and Kerckhoff 2 Powerhouse (underground)
- Associated tunnels, penstocks, adits, powerhouses, gages, and project access roads
- Nearby non-project facilities such as A.G. Wishon Powerhouse (non-project)

The map identifies surrounding land management agencies, including the **U.S. Forest Service, Bureau of Land Management (BLM), Bureau of Reclamation, State of California, PG&E**, and private lands. It also distinguishes **existing FERC project boundaries** and **proposed boundary additions and reductions**.

Maps A3-2a through A3-2o: Proposed FERC Boundary Modifications (Sheets 1–15)

These fifteen detailed map sheets present all proposed boundary modifications at a local scale. Together, they document refinements to the FERC project boundary to better align with actual operational needs, infrastructure footprints, and land management responsibilities.

Common Themes Across Maps A3-2a to A3-2o

Across these sheets, the proposed boundary changes include:

Reductions:

- Removal of areas outside of operational necessity, such as full 50-foot buffers around the **Kerckhoff Reservoir Normal Maximum Water Surface Elevation (NMWSE at 985 feet MSL, NGVD29)** where such buffers exceed project requirements
- Corrections to align the FERC boundary with historical metes and bounds descriptions
- Exclusion of non-project or publicly used roads and areas that are not required for project operations

Additions:

- Inclusion of areas required for operation and maintenance of project facilities, including:
 - Powerhouses, dams, tunnels, penstocks, surge chambers, headworks, switchyards, and communication buildings
 - Access roads, construction access corridors, and drainage features

- Fiber optics and 12 kV electrical lines supporting project operations
- Gaging stations and gaging cableways
- Helicopter Landing Zones (HLZs) used for inspection, emergency access, and maintenance
- **Geographic Areas Covered**

The boundary modification maps address areas around:

- Kerckhoff Reservoir shoreline and adjacent slopes
- Kerckhoff Dam and intake structures
- North and South adits and tunnel portals
- Kerckhoff 1 facilities near Smalley Road
- Kerckhoff 2 underground powerhouse area, including surge tank, discharge tunnel, switchyard, and staging areas
- Shared access roads managed by BLM that remain outside the FERC boundary where appropriate

Map A3-3: Proposed New Recreation Day Use Area and Reconstructed Trail

This map illustrates a proposed **recreation day-use area (DUA)** near **Millerton Lake** and the **San Joaquin River Project Bypass Reach**. Features include:

- A designated parking area and picnic facilities
- Vehicle control barriers
- A reconstructed and connected trail network that ties into existing regional trails, including the **San Joaquin River Trail**
- Continued BLM management of the land, with the recreation features incorporated into the proposed FERC project boundary

This map clarifies how recreational access is improved while maintaining agency management roles.

Map A3-4: Approximate Location of San Joaquin River Above Kerckhoff Reservoir Inflow Gage

This map shows the approximate location of a **potential new gaging station** upstream of **Kerckhoff Reservoir**, near **Powerhouse Road Bridge**. It identifies:

- The San Joaquin River channel above reservoir inflow
- Relationship to nearby powerhouses and roads

- The reservoir's NMWSE and proposed FERC project boundary

This gage location supports improved flow monitoring and compliance.

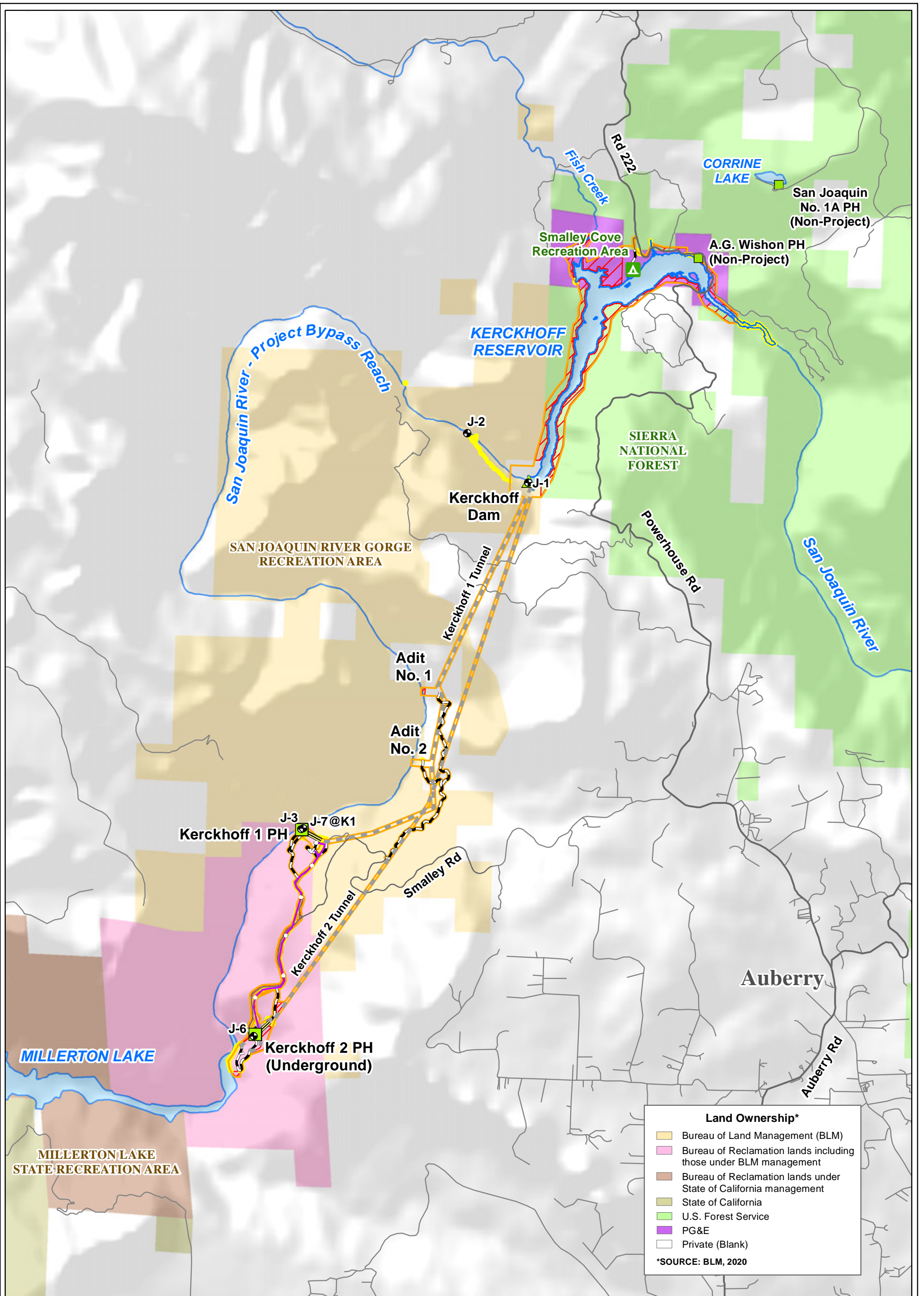
OVERALL INTENT OF APPENDIX A-3

Collectively, the maps in Appendix A-3 demonstrate that the proposed FERC boundary modifications:

- Improve accuracy and consistency with existing infrastructure
- Remove unnecessary land from the project boundary where it is no longer needed
- Add areas essential for safe operation, maintenance, monitoring, and emergency access
- Clarify land ownership and management responsibilities
- Support recreation, environmental monitoring, and regulatory compliance

This appendix is intended to provide FERC with clear spatial documentation supporting boundary revisions that reflect current and anticipated project conditions.

Appendix A-3 Maps



Land Ownership*

- Bureau of Land Management (BLM)
- Bureau of Reclamation lands including those under BLM management
- Bureau of Reclamation lands under State of California management
- State of California
- U.S. Forest Service
- PG&E
- Private (Blank)

*SOURCE: BLM, 2020

- PG&E Project Facilities**
- Powerhouse
 - Dam
 - Water Conduit
 - Penstock
 - 12kV and Fiber Optics Line
 - Project Road
 - Recreation Area
 - FERC Project Boundary

- Other Features**
- Other Road
 - Watercourse
 - Water Body
 - Gage

- Proposed FERC Boundary Modifications**
- Boundary Addition
 - Boundary Reduction

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 PG&E Kerckhoff Project (FERC No. 96)

Map A3-1

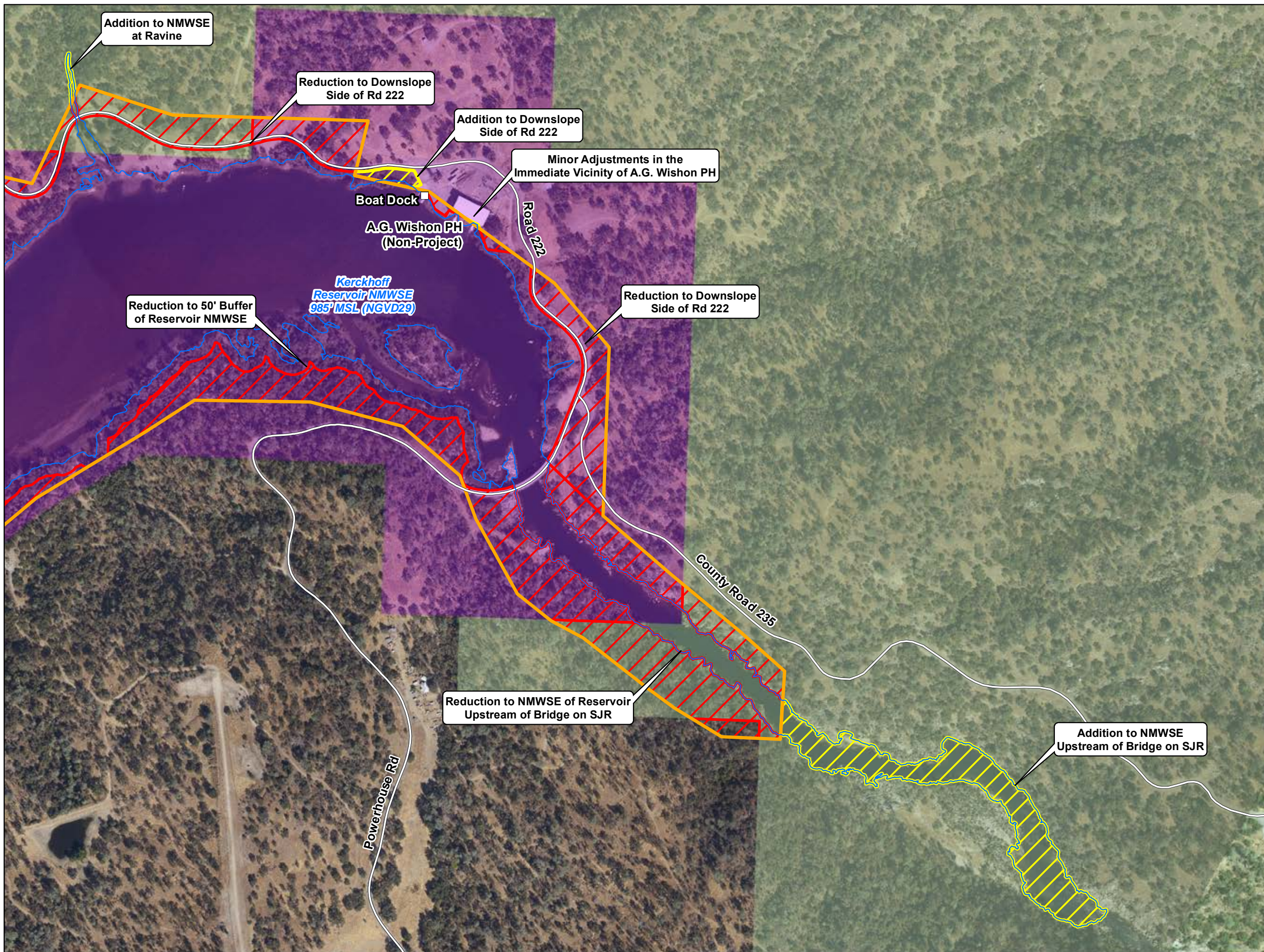
Overview of Major Project Facilities and Land Jurisdictions

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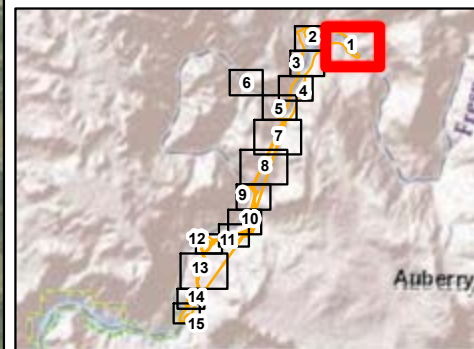
Miles

Projection: UTM, Zone 11 North
Datum: NAD 83

10/29/2020



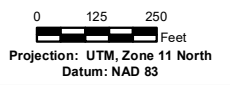
- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Building
 - Ancillary and Other Facilities
 - Helicopter Landing Zone (HLZ)
 - Tunnel
 - Penstock
 - Adit
 - Instream Flow Pipe
 - Runoff Piping
 - Fiber Optics & 12kV Pole Line
 - 6.6kV Line
 - Project Trail
 - Fence
 - FERC Project Boundary
 - Kerckhoff Reservoir Normal Maximum Water Surface Elevation (NMWSE, 985' MSL, NGVD29)
- Transportation System Features**
- Locked Access Gate
 - Project Road
 - BLM Shared
 - USFS Shared
 - Non-Project Public Access Road
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- Boundary Addition
 - Boundary Reduction
- Land Ownership***
- Bureau of Land Management (BLM)
 - Bureau of Reclamation lands including those under BLM management
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

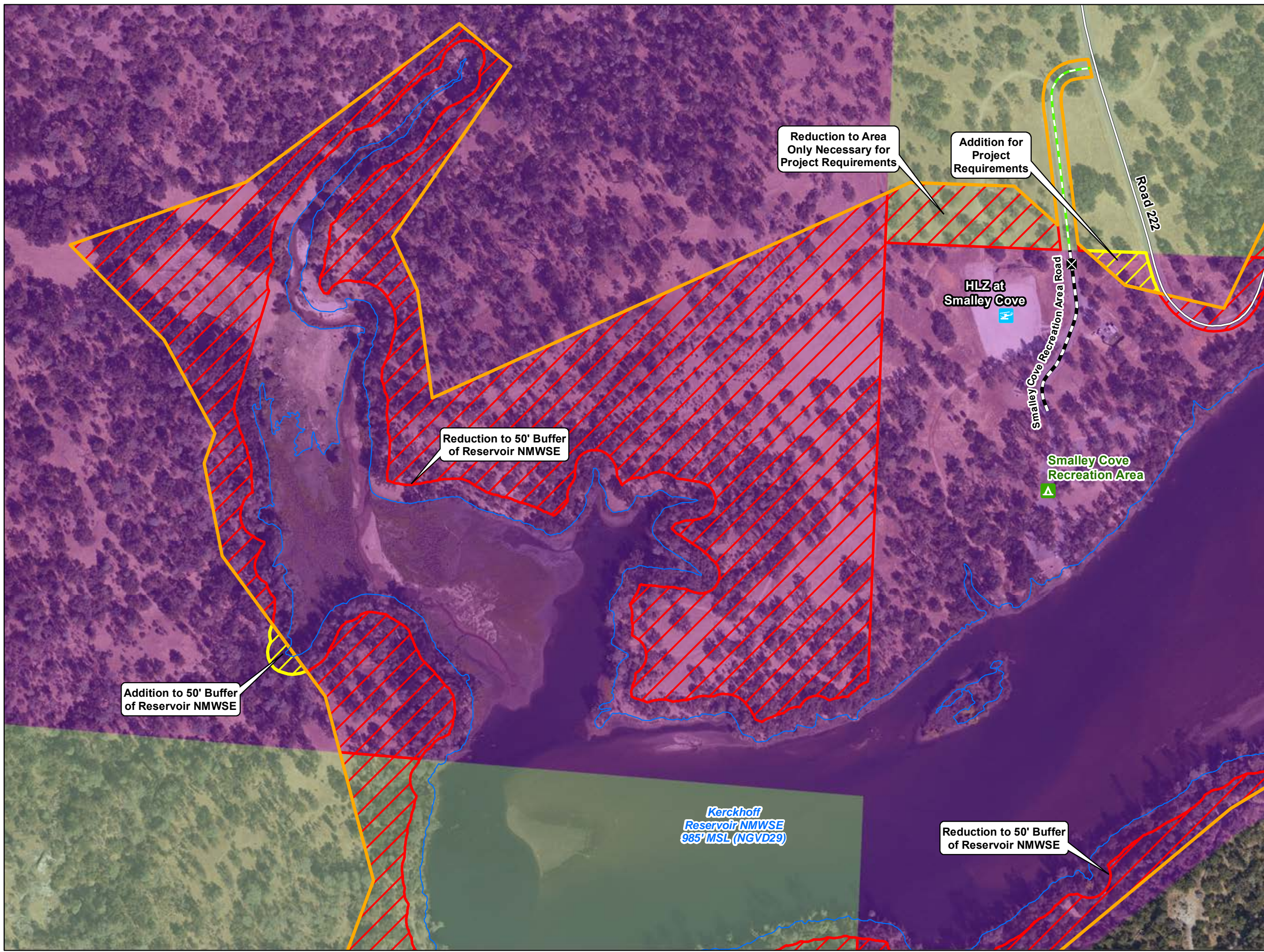
Map A3-2a

Proposed FERC Boundary Modifications (Sheet 1 of 15)

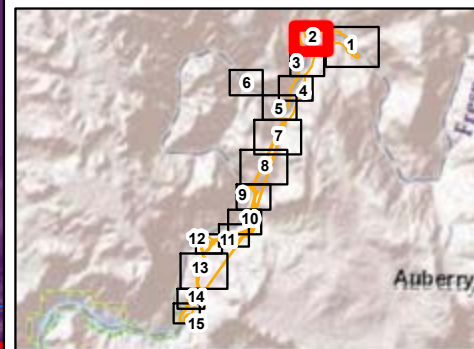


Date: 1/11/2022

Projection: UTM, Zone 11 North
Datum: NAD 83



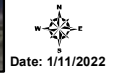
- PG&E Project Facilities**
- Dam
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 - Switchyard
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 - Gage
 - Building
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 - Bureau of Reclamation lands including those under BLM management
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

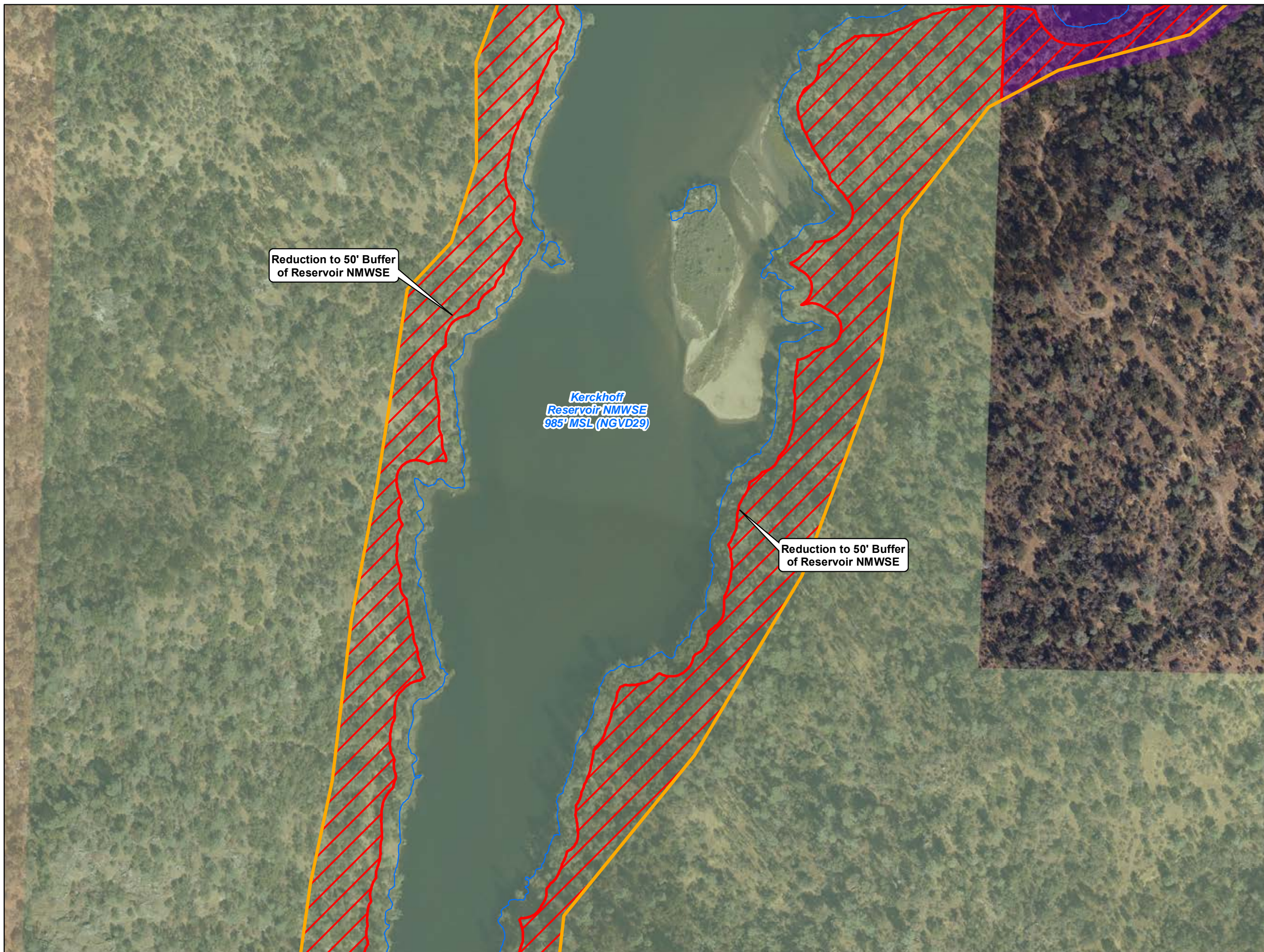
Map A3-2b

Proposed FERC Boundary Modifications (Sheet 2 of 15)



0 125 250 Feet
 Projection: UTM, Zone 11 North
 Datum: NAD 83

Date: 1/11/2022

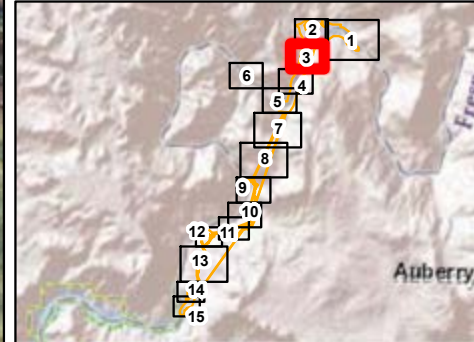


Reduction to 50' Buffer of Reservoir NMWSE

Reduction to 50' Buffer of Reservoir NMWSE

Kerckhoff Reservoir NMWSE 985' MSL (NGVD29)

- PG&E Project Facilities**
- Dam
 - Powerhouse
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 - Building
 - Ancillary and Other Facilities
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 - Bureau of Reclamation lands including those under BLM management
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



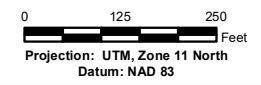
PG&E Kerckhoff Project (FERC No. 96)

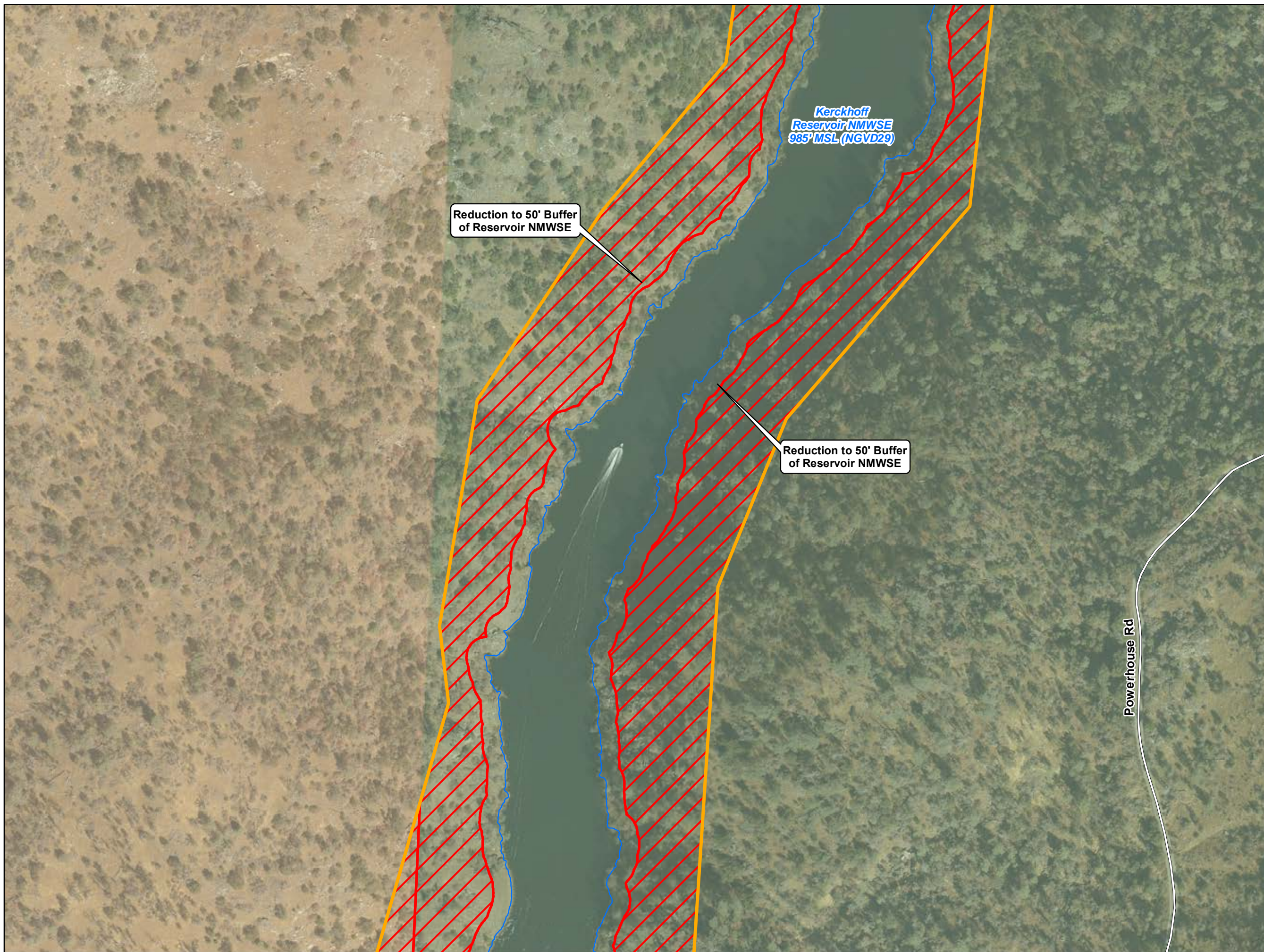
Map A3-2c

Proposed FERC Boundary Modifications (Sheet 3 of 15)

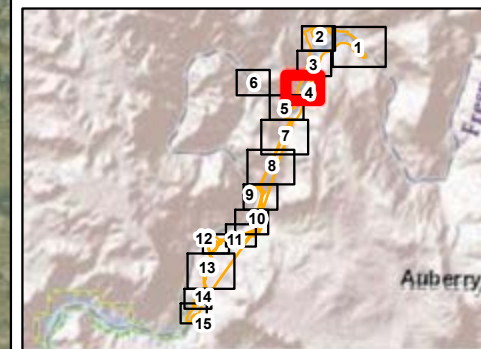


Date: 1/11/2022





- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Building
 - Ancillary and Other Facilities
 - Helicopter Landing Zone (HLZ)
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 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



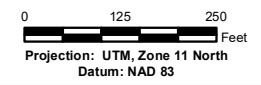
PG&E Kerckhoff Project (FERC No. 96)

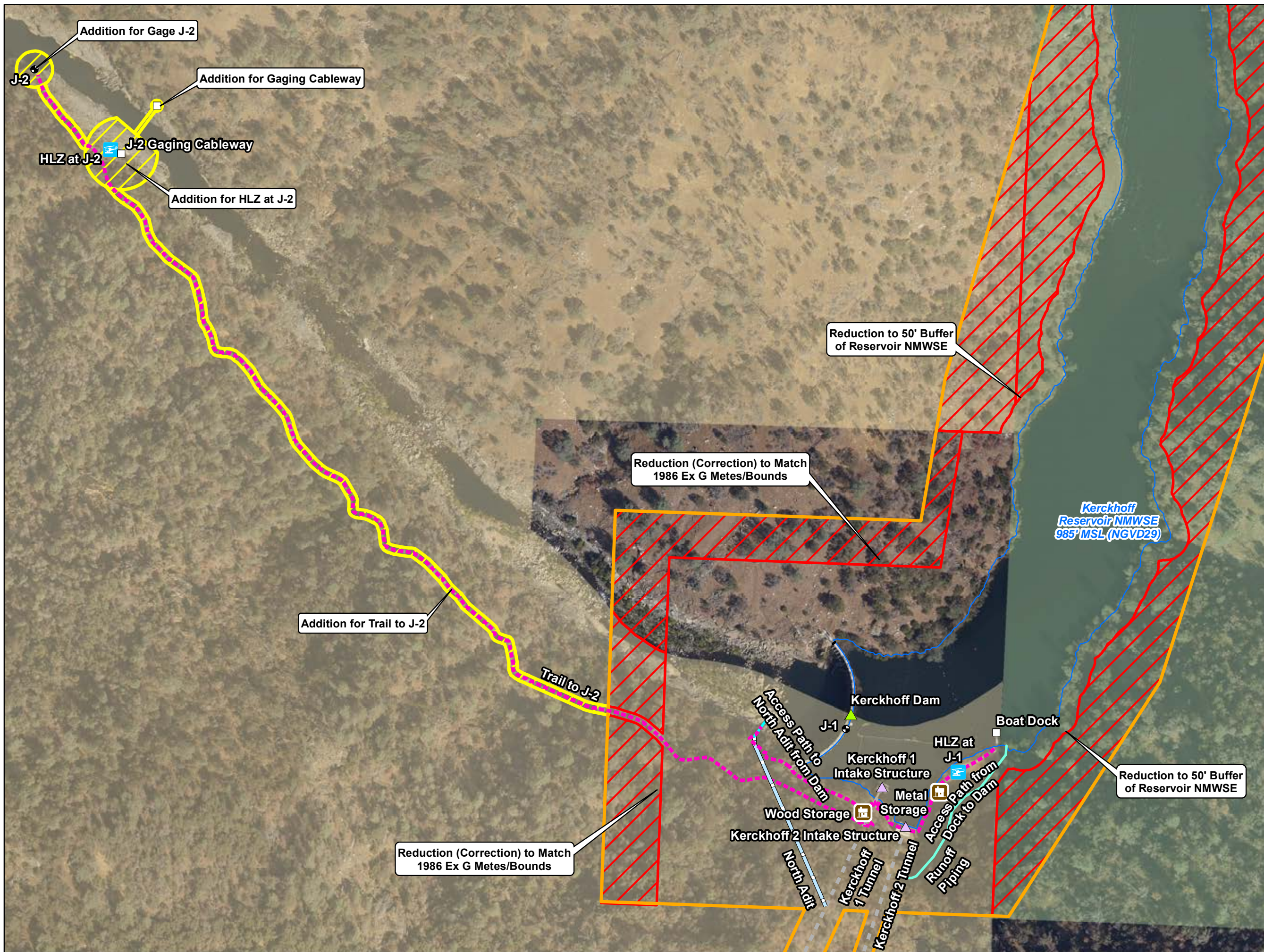
Map A3-2d

**Proposed FERC Boundary Modifications
(Sheet 4 of 15)**

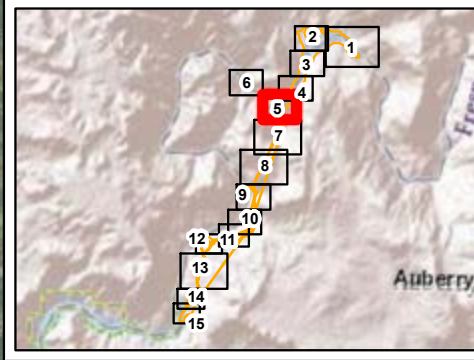


Date: 1/11/2022





- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
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 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



Pacific Gas and Electric Company

PG&E Kerckhoff Project (FERC No. 96)

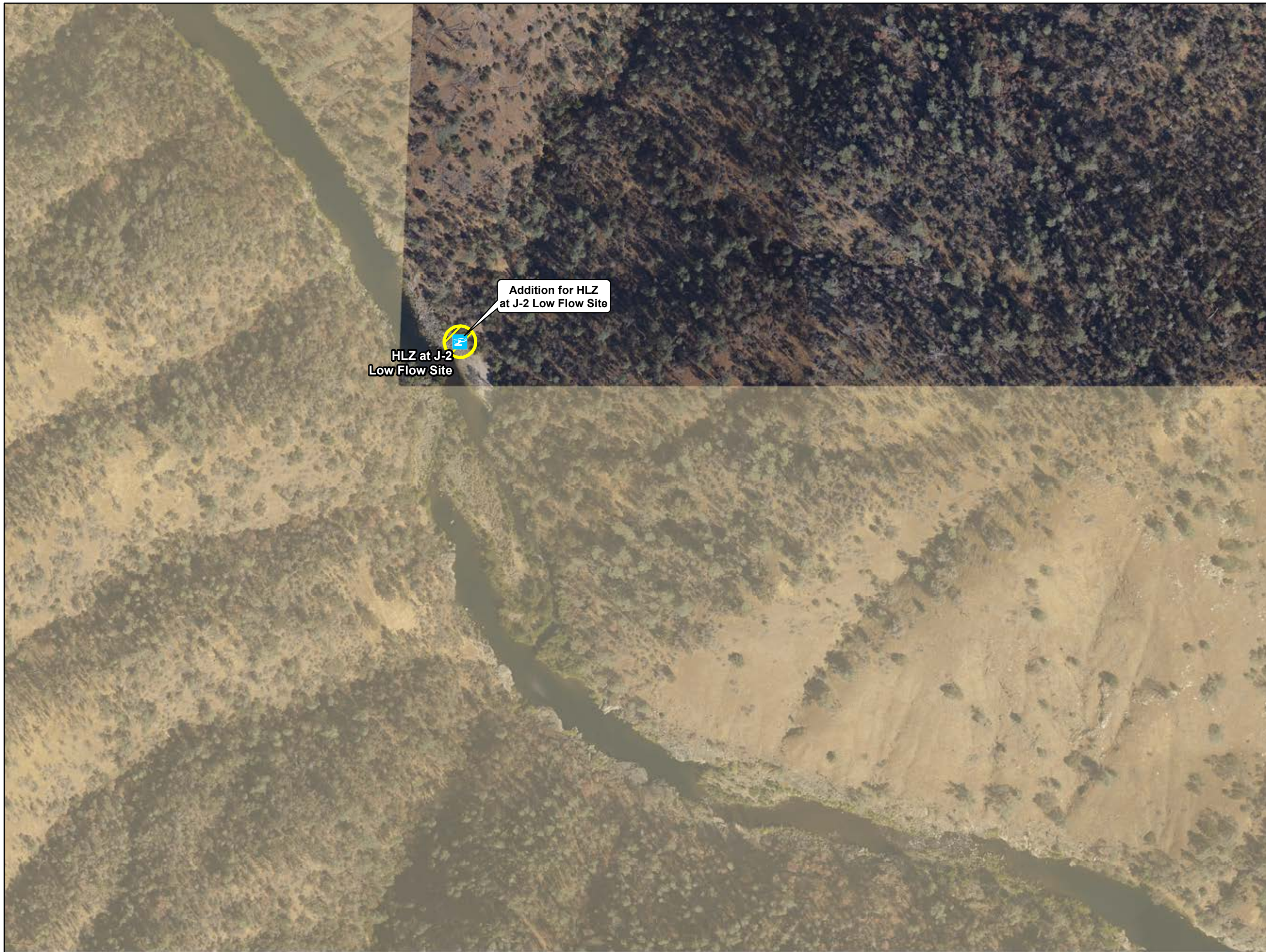
Map A3-2e

Proposed FERC Boundary Modifications (Sheet 5 of 15)

0 125 250 Feet

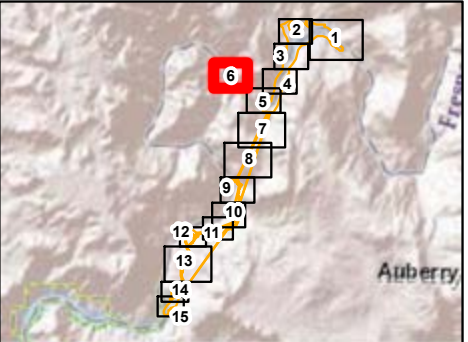
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Projection: UTM, Zone 11 North
Datum: NAD 83



- PG&E Project Facilities**
- Dam
 - Powerhouse
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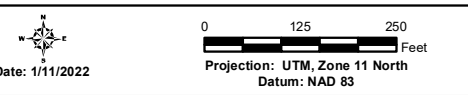
*SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

Map A3-2f

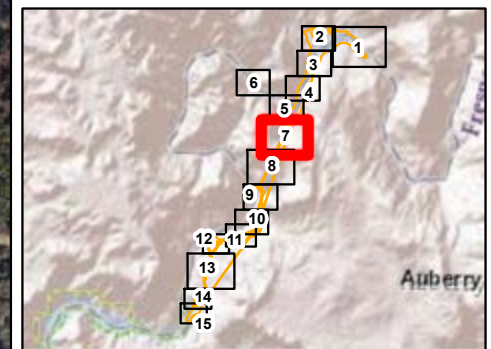
Proposed FERC Boundary Modifications
(Sheet 6 of 15)





- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
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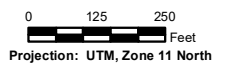
*SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

Map A3-2g

Proposed FERC Boundary Modifications
(Sheet 7 of 15)



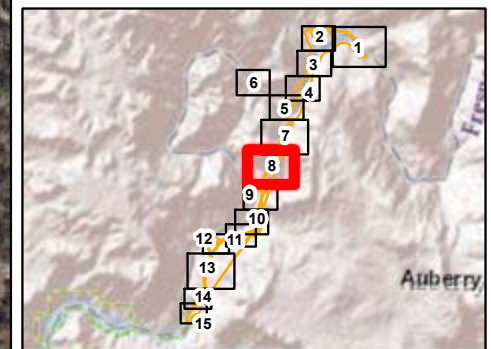
Date: 1/11/2022

Projection: UTM, Zone 11 North
Datum: NAD 83



- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Building
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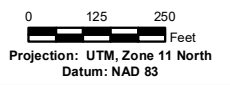
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PG&E Kerckhoff Project (FERC No. 96)

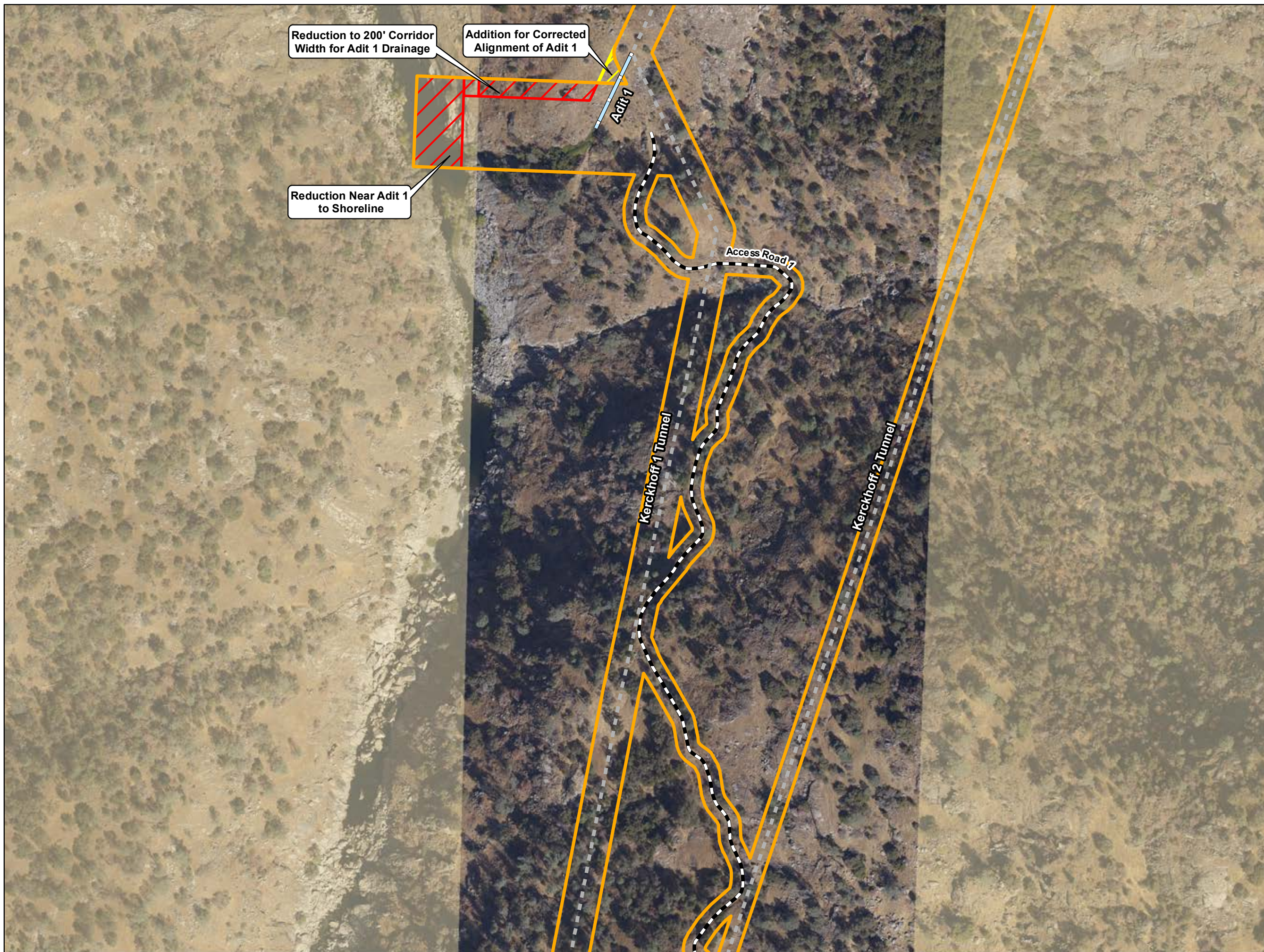
Map A3-2h

**Proposed FERC Boundary Modifications
(Sheet 8 of 15)**

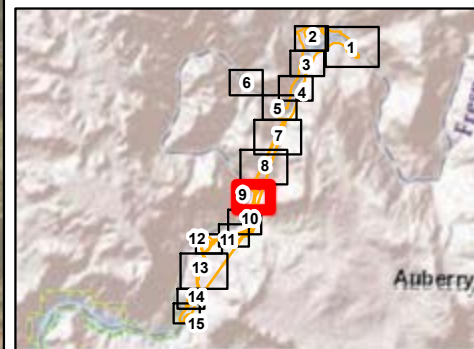


Date: 1/11/2022

Projection: UTM, Zone 11 North
Datum: NAD 83



- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
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 - Building
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- *SOURCE: BLM 2020, PG&E, 2021



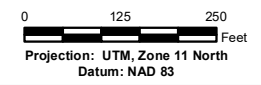
PG&E Kerckhoff Project (FERC No. 96)

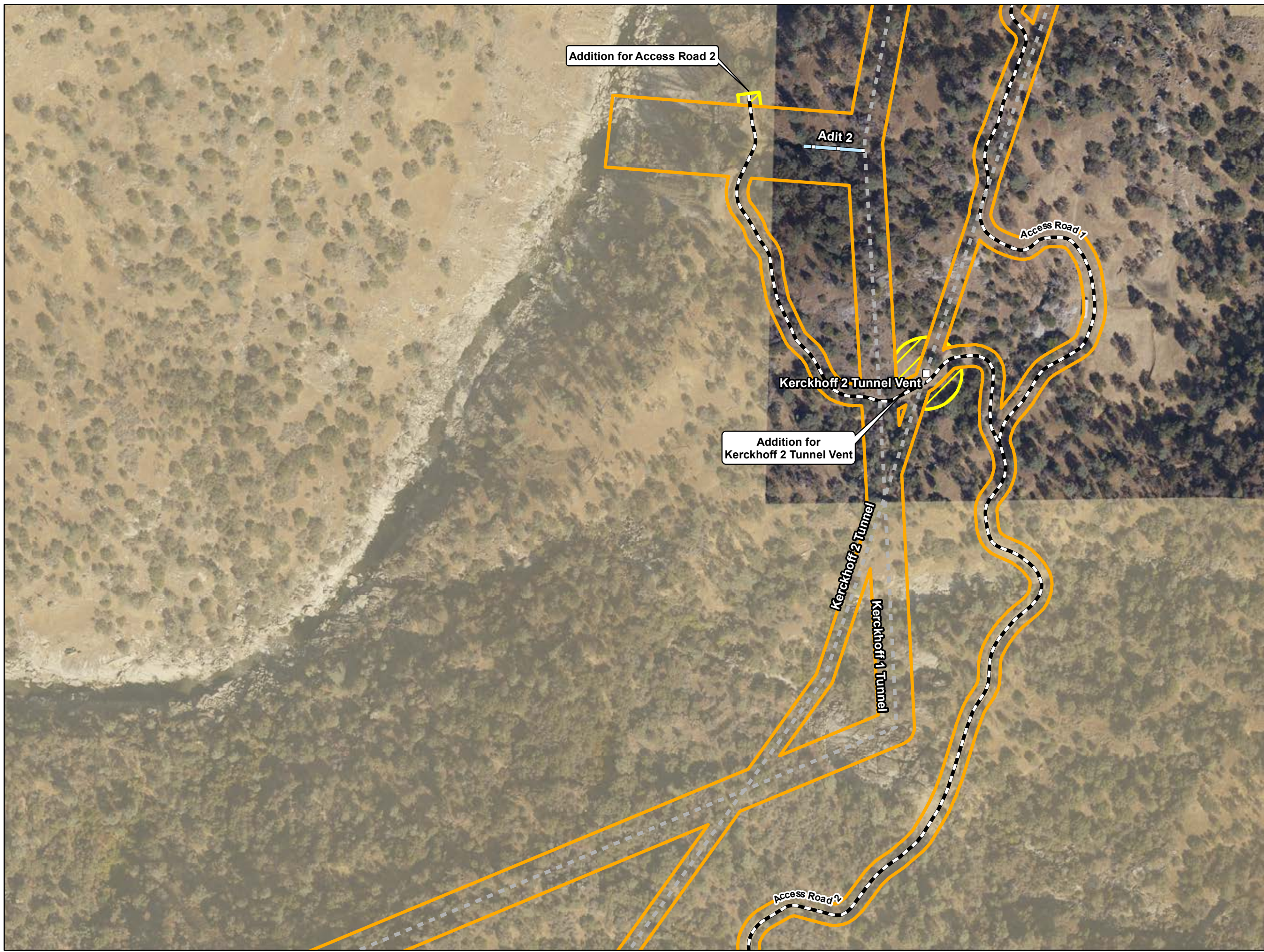
Map A3-2i

**Proposed FERC Boundary Modifications
(Sheet 9 of 15)**

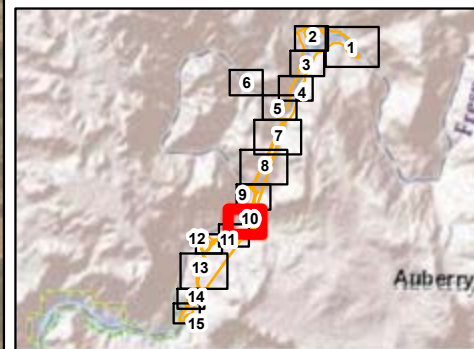


Date: 1/11/2022





- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
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 - Gage
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- *SOURCE: BLM 2020, PG&E, 2021



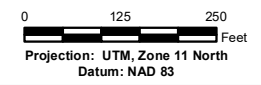
PG&E Kerckhoff Project (FERC No. 96)

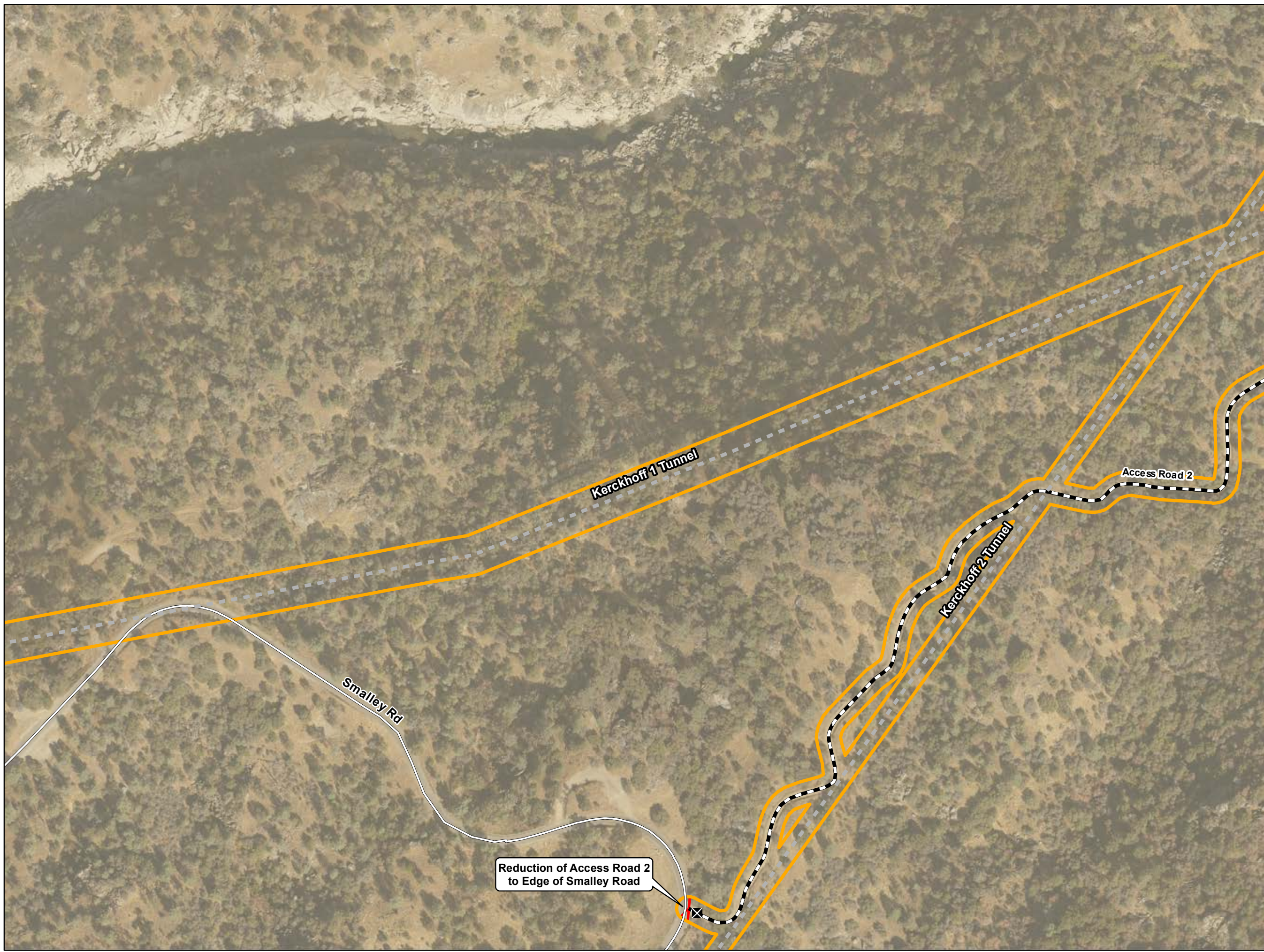
Map A3-2j

**Proposed FERC Boundary Modifications
(Sheet 10 of 15)**

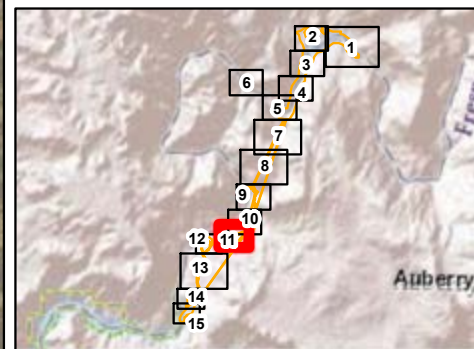


Date: 1/11/2022





- PG&E Project Facilities**
- Dam
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 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

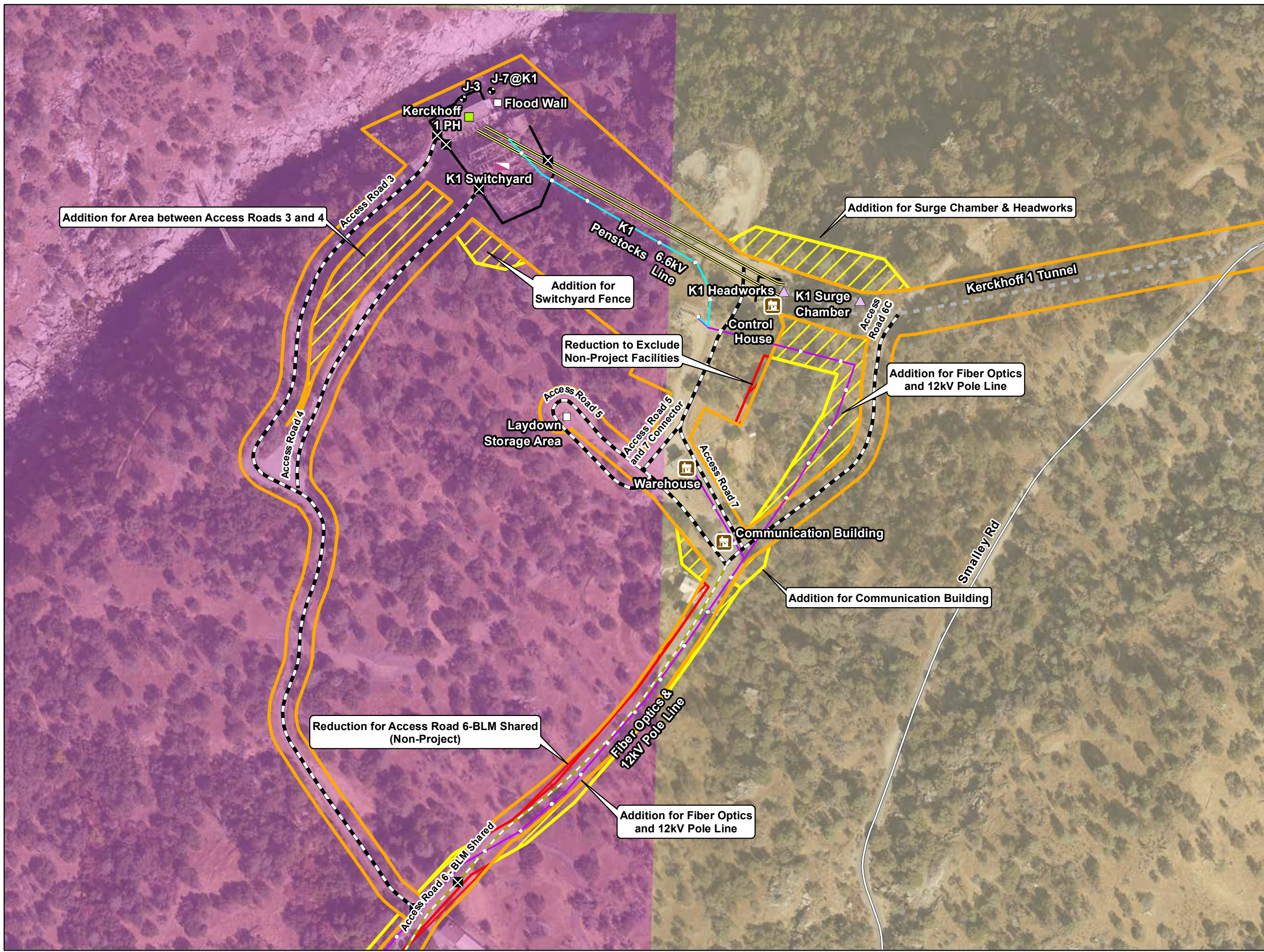
Map A3-2k

**Proposed FERC Boundary Modifications
(Sheet 11 of 15)**

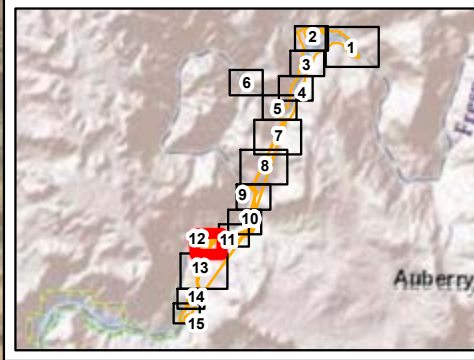


0 125 250 Feet
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 Datum: NAD 83

Date: 1/11/2022



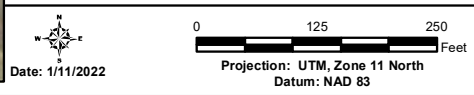
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- Land Ownership***
- Bureau of Land Management (BLM)
 - Bureau of Reclamation lands including those under BLM management
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021

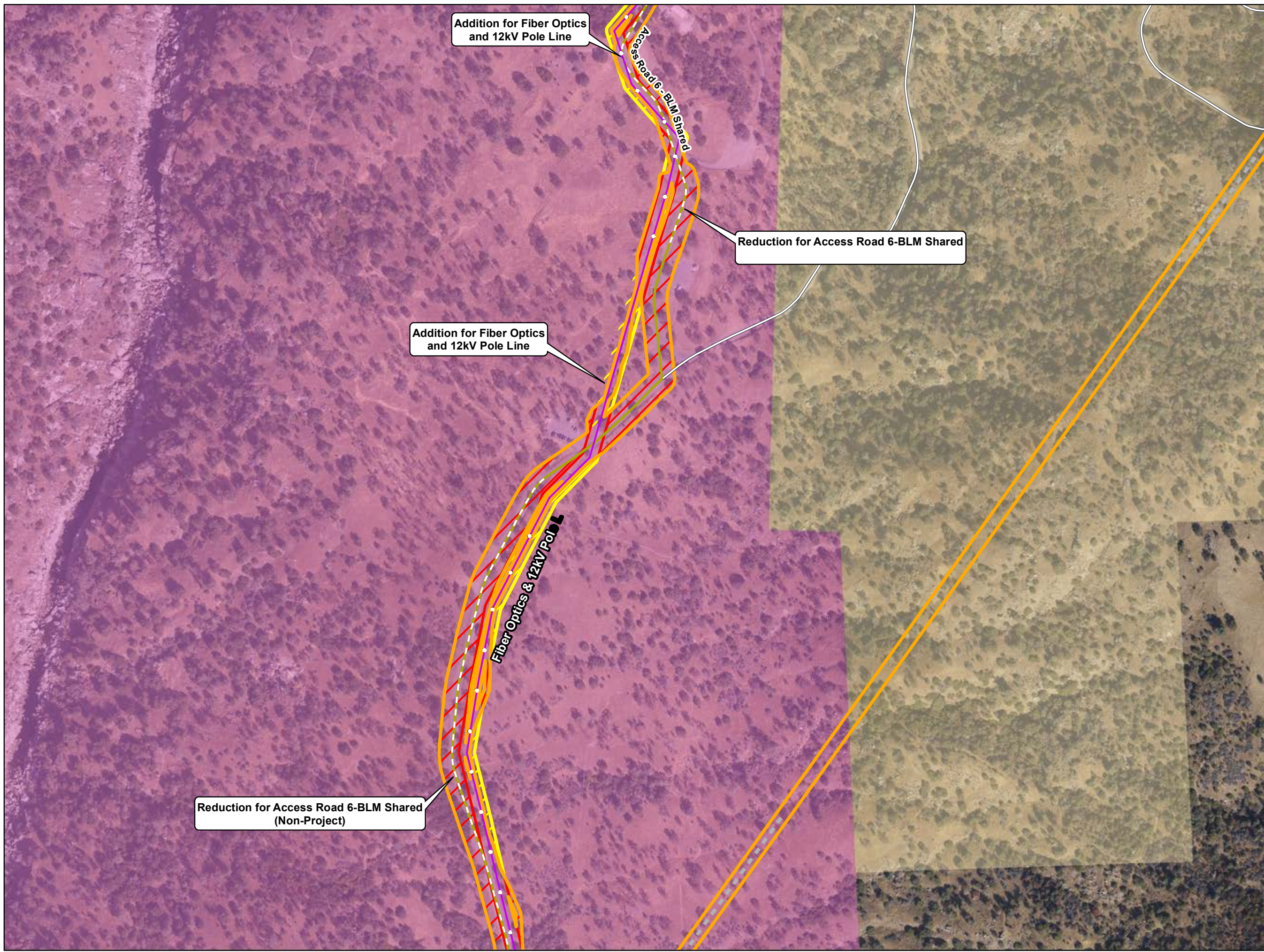


PG&E Kerckhoff Project (FERC No. 96)

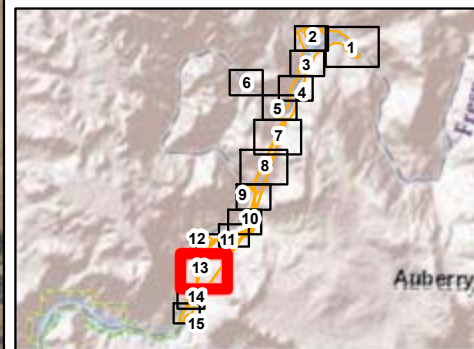
Map A3-21

**Proposed FERC Boundary Modifications
(Sheet 12 of 15)**





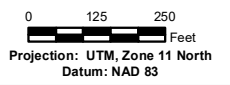
- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Building
 - Ancillary and Other Facilities
 - Helicopter Landing Zone (HLZ)
 - Tunnel
 - Penstock
 - Adit
 - Instream Flow Pipe
 - Runoff Piping
 - Fiber Optics & 12kV Pole Line
 - 6.6kV Line
 - Project Trail
 - Fence
 - FERC Project Boundary
 - Kerckhoff Reservoir Normal Maximum Water Surface Elevation (NMWSE, 985' MSL, NGVD29)
- Transportation System Features**
- Locked Access Gate
 - Project Road
 - BLM Shared
 - USFS Shared
 - Non-Project Public Access Road
- Proposed FERC Boundary Modifications**
- Boundary Addition
 - Boundary Reduction
- Land Ownership***
- Bureau of Land Management (BLM)
 - Bureau of Reclamation lands including those under BLM management
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

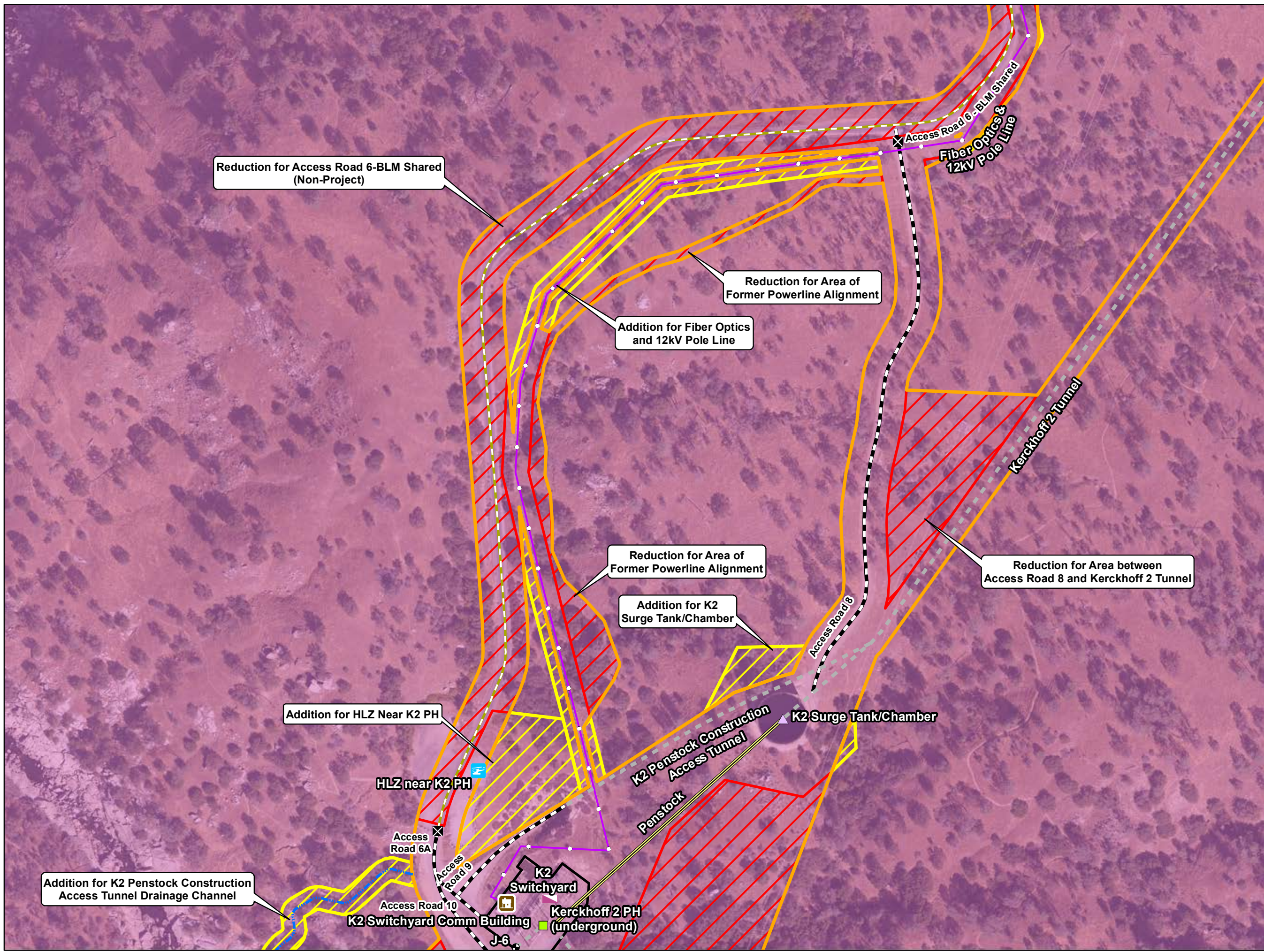
Map A3-2m

**Proposed FERC Boundary Modifications
(Sheet 13 of 15)**

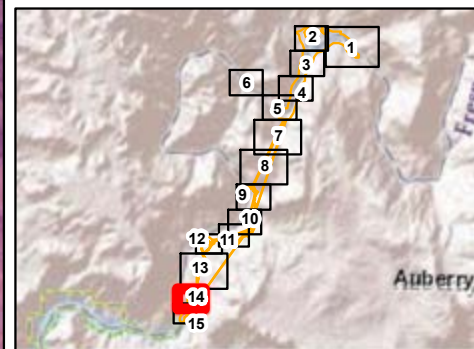


Date: 1/11/2022

Projection: UTM, Zone 11 North
Datum: NAD 83



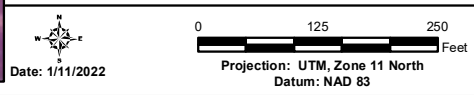
- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Building
 - Ancillary and Other Facilities
 - Helicopter Landing Zone (HLZ)
 - Tunnel
 - Penstock
 - Adit
 - Instream Flow Pipe
 - Runoff Piping
 - Fiber Optics & 12kV Pole Line
 - 6.6kV Line
 - Project Trail
 - Fence
 - FERC Project Boundary
 - Kerckhoff Reservoir Normal Maximum Water Surface Elevation (NMWSE, 985' MSL, NGVD29)
- Transportation System Features**
- Locked Access Gate
 - Project Road
 - BLM Shared
 - USFS Shared
 - Non-Project Public Access Road
- Proposed FERC Boundary Modifications**
- Boundary Addition
 - Boundary Reduction
- Land Ownership***
- Bureau of Land Management (BLM)
 - Bureau of Reclamation lands including those under BLM management
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021

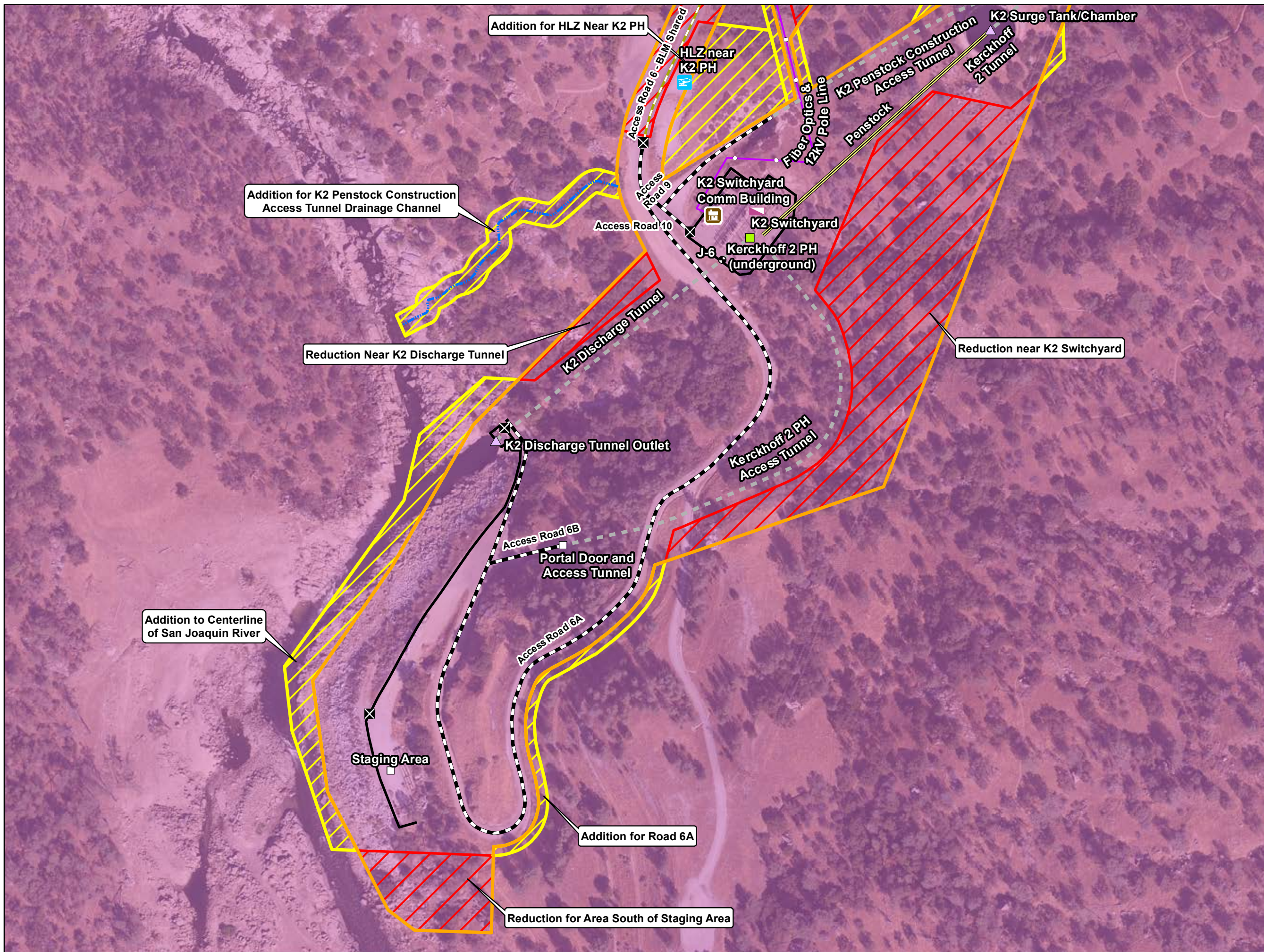


PG&E Kerckhoff Project (FERC No. 96)

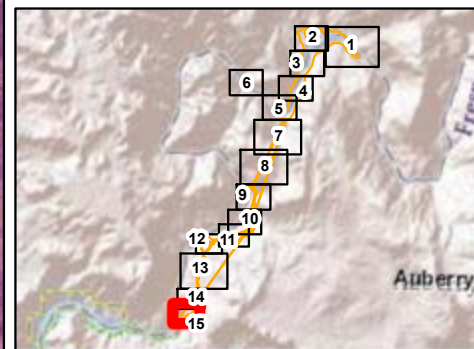
Map A3-2n

Proposed FERC Boundary Modifications (Sheet 14 of 15)





- PG&E Project Facilities**
- Dam
 - Powerhouse
 - Switchyard
 - Water Conveyance Feature
 - Gage
 - Building
 - Ancillary and Other Facilities
 - Helicopter Landing Zone (HLZ)
 - Tunnel
 - Penstock
 - Adit
 - Instream Flow Pipe
 - Runoff Piping
 - Fiber Optics & 12kV Pole Line
 - 6.6kV Line
 - Project Trail
 - Fence
 - FERC Project Boundary
 - Kerckhoff Reservoir Normal Maximum Water Surface Elevation (NMWSE, 985' MSL, NGVD29)
- Transportation System Features**
- Locked Access Gate
 - Project Road
 - BLM Shared
 - USFS Shared
 - Non-Project Public Access Road
- Proposed FERC Boundary Modifications**
- Boundary Addition
 - Boundary Reduction
- Land Ownership***
- Bureau of Land Management (BLM)
 - Bureau of Reclamation lands including those under BLM management
 - U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

Map A3-2o

Proposed FERC Boundary Modifications
(Sheet 15 of 15)



Date: 1/11/2022

Projection: UTM, Zone 11 North
Datum: NAD 83



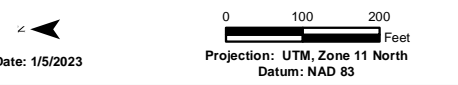
- Project Facilities**
- Switchyard
 - Powerhouse
 - Helicopter Landing Zone (HLZ)
 - Water Conveyance Feature
 - Tunnel
 - Penstock
 - Fiber Optics & 12kV Pole Line
 - Proposed FERC Project Boundary
- Transportation System Features**
- Locked Access Gate
 - Project Road
 - BLM Shared Road
 - Existing Non-Project Trail
- DUA Project Features**
- Parking Area
 - Picnic Area
 - Paved Access Road
 - DUA Connecting Route or Trail
 - Vehicle Control Barriers
 - Locked Access Gate
- NOTE: All land in the map extent is owned by BOR and managed by BLM



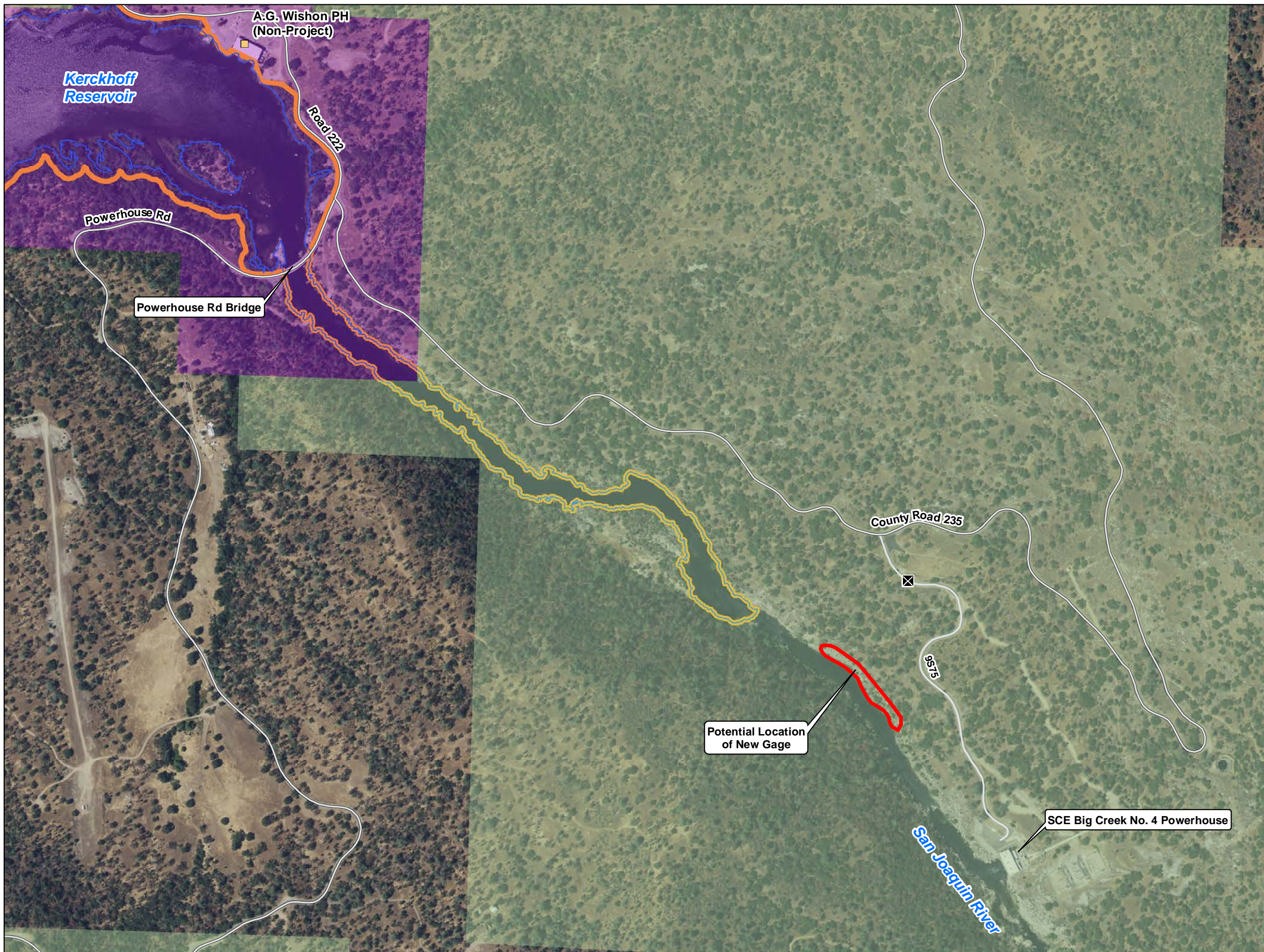
PG&E Kerckhoff Project (FERC No. 96)

Map A3-3

Proposed New Recreation Day Use Area and Reconstructed Trail



Date: 1/5/2023



- FERC Project Boundaries**
- Kerckhoff Proposed FERC Project Boundary
- Kerckhoff Reservoir**
- NMWSE (985 ft MSL) of Reservoir (LiDAR Data Adjusted to NGVD29)
- Land Ownership***
- U.S. Forest Service
 - PG&E
 - Private (Blank)
- *SOURCE: BLM 2020, PG&E, 2021



PG&E Kerckhoff Project (FERC No. 96)

Map A3-4

Approximate Location of San Joaquin River above Kerckhoff Reservoir Inflow Gage

Date: 1/9/2023
 Projection: UTM, Zone 11 North
 Datum: NAD 83

Appendix B

Flow Data

Appendix B provides modeled flow data for the Project in the tables below, based on the information provided in the 2023 Second Supplemental FLA (Tables B-1 through B-8) and additional analysis for WY 2018-2023 (Table B-9).

Table B-1 Average Monthly Flows in the San Joaquin River (SJR) below Kerckhoff Dam (WY 1985–2017).

Month	Dry WYs (cfs)			Normal WYs (cfs)			All WYs (cfs)		
	Without Project	Historical (Gage J-2)	Current Operations	Without Project	Historical (Gage J-2)	Current Operations	Without Project	Historical (Gage J-2)	Current Operations
October	714.3	127.4	384.4	964.2	116.6	319.3	911.2	118.9	333.1
November	550.1	89.8	179.8	868.1	214.8	360.9	800.7	188.3	322.5
December	513.2	56.6	121.7	1,031.3	64.2	237.6	921.4	62.6	213.0
January	552.0	46.5	51.8	1,675.8	298.5	302.6	1,437.4	245.1	249.4
February	610.6	26.7	28.8	2,043.5	293.5	348.8	1,740.6	237.1	281.2
March	924.1	26.8	28.8	2,761.3	195.2	305.0	2,371.6	159.5	246.4
April	1,418.7	27.2	23.3	3,401.5	242.0	284.2	2,980.9	196.5	228.8
May	1,798.6	23.3	19.5	5,184.5	1,039.4	1,469.9	4,466.3	823.9	1,162.2
June	1,464.4	24.2	22.4	5,809.8	1,637.7	2,270.9	4,888.0	1,295.4	1,794.0
July	1,461.9	30.3	42.3	3,589.0	576.1	883.5	3,137.8	460.4	705.0
August	1,198.5	32.4	25.6	2,098.0	46.1	50.5	1,907.2	43.2	45.2
September	971.7	44.5	19.5	1,655.4	46.3	32.5	1,510.4	45.9	29.7

Source: PG&E. 2023. Second Supplemental FLA. Table 7.2-6.

Table B-2 Average Monthly Flows in the SJR below K2 Powerhouse (WY 1985-2017).

Month	Dry WYs (cfs)			Normal WYs (cfs)			All WYs (cfs)		
	Without Project	Historical (Gage J-2)	Current Operations	Without Project	Historical (Gage J-2)	Current Operations	Without Project	Historical (Gage J-2)	Current Operations
October	714.3	662.2	712.7	964.2	926.5	959.9	911.2	870.4	907.5
November	550.1	527.6	551.5	868.1	864.4	869.4	800.7	793.0	802.0
December	513.2	483.4	513.3	1,031.3	972.2	1,029.8	921.4	868.5	920.3
January	552.0	512.9	551.7	1,675.8	1,584.7	1,677.2	1,437.4	1,357.4	1,438.5
February	610.6	553.4	610.6	2,043.5	1,923.6	2,042.5	1,740.6	1,634.0	1,739.8
March	924.1	860.5	923.0	2,761.3	2,554.8	2,761.7	2,371.6	2,195.4	2,371.7
April	1,418.7	1,363.5	1,418.8	3,401.5	3,137.7	3,400.1	2,980.9	2,761.3	2,979.8
May	1,798.6	1,751.2	1,794.9	5,184.5	4,770.6	5,182.9	4,466.3	4,130.1	4,464.2
June	1,464.4	1,407.2	1,462.2	5,809.8	5,318.5	5,807.0	4,888.0	4,488.9	4,885.4
July	1,461.9	1,430.8	1,461.2	3,589.0	3,193.0	3,588.0	3,137.8	2,819.2	3,136.9
August	1,198.5	1,152.9	1,194.9	2,098.0	1,889.5	2,096.6	1,907.2	1,733.3	1,905.4
September	971.7	925.1	971.3	1,655.4	1,518.3	1,652.5	1,510.4	1,392.5	1,508.0

Source: PG&E. 2023. Second Supplemental FLA. Table 7.2-8.

Table B-3 Median, Minimum, and Maximum of the Median Monthly Flow in the SJR below Kerckhoff Dam (WY 1985–2017).

Month	Median (cfs)			Minimum (cfs)			Maximum (cfs)		
	Without Project	Historical (Gage J-2)	Current Operations	Without Project	Historical (Gage J-2)	Current Operations	Without Project	Historical (Gage J-2)	Current Operations
October	844.7	32.0	32.5	43.0	18.0	19.5	1,598.8	489.2	1,472.0
November	672.6	35.0	32.5	49.7	17.0	19.5	2,159.3	1,973.8	1,237.6
December	706.4	31.0	32.5	147.7	18.0	19.5	3,052.0	268.4	1,287.4
January	789.6	32.0	32.5	47.4	18.0	19.5	6,550.0	529.0	1,824.7
February	1,370.5	31.0	32.5	63.0	18.0	19.5	6,665.2	2,915.0	1,921.9
March	1,820.2	31.0	32.5	85.5	17.9	19.5	5,147.0	955.4	3,137.4
April	2,469.9	31.0	32.5	58.9	17.0	19.5	7,828.6	3,215.0	2,727.6
May	3,140.0	32.0	32.5	52.3	17.0	19.5	11,989.6	6190.0	7,063.4
June	2,916.6	33.0	32.5	345.7	17.0	19.5	13,923.9	8,965.0	9,170.0
July	1,990.6	35.0	32.5	742.2	17.0	20.2	10,598.0	4,710.0	6,180.7
August	1,794.1	36.4	32.5	692.1	17.0	19.5	3,468.0	67.0	46.2
September	1,452.4	34.0	32.5	450.8	17.0	19.5	2,914.5	66.5	32.5

Source: PG&E. 2023. Second Supplemental FLA. Table 7.2-7.

Table B-1 Median, Minimum, and Maximum of the Median Monthly Flow in the SJR below the K2 Powerhouse (WY 1985–2017).

Month	Median (cfs)			Minimum (cfs)			Maximum (cfs)		
	Without Project	Historical (Gages J-2 + J-6)	Current Operations	Without Project	Historical (Gages J-2 + J-6)	Current Operations	Without Project	Historical (Gages J-2 + J-6)	Current Operations
October	844.7	809.0	843.4	43.0	22.0	19.5	1,598.8	1,527.0	1,591.5
November	672.6	693.5	674.7	49.7	20.1	19.5	2,159.3	2,497.8	2,178.0
December	706.4	688.0	687.4	147.7	30.0	152.4	3,052.0	2,920.0	2,862.4
January	789.6	901.6	789.3	47.4	52.1	19.5	6,550.0	5,790.0	6,549.7
February	1,370.5	1,329.0	1,364.3	63.0	53.9	19.5	6,665.2	4,787.4	6,664.9
March	1,820.2	1,719.0	1,770.7	85.5	174.7	43.7	5,147.0	5,079.9	5,146.4
April	2,469.9	2,251.5	2,515.3	58.9	19.7	19.5	7,828.6	5,415.9	7,827.6
May	3,140.0	2,983.6	3,149.5	52.3	42.7	19.5	11,989.6	11,794.0	11,988.3
June	2916.6	2,707.0	2,856.8	345.7	355.7	366.5	13,923.9	11,797.5	13,921.9
July	1,990.6	1,881.4	2,092.4	742.2	914.1	723.6	10,598.0	10,340.0	10,595.6
August	1,794.1	1,669.9	1,775.3	692.1	519.2	747.7	3,468.0	3,443.5	3,596.2
September	1,452.4	1,319.0	1,448.0	450.8	445.8	499.8	2,914.5	2,623.0	2,834.1

Source: PG&E. 2023. Second Supplemental FLA. Table 7.2-9.

Note: Small differences—approximately 2 cfs in each of the monthly medians—occur between the with- and without-Project flows. These differences are the result of evaporation, which is accounted for in the HEC-ResSim reservoir modeling and reduces the with-Project flows compared to the without-Project flows. Also, at times, the reservoir may be surcharging with incoming flows. In one instance, a more substantial difference in the minimum monthly median flow occurs in June when the with-Project flows were 438.0 cfs and without-Project flows were 331.0 cfs. These flows were likely attributable to American shad spawning flow requirements that included up to 1,200 cfs through the K2 Powerhouse from May 15 to June 30.

Table B-2 Average Monthly Flows through K2 Powerhouse (WY 1985–2017).

Month	Dry WYs (cfs)		Normal WYs (cfs)		All WYs (cfs)	
	Historical (Gage J-6)	Current Operations	Historical (Gage J-6)	Current Operations	Historical (Gage J-6)	Current Operations
October	412.2	328.3	671.8	640.6	616.7	574.4
November	202.1	371.6	288.9	508.5	270.5	479.5
December	354.7	391.6	840.7	792.2	737.6	707.3
January	434.1	499.9	1,224.2	1,374.7	1,056.6	1,189.1
February	511.2	581.8	1,535.8	1,693.7	1,319.3	1,458.7
March	805.2	894.2	2,242.5	2,456.8	1,937.6	2,125.3
April	1,285.5	1,395.5	2,712.8	3,115.9	2,410.0	2,751.0
May	1,630.7	1,775.4	3,152.8	3,713.1	2,829.9	3,302.0
June	1,261.9	1,439.8	2,996.8	3,536.1	2,628.8	3,091.4
July	1,394.0	1,418.9	2,360.5	2,704.6	2,155.4	2,431.8
August	1,113.4	1,169.3	1,808.9	2,046.1	1,661.3	1,860.1
September	867.9	951.8	1,468.8	1,620.0	1,341.3	1,478.2

Source: PG&E. 2023. Second Supplemental FLA. Table 7.2-10.

Table B-6 Modeled Flow Statistics in the Project Bypass Reach below Kerckhoff Dam during WYs 1985–2017 under the No-Action Alternative and the Proposed Action.

Month	Daily Exceedance Flows by Month (cfs)			Maximum, Minimum, and Average Daily Flows (cfs)		
	25%	50%	75%	Max	Min	Avg
No-Action Alternative						
Oct	439.6	32.5	32.5	2,663.5	19.5	333.1
Nov	513.9	32.5	32.5	2,821.2	19.5	322.5
Dec	32.5	32.5	32.5	4,786.5	19.5	213.0
Jan	32.5	32.5	32.5	35,167.8	19.5	249.4
Feb	32.5	32.5	32.5	9,671.1	19.5	281.2
Mar	32.5	32.5	32.5	12,743.6	19.5	246.4
Apr	32.5	32.5	32.5	15,341.0	19.5	228.8
May	1,044.4	32.5	32.5	20,490.1	19.5	1,162.2
Jun	2,519.4	32.5	32.5	12,629.2	19.5	1,794.0
Jul	50.0	32.5	32.5	13,247.6	19.7	705.0
Aug	32.5	32.5	32.5	2,817.5	19.5	45.2
Sep	32.5	32.5	32.5	32.5	19.5	29.7
Proposed Action						
Oct	443.5	32.5	32.5	2,883.9	19.5	337.6
Nov	500.0	32.5	32.5	2,821.2	19.5	318.7
Dec	32.5	32.5	32.5	4,769.2	19.5	212.8
Jan	32.5	32.5	32.5	34,325.4	19.5	250.1
Feb	32.5	32.5	32.5	9,628.0	19.5	281.2
Mar	32.5	32.5	32.5	12,606.6	19.5	247.1
Apr	32.5	32.5	32.5	15,178.9	19.5	230.1
May	1,532.9	32.5	32.5	19,912.3	19.5	1,219.8
Jun	2,552.5	32.5	32.5	12,590.0	19.5	1,847.9
Jul	50.0	32.5	32.5	13,140.1	19.7	759.5
Aug	32.5	32.5	32.5	2,783.5	19.5	65.1
Sep	32.5	32.5	32.5	40.2	19.5	29.8
Flow Difference between Proposed Action and No-Action Alternative						
Oct	3.9	-	-	220.4	-	4.4
Nov	(13.9)	-	-	-	-	(3.7)
Dec	-	-	-	(17.3)	-	(0.2)
Jan	-	-	-	(842.4)	-	0.7
Feb	-	-	-	(43.1)	-	-
Mar	-	-	-	(137.0)	-	0.7
Apr	-	-	-	(162.1)	-	1.3
May	488.5	-	-	(577.8)	-	57.6
Jun	33.1	-	-	(39.2)	-	53.9
Jul	-	-	-	(107.5)	-	54.5
Aug	-	-	-	(34.0)	-	19.9
Sep	-	-	-	7.7	-	-

Note: cfs – cubic feet per second
WY – water year
Parentheses indicate a negative value.

Source: PG&E. 2023. Second Supplemental FLA. Table 8.2-1.

Table B-7 Modeled Flow Statistics in the Project Bypass Reach below Kerckhoff Dam during Dry WYs (WY 1985–2017) under the No-Action Alternative and the Proposed Action.

Month	Daily Exceedance Flows by Month (cfs)			Maximum, Minimum, and Average Daily Flows (cfs)		
	25%	50%	75%	Max	Min	Avg
No-Action Alternative						
Oct	435.4	32.5	19.5	2,282.6	19.5	384.4
Nov	197.0	32.5	32.5	1,349.0	19.5	179.8
Dec	32.5	32.5	19.5	908.6	19.5	121.7
Jan	32.5	32.5	19.5	2,556.4	19.5	51.8
Feb	32.5	32.5	19.5	32.5	19.5	28.8
Mar	32.5	32.5	19.5	32.5	19.5	28.8
Apr	32.5	19.5	19.5	32.5	19.5	23.3
May	19.5	19.5	19.5	23.8	19.5	19.5
Jun	20.6	19.5	19.5	50.0	19.5	22.4
Jul	50.0	50.0	37.2	50.0	19.7	42.3
Aug	36.5	19.5	19.5	49.9	19.5	25.6
Sep	19.5	19.5	19.5	19.5	19.5	19.5
Proposed Action						
Oct	440.9	32.5	32.5	2,265.1	19.5	389.1
Nov	188.6	32.5	32.5	1,349.9	19.5	176.5
Dec	32.5	32.5	19.5	905.3	19.5	120.9
Jan	32.5	32.5	19.5	2,486.2	19.5	52.4
Feb	32.5	32.5	19.5	36.7	19.5	28.8
Mar	32.5	32.5	19.5	32.5	19.5	28.8
Apr	32.5	19.5	19.5	32.5	19.5	23.2
May	19.5	19.5	19.5	1,700.0	19.5	105.4
Jun	20.9	19.5	19.5	1,700.0	19.5	62.4
Jul	50.0	50.0	37.4	50.0	19.7	43.5
Aug	47.4	36.4	19.5	50.0	19.5	32.5
Sep	19.5	19.5	19.5	38.7	19.5	19.6
Flow Difference between Proposed Action and No-Action Alternative						
Oct	5.5	-	13.0	(17.5)	-	4.7
Nov	(8.4)	-	-	0.9	-	(3.3)
Dec	-	-	-	(3.3)	-	(0.8)
Jan	-	-	-	(70.3)	-	0.6
Feb	-	-	-	4.2	-	-
Mar	-	-	-	-	-	-
Apr	-	-	-	-	-	(0.1)
May	-	-	-	1,676.2	-	85.9
Jun	0.2	-	-	1,650.0	-	40.1
Jul	-	-	0.2	-	-	1.2
Aug	10.9	16.9	-	0.1	-	6.9
Sep	-	-	-	19.2	-	0.1

Note: cfs – cubic feet per second
WY – water year
Parentheses indicate a negative value.

Source: PG&E. 2023. Second Supplemental FLA. Table 8.2-2.

Table B-8 Modeled Flow Statistics in the Project Bypass Reach below Kerckhoff Dam during Normal WYs (WY 1985–2017) under the No-Action Alternative and the Proposed Action.

Month	Daily Exceedance Flows by Month (cfs)			Maximum, Minimum, and Average Daily Flows (cfs)		
	25%	50%	75%	Max	Min	Avg
No-Action Alternative						
Oct	440.0	32.5	32.5	2,663.5	19.5	319.3
Nov	553.4	32.5	32.5	2,821.2	19.5	360.9
Dec	322.8	32.5	32.5	4,786.5	19.5	237.6
Jan	32.5	32.5	32.5	35,167.8	19.5	302.6
Feb	32.5	32.5	32.5	9,671.1	19.5	348.8
Mar	32.5	32.5	32.5	12,743.6	19.5	305.0
Apr	32.5	32.5	32.5	15,341.0	29.3	284.2
May	2,131.1	32.5	32.5	20,490.1	32.5	1,469.9
Jun	3,902.3	45.5	32.5	12,629.2	32.5	2,270.9
Jul	45.8	32.5	32.5	13,247.6	32.5	883.5
Aug	32.5	32.5	32.5	2,817.5	32.5	50.5
Sep	32.5	32.5	32.5	32.5	32.5	32.5
Proposed Action						
Oct	443.7	32.5	32.5	2,883.9	19.5	323.7
Nov	524.8	32.5	32.5	2,821.2	19.5	357.0
Dec	300.0	32.5	32.5	4,769.2	19.5	237.5
Jan	32.5	32.5	32.5	34,325.4	19.5	303.3
Feb	32.5	32.5	32.5	9,628.0	19.5	348.8
Mar	32.5	32.5	32.5	12,606.6	19.5	305.8
Apr	32.5	32.5	32.5	15,178.9	32.5	285.8
May	2,161.9	32.5	32.5	19,912.3	32.5	1,519.8
Jun	3,891.4	46.1	32.5	12,590.0	32.5	2,328.6
Jul	200.9	32.5	32.5	13,140.1	32.5	952.3
Aug	32.5	32.5	32.5	2,783.5	32.5	73.9
Sep	32.5	32.5	32.5	40.2	32.5	32.5
Flow Difference between Proposed Action and No-Action Alternative						
Oct	3.7	-	-	220.4	-	4.4
Nov	(28.7)	-	-	-	-	(3.9)
Dec	(22.8)	-	-	(17.3)	-	(0.1)
Jan	-	-	-	(842.4)	-	0.7
Feb	-	-	-	(43.1)	-	-
Mar	-	-	-	(137.0)	-	0.9
Apr	-	-	-	(162.1)	3.3	1.6
May	30.7	-	-	(577.8)	-	49.9
Jun	(10.9)	0.6	-	(39.2)	-	57.6
Jul	155.1	-	-	(107.5)	-	68.8
Aug	-	-	-	(34.0)	-	23.4
Sep	-	-	-	7.7	-	-

Note: cfs – cubic feet per second; WY – water year
 Parentheses indicate a negative value.

Source: PG&E. 2023. Second Supplemental FLA. Table 8.2-3.

Table B-9 Average Median, Average Minimum, and Average Maximum of the Monthly Flow Below the K2 Powerhouse and in the SJR below Kerckhoff Dam (WY 2018–2023).

Month	Median (cfs)		Minimum (cfs)		Maximum (cfs)	
	Flow Below K2 Powerhouse	Flow Below Kerckhoff Dam	Flow Below K2 Powerhouse	Flow Below Kerckhoff Dam	Flow Below K2 Powerhouse	Flow Below Kerckhoff Dam
October	646	327	0	43	1767	1240
November	485	327	0	41	1165	1369
December	1042	120	114	43	2294	728
January	1075	143	97	46	1932	937
February	1021	161	0	43	2074	768
March	1637	601	291	43	2935	2728
April	2751	972	849	46	4109	3280
May	3112	1661	1853	244	4187	3678
June	2751	972	849	46	4109	3280
July	2124	835	1141	46	2767	2446
August	1494	178	97	46	2944	1023
September	1602	170	0	46	2843	1209

Appendix C

License Articles and Orders

Table C-1 presents a summary of the Project license articles. This summary is provided for convenience only; the actual license articles should be read for a complete understanding of the articles' intent. Table B-2 provides a summary of other significant FERC orders and Project exhibits related to Project operations.

Table C-1. FERC license articles and related orders for the Project.

License Article	Condition
Article 1	The Project is subject to the provisions, terms, and conditions of the license.
Article 2	No substantial changes may be made in the plans, maps, specifications, and statements in the exhibits until approved by FERC.
Article 3	The Project will be in substantial conformity with the approved exhibits.
Article 4	The Project is subject to inspection by FERC's regional engineer.
Article 5	Requires the Licensee to acquire title in fee or the right to use in perpetuity all lands, other than lands of the United States, necessary or appropriate for Project construction, maintenance, and operation.
Article 6	In the event the Project is taken over by the United States upon termination or transfer of the license, Licensee will be responsible for and will make good any defect of title to or of right of occupancy, which is necessary for Project maintenance and operation.
Article 7	The Commission will determine the actual cost of the original Project and any addition thereto.
Article 8	Requires the Licensee to install and monitor stream gages and gaging stations.
Article 9	Requires the Licensee to install additional capacity or make other changes as directed by FERC.
Article 10	Requires coordination of Project with other power systems in the interest of power and other beneficial public uses of the water.
Article 11	Whenever the Licensee is directly benefited by the construction of other licensee, of a storage reservoir or other headwater benefit, the Licensee will reimburse the owner of the headwater improvement.
Article 12	The United States retains and safeguards the right to use water in such amount as may be necessary for the purposes of navigation and operations controlled for the protection of life, health, and property and in the interest of conservation and utilization for power purposes and other beneficial public uses.
Article 13	Requires the Licensee to permit reasonable use of reservoir or other Project properties as may be ordered by FERC in the interest of comprehensive development of the waterway.
Article 14	Requires the Licensee to avoid interference between Project transmission lines or other Project facilities and any other communication facilities installed before or after construction.
Article 15	Requires the Licensee to construct, maintain, and operate protective devices in the interest of fish and wildlife resource, as ordered by FERC after an opportunity for a hearing.
Article 16	Requires the Licensee to permit the United States to use free of cost Project works or lands to construct fish and wildlife facilities.
Article 17	Requires the Licensee to construct, maintain, and operate reasonable recreational facilities as directed by FERC, or as recommended by other federal or state agency after an opportunity for a hearing.
Article 18	Requires the Licensee to allow the public free access, to a reasonable extent (safety considerations), to Project waters and adjacent Project lands owned by the Licensee.

License Article	Condition
Article 19	Requires the Licensee to take reasonable measures to prevent soil erosion on land adjacent to the stream and prevent stream siltation and other forms of water or air pollution resulting from Project construction, operation, or maintenance.
Article 20	Requires the Licensee to clear and keep clear lands along open conduits, and remove all trees along the periphery of reservoirs that may die during Project operation.
Article 21	Requires the Licensee only conduct dredge and fill activities in association with work specifically authorized under the license; during maintenance of the Project; or after obtaining FERC approval.
Article 22	Requires the Licensee to convey to the United States, free of cost, lands and rights-of-way required to construct, complete, or improve navigation facilities in connection with the Project.
Article 23	Requires that operation of any navigation facilities constructed in connection with the Project are controlled by reasonable rules and regulations in the interest of navigation.
Article 24	Requires the Licensee to provide power, free of cost, to the United States for the operation and maintenance of navigation facilities in the vicinity of the Project.
Article 25	Requires the Licensee to construct, maintain, and operate lights and other signals for the protection of navigation.
Article 26	Requires payment by Licensee for timber cut, used, or destroyed in the construction and maintenance of the Project on lands of the United States.
Article 27	Requires the Licensee to prevent, control, and suppress fires on Project lands.
Article 28	Licensee may not object to or prevent use of water for fire suppression.
Article 29	Requires the Licensee to be liable for destruction of any structures or property of the United States during Project construction, maintenance, or operation.
Article 30	Requires the Licensee to permit any agency of the United States, without charge, to construct or permit conduits, chutes, ditches, railroads, roads, trails, telephone and power lines, and other means of transportation and communication not inconsistent with the Project license.
Article 31	Requires state or federal jurisdictional approval over the location and standards of roads and trails, and other uses of land, including quarries, borrow pits, and spoil disposal areas during construction and maintenance.
Article 32	Requires the Licensee to minimize interference with transmission, telegraph, telephone, etc., wires during construction and maintenance activities.
Article 33	Requires the Licensee to clear and maintain transmission rights-of-way.
Article 34	Requires the Licensee to cooperate with the disposal by the United States of mineral and vegetative materials, under the Act of July 31, 1947.
Article 35	Requires the Licensee to maintain and operate the Project in good faith and comply with terms of the license and, if not, FERC will consider the Licensee's intent to surrender and terminate the license.
Article 36	Right of the Licensee to use or occupy waters or lands of the United States for the purpose of maintaining the Project will cease at the end of the license period, unless the Licensee obtains a new license, or an annual license is issued.
Article 37	Terms and conditions in the license will not be construed as impairing any terms and conditions of the Federal Power Act.
Article 38	Requires the Licensee to implement, and modify when appropriate, the emergency action plan on file with the Commission designed to provide an early warning to upstream and downstream inhabitants and property owners if there should be an impending or actual sudden release of water caused by an accident to, or failure of, Project works.

License Article	Condition
Article 39	Requires the Licensee to install and operate any signs, lights, sirens, barriers, or other safety devices that may reasonably be needed to warn the public of fluctuations in flow from the Project and protect the public in its recreational use of Project lands and waters.
Article 40	Requires the Licensee to operate the Project during flood periods in a manner that will not cause peak river flows below Kerckhoff Dam and powerhouses to exceed the peak flows that would have occurred in the absence of the Project.
Article 41	Requires the Licensee to submit to the Commission a plan for the disposal of tunnel spoil, including measures for landscaping and revegetating any affected land areas and measures for minimizing any adverse impacts on water quality. This shall be done in consultation with the Bureau of Land Management of the Department of the Interior and at least 60 days prior to the commencement of tunnel excavation operations.
Article 42	Requires the Licensee, in consultation with the California State Resources Agency and the U.S. Fish and Wildlife Service of the Department of the Interior, to arrange for a preconstruction survey of all areas proposed to be disturbed by Project construction or operation, to determine the impacts, if any, on endangered or threatened species of flora and fauna.
Article 43	Requires the Licensee to continue to consult and cooperate with the California Department of Fish and Game, the U.S. Fish and Wildlife Service, and Bureau of Land Management of the Department of the Interior, and other appropriate agencies with regard to measures needed to ensure the protection of the natural resources and values of the Project Area, including the existing springs and associated riparian habitat.
Article 44	Requires the Licensee to file for approval a revised Exhibit S, within 3 years after the date of issuance of this license. By the end of the sixth year following commencement of commercial operation of Kerckhoff No.2 power plant, requires the Licensee to have assessed the fishery mitigation plan and determined if modifications should be made to further protect and enhance the fishery. Order approved revised Exhibit S and Wildlife Habitat Plan on August 29, 1984.
Article 45	Requires the Licensee to discharge minimum flows of 25 cfs during Normal years and 15 cfs during Dry years. The permanent American shad spawning season flow release regime shall be implemented each year from May 15 through June 30. Requires additional releases as determined necessary by the California Department of Fish and Game to (1) maintain stream temperatures at or below 27°C upstream of Kerckhoff 2 Powerhouse, and (2) flush sediments that may accumulate in the streambed below Kerckhoff Dam.
Article 46	At least 60 days prior to the start of construction, and after consultation with the California Water Resources Control Board, requires the Licensee to develop and file with the Commission a plan to minimize the quantity of inorganic sediments or other pollutants resulting from construction, operation, or maintenance of the Project, that might enter the Project waters.
Article 47	Requires the Licensee to implement programs to assess and monitor the impacts of construction and operation of the Project on water quality.
Article 48	Requires the Licensee to continue to cooperate with the California State Historic Preservation Officer (SHPO) in carrying out the measures for the protection and salvage of archaeological resources at the Project. The Licensee shall provide funds in a reasonable amount for these protective measures and data recovery work.
Article 49	Requires the Licensee to avoid or minimize any disturbance caused by construction and maintenance of the Project works to the natural, scenic, historical, and recreational values of the Project Area. At least 60 days prior to the start of construction, the Licensee shall submit to the Commission a detailed plan to avoid or minimize any disturbance to these values of the Project Area.

License Article	Condition
Article 50	At least 60 days prior to the start of construction, and after consultation with the U.S. Environmental Protection Agency and other appropriate federal and state agencies, the Licensee shall develop and file with the Commission a plan to protect ambient air quality at the Project during construction activities.
Article 51	Prior to the start of construction, requires the Licensee to prepare a plan for sewage effluent disposal at temporary and permanent Project facilities, in consultation and cooperation with the Bureau of Land Management, California State Water Resources Control Board, and the Fresno County Health Department.
Article 52	Requires the Licensee to prepare a solid waste management plan, in consultation with the California Department of Public Health. The plan shall be filed with the Commission within 1 year after the commencement of commercial operation of the Kerckhoff No. 2 power plant.
Article 53	Requires the Licensee to dispose of all temporary structures, unused timber, brush, refuse, or other material not needed for the purpose of the Project, which result from the clearing of lands or from the maintenance or alteration of the Project.
Article 54	After consultation with the Bureau of Land Management, the Licensee shall develop and file with the Commission, at least 60 days prior to the beginning of construction, a plan to control access into Squaw Leap Management Area.
Article 55	The Licensee shall, prior to May 7, 1985, file for Commission approval to show the Kerckhoff Project as finally constructed and located, and the amount of U.S. lands occupied by it.
Article 56	Requires the Licensee to pay the United States annual charges, effective November 1, 1979.
Article 57	One-half of the Project surplus earnings, if any, accumulated under the license, in excess of the specified rate of return per annum on the net investment, shall be set aside in a Project amortization reserve account as of the end of each fiscal year.
Article 58	Land Management License Article (Deletion of Article 58 and addition of Article 60).
Article 59	The Licensee shall retain a board of three or more qualified, independent engineering consultants to review for safety and adequacy the design, specifications, and construction of the new powerhouse, tunnel, and appurtenant facilities.
Article 60	The Licensee shall have the authority to grant permission for certain types of use and occupancy of Project lands and waters and to convey certain interests in Project lands and waters for certain other types of use and occupancy, without prior Commission approval. The Licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the Project.

Table C-2. Other significant FERC orders for the Project.

Date	Order
November 8, 1979	Order issuing Project license
November 28, 1980	Land Management License Article (deletion of Article 58 and addition of Article 60) – order giving Licensee the authority to grant permission for certain types of use and occupancy of Project lands and waters and to convey certain interests in Project lands and waters for certain other types of use and occupancy, without prior Commission approval
May 18, 1981	Order approving reconstruction of tramway
August 13, 1982	Supplement to Article 59
June 23, 1983	Order revising Article 47 – order requiring establishment of a construction and operational water quality monitoring programs, including filing requirements
June 5, 1984	Order amending license (Article 55) – order requiring filing of “as-built” Exhibits K, L, and M prior to May 7, 1985
August 29, 1984	Order approving revised Exhibit S (including results of pre-operational fisheries studies and fisheries study plan for a 2-year operational study in 1984–1985 to determine operational effects of Kerckhoff 2 Powerhouse on the striped bass and American shad stocks in the San Joaquin River [SJR]) and Wildlife Habitat Plan (watering holes for quail) (Article 44)
June 26, 1985	Order approving as-built exhibits (G, L, M) and revising annual charges (Article 56)
June 10, 1986	Order approving as-built exhibit (Exhibit R)
September 21, 1987	Order requiring PG&E to continue the flow study to determine the flow regime necessary to protect American shad and striped bass spawning, and file results and recommendations within 5 months
May 10, 1988	Order denying appeal and requiring an interim minimum flow and requiring Licensee to conduct the habitat-based flow study on American shad and striped bass spawning required by Commission order dated September 21, 1987
June 16, 1988	Order modifying interim minimum flow release
September 23, 1988	Order on rehearing (habitat-based assessment study to determine the flow needed to facilitate spawning of American shad and striped bass in the SJR)
October 20, 1988	Order amending Article 45, establishing a permanent minimum flow regime. Requires additional releases as determined necessary by the California Department of Fish and Game to (1) maintain stream temperatures at or below 27°C upstream of Kerckhoff 2 Powerhouse, and (2) flush sediments that may accumulate in the streambed below Kerckhoff Dam.
May 12, 1989	Order granting and modifying an interim flow regime and requiring shad monitoring in spring 1989.
May 8, 1990	Order establishing interim instream flow regime and approving further study (annual monitoring of shad spawning success May 15–June 30, including the number of shad eggs and larvae and the percentage of live eggs).
June 25, 1990	Order amending order establishing interim flow regime for American shad to allow for modifications due to the lack of insufficient inflows or operating emergencies.
May 15, 1991	Order establishing the flow regime (at the required interim flow releases for reservoir’s elevation at or below 545 feet msl) and requiring monitoring (errata notice issued June 13, 1991).
June 6, 1991	Order amending Study Plan (Full-Pool Study Plan to determine the permanent flow regime needed to provide surface water velocities suitable for American shad spawning when Millerton Lake is at full-pool level).

Date	Order
May 6, 1992	Order establishing (1992 interim American shad) flow regime and approving Shad Monitoring Plan.
May 26, 1992	Order approving modification of Full-Pool Study Plan for 1992 study, requiring surface water velocity measurements near Kerckhoff 2 Powerhouse tailrace over a range of discharges established as 1992 interim flow releases, with no requirements to sample for the presence of shad eggs and larvae.
April 22, 1993	Order establishing permanent flow release regime (adopting 1992 interim flow regime) for American shad.
March 4, 1996	Order amending license and revising annual charges (Article 56).
August 16, 1996	Order approving revised Exhibit G drawings.
December 22, 1998	Order granting license amendment to allow deletion of transmission lines.
September 12, 2001	Order denying rehearing (Appalachian Group's motion on order issued July 13, 2011).
January 10, 2002	Order permitting a combined answer to motions to intervene and comment (in response to December 13, 2001 notice).
February 9, 2007	Order amending license, revising annual charges, and approving revised Exhibit G drawings and Exhibit M.
April 16, 2013	Order amending license and revising annual charges (Article 56), revised Exhibits M and L (removing Unit No. 2 at Kerckhoff 1 Powerhouse).
December 15, 2014	Letter of exemption from filing FERC Form 80.
June 27, 2018	Order approving change in land rights to grant a deed of conservation easement and agreement for a perpetual conservation easement.

Appendix D

Kerckhoff Air Emissions Modeling

Appendix D1

Kerckhoff Summary

This brief summary is provided ahead of the full Kerckhoff Summary Report to offer readers and listeners a clear, high-level overview of the purpose, scope, and key conclusions of the associated analysis. The report that follows includes detailed tables, calculations, and technical data supporting a comprehensive assessment of air pollutant emissions, greenhouse gas emissions, climate-related risks, and health and equity considerations for the proposed project. This summary distills that detailed information into a plain-language narrative intended to orient the reader prior to review of the full technical report, which is included in its entirety and formatted to meet applicable Section 508 accessibility requirements.

1.0 Summary of Kerckhoff Climate, Emissions, and Equity Analysis

The **Kerckhoff Project** is a proposed industrial project located in **unincorporated Fresno County, California**, within the **San Joaquin Valley Air Basin**. Construction is anticipated to begin in **January 2028**, with operations extending into **2040**. The land use is classified as **General Heavy Industry** at the project/site scale.

2.0 Air Quality and Greenhouse Gas Emissions

Analysis of **construction-phase emissions** shows that all criteria pollutants and greenhouse gas emissions are **below applicable San Joaquin Valley Air Pollution Control District thresholds**. No annual or daily thresholds are exceeded, and no emission reduction measures were required to achieve compliance.

Similarly, **operational emissions** are forecast to remain **below all applicable thresholds** for criteria pollutants and greenhouse gases. The project does not exceed annual or daily limits for reactive organic gases (ROG), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM₁₀ and PM_{2.5}), or greenhouse gases.

3.0 Climate Risk Assessment

A climate risk screening identified **low overall vulnerability** for applicable climate hazards. After accounting for project design and adaptation measures:

- **Extreme precipitation** has a **moderate vulnerability score (3)**.
- **Wildfire** and **snowpack reduction** have **low vulnerability scores (2)**.
- Other hazards (extreme heat, flooding, drought, sea level rise, and air quality degradation) were determined to be **not applicable** to the project location.

4.0 Environmental Justice, Health, and Equity

The project is **not located** within a designated disadvantaged community, low-income community, or Community Air Protection Program area under applicable California

statutes. The **CalEnviroScreen score is 10.0**, indicating a relatively low pollution burden, and the **Healthy Places Index score is 55.0**, reflecting generally favorable community health conditions for the census tract.

5.0 Overall Conclusion

The Kerckhoff Project is expected to comply with applicable air quality thresholds, presents **low climate-related risk**, and does **not disproportionately affect disadvantaged or environmental justice communities**.

Kerckhoff Summary Report

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1. Basic Project Information

1.1. Basic Project Information

Data Field	Value
Project Name	Kerckhoff
Construction Start Date	1/3/2028
Operational Year	2040
Lead Agency	—
Land Use Scale	Project/site
Analysis Level for Defaults	County
Windspeed (m/s)	2.70
Precipitation (days)	30.4
Location	37.13929135404031, -119.56164855510147
County	Fresno
City	Unincorporated
Air District	San Joaquin Valley APCD
Air Basin	San Joaquin Valley
TAZ	2507
EDFZ	5
Electric Utility	Pacific Gas & Electric Company
Gas Utility	Pacific Gas & Electric
App Version	2022.1.1.29

1.2. Land Use Types

Land Use Subtype	Size	Unit	Lot Acreage	Building Area (sq ft)	Landscape Area (sq ft)	Special Landscape Area (sq ft)	Population	Description
General Heavy Industry	23.1	1000sqft	531	0.00	23,134,700	—	—	—

1.3. User-Selected Emission Reduction Measures by Emissions Sector

No measures selected

2. Emissions Summary

2.1. Construction Emissions Compared Against Thresholds

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Un/Mit.	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	1.58	1.58	8.03	80.6	0.15	0.31	0.16	0.39	0.31	0.04	0.33	—	16,422	16,422	0.66	0.13	0.40	16,478
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.05	0.05	0.03	0.36	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	75.9	75.9	< 0.005	< 0.005	0.01	77.2
Average Daily (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.07	0.07	0.35	3.53	0.01	0.01	0.01	0.02	0.01	< 0.005	0.01	—	720	720	0.03	0.01	0.02	722
Annual (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.01	0.01	0.06	0.64	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	119	119	< 0.005	< 0.005	< 0.005	120
Exceeds (Annual)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Threshold	—	10.0	10.0	100	27.0	—	—	15.0	—	—	15.0	—	—	—	—	—	—	—
Unmit.	—	No	No	No	No	—	—	No	—	—	No	—	—	—	—	—	—	—

2.4. Operations Emissions Compared Against Thresholds

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Un/Mit.	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.06	0.05	0.06	0.62	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	25.7	643	668	2.67	0.04	0.11	748
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.06	0.05	0.07	0.49	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	25.7	625	651	2.67	0.04	< 0.005	730
Average Daily (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.04	0.04	0.05	0.36	< 0.005	< 0.005	0.14	0.14	< 0.005	0.04	0.04	25.7	576	602	2.67	0.04	0.03	681
Annual (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.01	0.01	0.01	0.07	< 0.005	< 0.005	0.03	0.03	< 0.005	0.01	0.01	4.26	95.4	99.7	0.44	0.01	0.01	113
Exceeds (Annual)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Threshold	—	10.0	10.0	100	27.0	—	—	15.0	—	—	15.0	—	—	—	—	—	—	—
Unmit.	—	No	No	No	No	—	—	No	—	—	No	—	—	—	—	—	—	—

6. Climate Risk Detailed Report

6.2. Initial Climate Risk Scores

Climate Hazard	Exposure Score	Sensitivity Score	Adaptive Capacity Score	Vulnerability Score
Temperature and Extreme Heat	N/A	N/A	N/A	N/A
Extreme Precipitation	2	0	0	N/A
Sea Level Rise	N/A	N/A	N/A	N/A
Wildfire	1	0	0	N/A
Flooding	N/A	N/A	N/A	N/A

Drought	N/A	N/A	N/A	N/A
Snowpack Reduction	0	0	0	N/A
Air Quality Degradation	N/A	N/A	N/A	N/A

The sensitivity score reflects the extent to which a project would be adversely affected by exposure to a climate hazard. Exposure is rated on a scale of 1 to 5, with a score of 5 representing the greatest exposure.

The adaptive capacity of a project refers to its ability to manage and reduce vulnerabilities from projected climate hazards. Adaptive capacity is rated on a scale of 1 to 5, with a score of 5 representing the greatest ability to adapt.

The overall vulnerability scores are calculated based on the potential impacts and adaptive capacity assessments for each hazard. Scores do not include implementation of climate risk reduction measures.

6.3. Adjusted Climate Risk Scores

Climate Hazard	Exposure Score	Sensitivity Score	Adaptive Capacity Score	Vulnerability Score
Temperature and Extreme Heat	N/A	N/A	N/A	N/A
Extreme Precipitation	2	1	1	3
Sea Level Rise	N/A	N/A	N/A	N/A
Wildfire	1	1	1	2
Flooding	N/A	N/A	N/A	N/A
Drought	N/A	N/A	N/A	N/A
Snowpack Reduction	1	1	1	2
Air Quality Degradation	N/A	N/A	N/A	N/A

The sensitivity score reflects the extent to which a project would be adversely affected by exposure to a climate hazard. Exposure is rated on a scale of 1 to 5, with a score of 5 representing the greatest exposure.

The adaptive capacity of a project refers to its ability to manage and reduce vulnerabilities from projected climate hazards. Adaptive capacity is rated on a scale of 1 to 5, with a score of 5 representing the greatest ability to adapt.

The overall vulnerability scores are calculated based on the potential impacts and adaptive capacity assessments for each hazard. Scores include implementation of climate risk reduction measures.

7. Health and Equity Details

7.3. Overall Health & Equity Scores

Metric	Result for Project Census Tract
CalEnviroScreen 4.0 Score for Project Location (a)	10.0

Healthy Places Index Score for Project Location (b)	55.0
Project Located in a Designated Disadvantaged Community (Senate Bill 535)	No
Project Located in a Low-Income Community (Assembly Bill 1550)	No
Project Located in a Community Air Protection Program Community (Assembly Bill 617)	No

a: The maximum CalEnviroScreen score is 100. A high score (i.e., greater than 50) reflects a higher pollution burden compared to other census tracts in the state.

b: The maximum Health Places Index score is 100. A high score (i.e., greater than 50) reflects healthier community conditions compared to other census tracts in the state.

7.5. Evaluation Scorecard

Health & Equity Evaluation Scorecard not completed.

Appendix D2

Kerckhoff Detailed Report

This brief summary is provided in advance of the full Kerckhoff Detailed Report to give readers and listeners an accessible, high-level overview of the purpose, scope, and conclusions of the underlying analysis. The source document that follows contains extensive tables, calculations, and technical data supporting a comprehensive evaluation of air quality emissions, greenhouse gas emissions, climate risk, and health and equity considerations for the proposed project. This summary condenses that large volume of information into a plain-language description intended to help orient the reader before reviewing the detailed report, which is included in full and has been formatted to meet Section 508 accessibility requirements.

1.0 Summary of Kerckhoff Detailed Report

This document presents a comprehensive air quality, greenhouse gas (GHG), climate risk, and health and equity evaluation for the proposed Kerckhoff Project activities. The analysis supports regulatory review and FERC licensing by documenting emissions, compliance with applicable thresholds, and potential environmental and community effects.

2.0 Project Overview

The Kerckhoff Project is located in Fresno County, California, within the San Joaquin Valley Air Basin and San Joaquin Valley Air Pollution Control District jurisdiction. The project area is classified as General Heavy Industry and includes approximately 531 acres. Construction activities are planned between 2027 and 2036, with project operations extending through at least 2040. Project components include installation of a flow gage, improvements at Smalley Cove, a dam upgrade, Vista Day Use Area construction, trail reconstruction, and upgrades at the K1 Powerhouse.

3.0 Emissions Analysis

The report evaluates criteria air pollutants and greenhouse gas emissions from both construction and operational activities. Emissions were quantified for all applicable sources, including off-road equipment, worker vehicles, and operational activities. No emission reduction measures were applied; therefore, all values reflect unmitigated, conservative (worst-case) conditions.

Construction emissions were evaluated by year and activity. Across all construction phases, the maximum annual emissions of reactive organic gases, nitrogen oxides, carbon monoxide, particulate matter (PM₁₀ and PM_{2.5}), and GHGs were all well below applicable San Joaquin Valley APCD thresholds.

Operational emissions were evaluated by sector, including mobile, water, and waste sources. Annual operational emissions for all criteria pollutants and GHGs also remain below regulatory significance thresholds.

No exceedances of daily or annual air quality or GHG thresholds were identified for either construction or operational conditions.

4.0 Climate Risk Evaluation

The report includes a climate risk assessment addressing potential exposure to hazards such as extreme heat, wildfire, and changes in snowpack. Identified risks are generally low to moderate. No sea level rise exposure is present due to the inland project location. No specific climate risk reduction measures were required based on the assessed vulnerability.

5.0 Health and Environmental Justice

Health and equity metrics were evaluated using CalEnviroScreen and the Healthy Places Index. The project area is not located within a designated disadvantaged, low-income, or AB 617 community. Overall pollution burden and population vulnerability scores are low, indicating no disproportionate impact on sensitive or underserved communities.

6.0 Conclusion

The analysis demonstrates that the Kerckhoff Project complies with applicable air quality and greenhouse gas thresholds under unmitigated conditions. Emissions are low, localized, and temporary during construction, and minimal during operation. Climate risks and health and equity impacts are limited. Based on the findings presented, no significant air quality, climate, or environmental justice impacts are anticipated as a result of the proposed project activities.

Kerckhoff Detailed Report

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1. Basic Project Information

1.1. Basic Project Information

Data Field	Value
Project Name	Kerckhoff
Construction Start Date	1/3/2028
Operational Year	2040
Lead Agency	—
Land Use Scale	Project/site
Analysis Level for Defaults	County
Windspeed (m/s)	2.70
Precipitation (days)	30.4
Location	37.13929135404031, -119.56164855510147
County	Fresno
City	Unincorporated
Air District	San Joaquin Valley APCD
Air Basin	San Joaquin Valley
TAZ	2507
EDFZ	5
Electric Utility	Pacific Gas & Electric Company
Gas Utility	Pacific Gas & Electric
App Version	2022.1.1.29

1.2. Land Use Types

Land Use Subtype	Size	Unit	Lot Acreage	Building Area (sq ft)	Landscape Area (sq ft)	Special Landscape Area (sq ft)	Population	Description
General Heavy Industry	23.1	1000sqft	531	0.00	23,134,700	—	—	—

1.3. User-Selected Emission Reduction Measures by Emissions Sector

No measures selected

2. Emissions Summary

2.1. Construction Emissions Compared Against Thresholds

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Un/Mit.	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	1.58	1.58	8.03	80.6	0.15	0.31	0.16	0.39	0.31	0.04	0.33	—	16,422	16,422	0.66	0.13	0.40	16,478
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.05	0.05	0.03	0.36	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	75.9	75.9	< 0.005	< 0.005	0.01	77.2
Average Daily (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.07	0.07	0.35	3.53	0.01	0.01	0.01	0.02	0.01	< 0.005	0.01	—	720	720	0.03	0.01	0.02	722
Annual (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.01	0.01	0.06	0.64	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	119	119	< 0.005	< 0.005	< 0.005	120
Exceeds (Annual)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Threshold	—	10.0	10.0	100	27.0	—	—	15.0	—	—	15.0	—	—	—	—	—	—	—
Unmit.	—	No	No	No	No	—	—	No	—	—	No	—	—	—	—	—	—	—

2.2. Construction Emissions by Year, Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Year	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily - Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2027	0.22	0.22	0.86	8.89	0.02	0.03	0.08	0.11	0.03	0.02	0.05	—	1,778	1,778	0.07	0.02	0.28	1,785
2028	0.13	0.12	0.67	4.68	0.01	0.01	0.08	0.09	0.01	0.02	0.03	—	901	901	0.04	0.01	0.25	906
2030	0.50	0.49	2.41	23.1	0.04	0.08	0.16	0.24	0.08	0.04	0.12	—	4,477	4,477	0.18	0.04	0.40	4,493
2036	1.58	1.58	8.03	80.6	0.15	0.31	0.08	0.39	0.31	0.02	0.33	—	16,422	16,422	0.66	0.13	0.09	16,478
Daily - Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2027	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
2028	0.05	0.05	0.03	0.36	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	75.9	75.9	< 0.005	< 0.005	0.01	77.2
2030	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
2036	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2027	0.01	0.01	0.02	0.24	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	48.5	48.5	< 0.005	< 0.005	< 0.005	48.7
2028	0.01	0.01	0.01	0.12	< 0.005	< 0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	—	25.0	25.0	< 0.005	< 0.005	0.02	25.3
2030	0.02	0.02	0.08	0.72	< 0.005	< 0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	—	139	139	0.01	< 0.005	0.01	139
2036	0.07	0.07	0.35	3.53	0.01	0.01	< 0.005	0.02	0.01	< 0.005	0.01	—	720	720	0.03	0.01	< 0.005	722
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2027	< 0.005	< 0.005	< 0.005	0.04	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	8.03	8.03	< 0.005	< 0.005	< 0.005	8.07
2028	< 0.005	< 0.005	< 0.005	0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	4.15	4.15	< 0.005	< 0.005	< 0.005	4.18
2030	< 0.005	< 0.005	0.02	0.13	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	22.9	22.9	< 0.005	< 0.005	< 0.005	23.0
2036	0.01	0.01	0.06	0.64	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	119	119	< 0.005	< 0.005	< 0.005	120

2.4. Operations Emissions Compared Against Thresholds

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Un/Mit.	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
---------	-----	-----	-----	----	-----	-------	-------	-------	--------	--------	--------	------	-------	------	-----	-----	---	------

Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.06	0.05	0.06	0.62	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	25.7	643	668	2.67	0.04	0.11	748
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.06	0.05	0.07	0.49	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	25.7	625	651	2.67	0.04	< 0.005	730
Average Daily (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.04	0.04	0.05	0.36	< 0.005	< 0.005	0.14	0.14	< 0.005	0.04	0.04	25.7	576	602	2.67	0.04	0.03	681
Annual (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.01	0.01	0.01	0.07	< 0.005	< 0.005	0.03	0.03	< 0.005	0.01	0.01	4.26	95.4	99.7	0.44	0.01	0.01	113
Exceeds (Annual)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Threshold	—	10.0	10.0	100	27.0	—	—	15.0	—	—	15.0	—	—	—	—	—	—	—
Unmit.	—	No	No	No	No	—	—	No	—	—	No	—	—	—	—	—	—	—

2.5. Operations Emissions by Sector, Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Sector	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	0.06	0.05	0.06	0.62	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	—	201	201	< 0.005	0.01	0.11	204
Area	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Water	—	—	—	—	—	—	—	—	—	—	—	10.3	441	451	1.12	0.03	—	490
Waste	—	—	—	—	—	—	—	—	—	—	—	15.5	0.00	15.5	1.55	0.00	—	54.1

Refrig.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Total	0.06	0.05	0.06	0.62	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	25.7	643	668	2.67	0.04	0.11	748
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	0.06	0.05	0.07	0.49	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	—	184	184	< 0.005	0.01	< 0.005	187
Area	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Water	—	—	—	—	—	—	—	—	—	—	—	10.3	441	451	1.12	0.03	—	490
Waste	—	—	—	—	—	—	—	—	—	—	—	15.5	0.00	15.5	1.55	0.00	—	54.1
Refrig.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Total	0.06	0.05	0.07	0.49	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	25.7	625	651	2.67	0.04	< 0.005	730
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	0.04	0.04	0.05	0.36	< 0.005	< 0.005	0.14	0.14	< 0.005	0.04	0.04	—	135	135	< 0.005	0.01	0.03	137
Area	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Water	—	—	—	—	—	—	—	—	—	—	—	10.3	441	451	1.12	0.03	—	490
Waste	—	—	—	—	—	—	—	—	—	—	—	15.5	0.00	15.5	1.55	0.00	—	54.1
Refrig.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Total	0.04	0.04	0.05	0.36	< 0.005	< 0.005	0.14	0.14	< 0.005	0.04	0.04	25.7	576	602	2.67	0.04	0.03	681
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	0.01	0.01	0.01	0.07	< 0.005	< 0.005	0.03	0.03	< 0.005	0.01	0.01	—	22.3	22.3	< 0.005	< 0.005	0.01	22.7
Area	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Water	—	—	—	—	—	—	—	—	—	—	—	1.70	73.1	74.7	0.19	0.01	—	81.1
Waste	—	—	—	—	—	—	—	—	—	—	—	2.56	0.00	2.56	0.26	0.00	—	8.96
Refrig.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Total	0.01	0.01	0.01	0.07	< 0.005	< 0.005	0.03	0.03	< 0.005	0.01	0.01	4.26	95.4	99.7	0.44	0.01	0.01	113

3. Construction Emissions Details

3.1. Installation of Flow Gage (2027) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.16	0.16	0.83	8.41	0.02	0.03	—	0.03	0.03	—	0.03	—	1,691	1,691	0.07	0.01	—	1,697
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	< 0.005	< 0.005	0.02	0.23	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	46.3	46.3	< 0.005	< 0.005	—	46.5
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	< 0.005	< 0.005	< 0.005	0.04	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	7.67	7.67	< 0.005	< 0.005	—	7.70
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.06	0.06	0.03	0.47	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	87.2	87.2	< 0.005	< 0.005	0.28	88.6
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.01	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	2.20	2.20	< 0.005	< 0.005	< 0.005	2.23
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	0.36	0.36	< 0.005	< 0.005	< 0.005	0.37
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

3.3. Smalley Cove Improvements (2028) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.07	0.07	0.65	4.24	0.01	0.01	—	0.01	0.01	—	0.01	—	816	816	0.03	0.01	—	819
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	< 0.005	< 0.005	0.01	0.07	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	13.4	13.4	< 0.005	< 0.005	—	13.5
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	< 0.005	< 0.005	< 0.005	0.01	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	2.22	2.22	< 0.005	< 0.005	—	2.23
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.06	0.05	0.02	0.44	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	85.5	85.5	< 0.005	< 0.005	0.25	86.9
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.01	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	1.29	1.29	< 0.005	< 0.005	< 0.005	1.31
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Worker	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	0.21	0.21	< 0.005	< 0.005	< 0.005	0.22
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

3.5. Upgrade to Dam (2028) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.06	0.05	0.02	0.44	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	85.5	85.5	< 0.005	< 0.005	0.25	86.9
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.05	0.05	0.03	0.36	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	75.9	75.9	< 0.005	< 0.005	0.01	77.2
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	< 0.005	0.05	0.00	0.00	0.01	0.01	0.00	< 0.005	< 0.005	—	10.3	10.3	< 0.005	< 0.005	0.01	10.5
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.01	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	1.71	1.71	< 0.005	< 0.005	< 0.005	1.74
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

3.7. Vista Day Area Construction (2030) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.12	0.12	0.91	7.06	0.02	0.02	—	0.02	0.02	—	0.02	—	1,337	1,337	0.05	0.01	—	1,342
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.01	0.01	0.06	0.48	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	91.6	91.6	< 0.005	< 0.005	—	91.9
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	< 0.005	< 0.005	0.01	0.09	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	15.2	15.2	< 0.005	< 0.005	—	15.2
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.05	0.05	0.02	0.38	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	82.4	82.4	< 0.005	< 0.005	0.20	83.0
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.02	0.00	0.00	0.01	0.01	0.00	< 0.005	< 0.005	—	5.20	5.20	< 0.005	< 0.005	0.01	5.28
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	0.86	0.86	< 0.005	< 0.005	< 0.005	0.87
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

3.9. Trail Segment Reconstruction (2030) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.28	0.28	1.46	15.2	0.03	0.06	—	0.06	0.06	—	0.06	—	2,975	2,975	0.12	0.02	—	2,985
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	< 0.005	< 0.005	0.02	0.21	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	40.7	40.7	< 0.005	< 0.005	—	40.9
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	< 0.005	< 0.005	< 0.005	0.04	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	6.75	6.75	< 0.005	< 0.005	—	6.77
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Worker	0.05	0.05	0.02	0.38	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	82.4	82.4	< 0.005	< 0.005	0.20	83.0
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	1.04	1.04	< 0.005	< 0.005	< 0.005	1.06
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	0.17	0.17	< 0.005	< 0.005	< 0.005	0.17
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

3.11. K1 Powerhouse (2036) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.54	1.54	8.02	80.4	0.15	0.31	—	0.31	0.31	—	0.31	—	16,346	16,346	0.66	0.13	—	16,402
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.07	0.07	0.35	3.52	0.01	0.01	—	0.01	0.01	—	0.01	—	717	717	0.03	0.01	—	719
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.01	0.01	0.06	0.64	< 0.005	< 0.005	—	< 0.005	< 0.005	—	< 0.005	—	119	119	< 0.005	< 0.005	—	119
Onsite truck	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.03	0.03	0.01	0.28	0.00	0.00	0.08	0.08	0.00	0.02	0.02	—	76.0	76.0	< 0.005	< 0.005	0.09	76.4
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.01	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	3.07	3.07	< 0.005	< 0.005	< 0.005	3.08
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	0.51	0.51	< 0.005	< 0.005	< 0.005	0.51
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

4. Operations Emissions Details

4.1. Mobile Emissions by Land Use

4.1.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	0.06	0.05	0.06	0.62	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	—	201	201	< 0.005	0.01	0.11	204
Total	0.06	0.05	0.06	0.62	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	—	201	201	< 0.005	0.01	0.11	204
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	0.06	0.05	0.07	0.49	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	—	184	184	< 0.005	0.01	< 0.005	187
Total	0.06	0.05	0.07	0.49	< 0.005	< 0.005	0.20	0.20	< 0.005	0.05	0.05	—	184	184	< 0.005	0.01	< 0.005	187
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	0.01	0.01	0.01	0.07	< 0.005	< 0.005	0.03	0.03	< 0.005	0.01	0.01	—	22.3	22.3	< 0.005	< 0.005	0.01	22.7
Total	0.01	0.01	0.01	0.07	< 0.005	< 0.005	0.03	0.03	< 0.005	0.01	0.01	—	22.3	22.3	< 0.005	< 0.005	0.01	22.7

4.2. Energy

4.2.1. Electricity Emissions By Land Use - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
Total	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
Total	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
Total	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00

4.2.3. Natural Gas Emissions By Land Use - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00

4.3. Area Emissions by Source

4.3.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Source	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Consumer Products	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Architectural Coatings	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Landscape Equipment	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Consumer Products	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Architectural Coatings	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Consumer Products	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Architectural Coatings	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Landscape Equipment	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00

4.4. Water Emissions by Land Use

4.4.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	10.3	441	451	1.12	0.03	—	490
Total	—	—	—	—	—	—	—	—	—	—	—	10.3	441	451	1.12	0.03	—	490
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	10.3	441	451	1.12	0.03	—	490
Total	—	—	—	—	—	—	—	—	—	—	—	10.3	441	451	1.12	0.03	—	490
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	1.70	73.1	74.7	0.19	0.01	—	81.1
Total	—	—	—	—	—	—	—	—	—	—	—	1.70	73.1	74.7	0.19	0.01	—	81.1

4.5. Waste Emissions by Land Use

4.5.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	15.5	0.00	15.5	1.55	0.00	—	54.1
Total	—	—	—	—	—	—	—	—	—	—	—	15.5	0.00	15.5	1.55	0.00	—	54.1
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	15.5	0.00	15.5	1.55	0.00	—	54.1
Total	—	—	—	—	—	—	—	—	—	—	—	15.5	0.00	15.5	1.55	0.00	—	54.1
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	2.56	0.00	2.56	0.26	0.00	—	8.96
Total	—	—	—	—	—	—	—	—	—	—	—	2.56	0.00	2.56	0.26	0.00	—	8.96

4.6. Refrigerant Emissions by Land Use

4.6.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
General Heavy Industry	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00

Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
-------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	------	------

4.7. Offroad Emissions By Equipment Type

4.7.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Equipm ent Type	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.8. Stationary Emissions By Equipment Type

4.8.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Equipm ent Type	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.9. User Defined Emissions By Equipment Type

4.9.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Equipm ent Type	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.10. Soil Carbon Accumulation By Vegetation Type

4.10.1. Soil Carbon Accumulation By Vegetation Type - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Vegetati on	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
-------------	-----	-----	-----	----	-----	-------	-------	-------	--------	--------	--------	------	-------	------	-----	-----	---	------

Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.10.2. Above and Belowground Carbon Accumulation by Land Use Type - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.10.3. Avoided and Sequestered Emissions by Species - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Species	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Avoided	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequestered	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Removed	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Avoided	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequestered	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Removed	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Avoided	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequestered	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Removed	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

5. Activity Data

5.1. Construction Schedule

Phase Name	Phase Type	Start Date	End Date	Days Per Week	Work Days per Phase	Phase Description
Installation of Flow Gage	Building Construction	8/2/2027	8/13/2027	5.00	10.0	—
Smalley Cove Improvements	Building Construction	8/7/2028	8/14/2028	5.00	6.00	—
Upgrade to Dam	Building Construction	9/4/2028	11/8/2028	5.00	48.0	—
Vista Day Area Construction	Building Construction	8/5/2030	9/6/2030	5.00	25.0	—
Trail Segment Reconstruction	Building Construction	8/5/2030	8/9/2030	5.00	5.00	—
K1 Powerhouse	Building Construction	4/7/2036	4/28/2036	5.00	16.0	—

5.2. Off-Road Equipment

5.2.1. Unmitigated

Phase Name	Equipment Type	Fuel Type	Engine Tier	Number per Day	Hours Per Day	Horsepower	Load Factor
Installation of Flow Gage	Off-Highway Trucks	Diesel	Tier 4 Final	1.00	8.00	376	0.38
Installation of Flow Gage	Other General Industrial Equipment	Diesel	Tier 4 Final	1.00	2.50	367	0.29
Installation of Flow Gage	Tractors/Loaders/Back hoes	Diesel	Tier 4 Final	1.00	2.50	82.0	0.20
Smalley Cove Improvements	Dumpers/Tenders	Diesel	Tier 4 Final	1.00	1.30	84.0	0.37
Smalley Cove Improvements	Graders	Diesel	Tier 4 Final	1.00	2.70	367	0.29
Smalley Cove Improvements	Off-Highway Trucks	Diesel	Tier 4 Final	1.00	8.00	82.0	0.20

Smalley Cove Improvements	Skid Steer Loaders	Diesel	Tier 4 Final	1.00	5.30	14.0	0.74
Smalley Cove Improvements	Tractors/Loaders/Back hoes	Diesel	Tier 4 Final	1.00	2.70	46.0	0.45
Smalley Cove Improvements	Tractors/Loaders/Back hoes	Diesel	Tier 4 Final	1.00	2.70	84.0	0.37
Smalley Cove Improvements	Plate Compactors	Diesel	Tier 4 Final	1.00	2.70	8.00	0.43
Vista Day Area Construction	Dumpers/Tenders	Diesel	Tier 4 Final	2.00	3.20	367	0.29
Vista Day Area Construction	Excavators	Diesel	Tier 4 Final	1.00	1.30	82.0	0.20
Vista Day Area Construction	Graders	Diesel	Tier 4 Final	1.00	1.60	14.0	0.74
Vista Day Area Construction	Off-Highway Trucks	Diesel	Tier 4 Final	1.00	8.00	84.0	0.37
Vista Day Area Construction	Other Construction Equipment	Diesel	Tier 4 Final	1.00	0.60	46.0	0.45
Vista Day Area Construction	Pavers	Diesel	Tier 4 Final	1.00	0.60	81.0	0.42
Vista Day Area Construction	Plate Compactors	Diesel	Tier 4 Final	1.00	1.60	8.00	0.43
Vista Day Area Construction	Skid Steer Loaders	Diesel	Tier 4 Final	1.00	1.60	71.0	0.37
Vista Day Area Construction	Tractors/Loaders/Back hoes	Diesel	Tier 4 Final	1.00	1.30	84.0	0.37
Trail Segment Reconstruction	Off-Highway Trucks	Diesel	Tier 4 Final	2.00	8.00	376	0.38
Trail Segment Reconstruction	Other General Industrial Equipment	Diesel	Tier 4 Final	2.00	8.00	82.0	0.20
K1 Powerhouse	Cranes	Diesel	Tier 4 Final	1.00	2.00	367	0.29
K1 Powerhouse	Off-Highway Trucks	Diesel	Tier 4 Final	16.0	6.00	376	0.38
K1 Powerhouse	Off-Highway Trucks	Diesel	Tier 4 Final	2.00	0.50	14.0	0.74

K1 Powerhouse	Other General Industrial Equipment	Diesel	Tier 4 Final	1.00	2.00	84.0	0.37
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5.3. Construction Vehicles

5.3.1. Unmitigated

Phase Name	Trip Type	One-Way Trips per Day	Miles per Trip	Vehicle Mix
Upgrade to Dam	—	—	—	—
Upgrade to Dam	Worker	15.0	7.70	LDA,LDT1,LDT2
Upgrade to Dam	Vendor	0.00	4.00	HHDT,MHDT
Upgrade to Dam	Hauling	0.00	20.0	HHDT
Upgrade to Dam	Onsite truck	—	—	HHDT
Smalley Cove Improvements	—	—	—	—
Smalley Cove Improvements	Worker	15.0	7.70	LDA,LDT1,LDT2
Smalley Cove Improvements	Vendor	0.00	4.00	HHDT,MHDT
Smalley Cove Improvements	Hauling	0.00	20.0	HHDT
Smalley Cove Improvements	Onsite truck	—	—	HHDT
Installation of Flow Gage	—	—	—	—
Installation of Flow Gage	Worker	15.0	7.70	LDA,LDT1,LDT2
Installation of Flow Gage	Vendor	0.00	4.00	HHDT,MHDT
Installation of Flow Gage	Hauling	0.00	20.0	HHDT
Installation of Flow Gage	Onsite truck	—	—	HHDT
Vista Day Area Construction	—	—	—	—
Vista Day Area Construction	Worker	15.0	7.70	LDA,LDT1,LDT2
Vista Day Area Construction	Vendor	0.00	4.00	HHDT,MHDT
Vista Day Area Construction	Hauling	0.00	20.0	HHDT
Vista Day Area Construction	Onsite truck	—	—	HHDT
Trail Segment Reconstruction	—	—	—	—
Trail Segment Reconstruction	Worker	15.0	7.70	LDA,LDT1,LDT2

Trail Segment Reconstruction	Vendor	0.00	4.00	HHDT,MHDT
Trail Segment Reconstruction	Hauling	0.00	20.0	HHDT
Trail Segment Reconstruction	Onsite truck	—	—	HHDT
K1 Powerhouse	—	—	—	—
K1 Powerhouse	Worker	15.0	7.70	LDA,LDT1,LDT2
K1 Powerhouse	Vendor	0.00	4.00	HHDT,MHDT
K1 Powerhouse	Hauling	0.00	20.0	HHDT
K1 Powerhouse	Onsite truck	—	—	HHDT

5.4. Vehicles

5.4.1. Construction Vehicle Control Strategies

Non-applicable. No control strategies activated by user.

5.5. Architectural Coatings

Phase Name	Residential Interior Area Coated (sq ft)	Residential Exterior Area Coated (sq ft)	Non-Residential Interior Area Coated (sq ft)	Non-Residential Exterior Area Coated (sq ft)	Parking Area Coated (sq ft)
------------	--	--	--	--	-----------------------------

5.6. Dust Mitigation

5.6.1. Construction Earthmoving Activities

Phase Name	Material Imported (cy)	Material Exported (cy)	Acres Graded (acres)	Material Demolished (sq. ft.)	Acres Paved (acres)
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5.6.2. Construction Earthmoving Control Strategies

Non-applicable. No control strategies activated by user.

5.7. Construction Paving

Land Use	Area Paved (acres)	% Asphalt
General Heavy Industry	0.00	0%

5.8. Construction Electricity Consumption and Emissions Factors

kWh per Year and Emission Factor (lb/MWh)

Year	kWh per Year	CO2	CH4	N2O
2028	0.00	204	0.03	< 0.005
2030	0.00	204	0.03	< 0.005
2036	0.00	204	0.03	< 0.005
2027	0.00	204	0.03	< 0.005

5.9. Operational Mobile Sources

5.9.1. Unmitigated

Land Use Type	Trips/Weekday	Trips/Saturday	Trips/Sunday	Trips/Year	VMT/Weekday	VMT/Saturday	VMT/Sunday	VMT/Year
General Heavy Industry	23.1	0.00	0.00	6,031	288	0.00	0.00	75,027

5.10. Operational Area Sources

5.10.1. Hearths

5.10.1.1. Unmitigated

5.10.2. Architectural Coatings

Residential Interior Area Coated (sq ft)	Residential Exterior Area Coated (sq ft)	Non-Residential Interior Area Coated (sq ft)	Non-Residential Exterior Area Coated (sq ft)	Parking Area Coated (sq ft)
0	0.00	0.00	0.00	—

5.10.3. Landscape Equipment

Season	Unit	Value
Snow Days	day/yr	0.00

Summer Days	day/yr	180
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5.11. Operational Energy Consumption

5.11.1. Unmitigated

Electricity (kWh/yr) and CO2 and CH4 and N2O and Natural Gas (kBTU/yr)

Land Use	Electricity (kWh/yr)	CO2	CH4	N2O	Natural Gas (kBTU/yr)
General Heavy Industry	0.00	204	0.0330	0.0040	0.00

5.12. Operational Water and Wastewater Consumption

5.12.1. Unmitigated

Land Use	Indoor Water (gal/year)	Outdoor Water (gal/year)
General Heavy Industry	5,349,738	317,574,909

5.13. Operational Waste Generation

5.13.1. Unmitigated

Land Use	Waste (ton/year)	Cogeneration (kWh/year)
General Heavy Industry	28.7	—

5.14. Operational Refrigeration and Air Conditioning Equipment

5.14.1. Unmitigated

Land Use Type	Equipment Type	Refrigerant	GWP	Quantity (kg)	Operations Leak Rate	Service Leak Rate	Times Serviced
General Heavy Industry	Other commercial A/C and heat pumps	R-410A	2,088	0.30	4.00	4.00	18.0

5.15. Operational Off-Road Equipment

5.15.1. Unmitigated

Equipment Type	Fuel Type	Engine Tier	Number per Day	Hours Per Day	Horsepower	Load Factor
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5.16. Stationary Sources

5.16.1. Emergency Generators and Fire Pumps

Equipment Type	Fuel Type	Number per Day	Hours per Day	Hours per Year	Horsepower	Load Factor
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5.16.2. Process Boilers

Equipment Type	Fuel Type	Number	Boiler Rating (MMBtu/hr)	Daily Heat Input (MMBtu/day)	Annual Heat Input (MMBtu/yr)
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5.17. User Defined

Equipment Type	Fuel Type
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5.18. Vegetation

5.18.1. Land Use Change

5.18.1.1. Unmitigated

Vegetation Land Use Type	Vegetation Soil Type	Initial Acres	Final Acres
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5.18.1. Biomass Cover Type

5.18.1.1. Unmitigated

Biomass Cover Type	Initial Acres	Final Acres
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5.18.2. Sequestration

5.18.2.1. Unmitigated

Tree Type	Number	Electricity Saved (kWh/year)	Natural Gas Saved (btu/year)
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6. Climate Risk Detailed Report

6.1. Climate Risk Summary

Cal-Adapt midcentury 2040–2059 average projections for four hazards are reported below for your project location. These are under Representation Concentration Pathway (RCP) 8.5 which assumes GHG emissions will continue to rise strongly through 2050 and then plateau around 2100.

Climate Hazard	Result for Project Location	Unit
Temperature and Extreme Heat	36.0	annual days of extreme heat
Extreme Precipitation	9.85	annual days with precipitation above 20 mm
Sea Level Rise	0.00	meters of inundation depth
Wildfire	21.4	annual hectares burned

Temperature and Extreme Heat data are for grid cell in which your project are located. The projection is based on the 98th historical percentile of daily maximum/minimum temperatures from observed historical data (32 climate model ensemble from Cal-Adapt, 2040–2059 average under RCP 8.5). Each grid cell is 6 kilometers (km) by 6 km, or 3.7 miles (mi) by 3.7 mi.

Extreme Precipitation data are for the grid cell in which your project are located. The threshold of 20 mm is equivalent to about ¾ an inch of rain, which would be light to moderate rainfall if received over a full day or heavy rain if received over a period of 2 to 4 hours. Each grid cell is 6 kilometers (km) by 6 km, or 3.7 miles (mi) by 3.7 mi.

Sea Level Rise data are for the grid cell in which your project are located. The projections are from Radke et al. (2017), as reported in Cal-Adapt (Radke et al., 2017, CEC-500-2017-008), and consider inundation location and depth for the San Francisco Bay, the Sacramento-San Joaquin River Delta and California coast resulting different increments of sea level rise coupled with extreme storm events. Users may select from four scenarios to view the range in potential inundation depth for the grid cell. The four scenarios are: No rise, 0.5 meter, 1.0 meter, 1.41 meters

Wildfire data are for the grid cell in which your project are located. The projections are from UC Davis, as reported in Cal-Adapt (2040–2059 average under RCP 8.5), and consider historical data of climate, vegetation, population density, and large (> 400 ha) fire history. Users may select from four model simulations to view the range in potential wildfire probabilities for the grid cell. The four simulations make different assumptions about expected rainfall and temperature are: Warmer/drier (HadGEM2-ES), Cooler/wetter (CNRM-CM5), Average conditions (CanESM2), Range of different rainfall and temperature possibilities (MIROC5). Each grid cell is 6 kilometers (km) by 6 km, or 3.7 miles (mi) by 3.7 mi.

6.2. Initial Climate Risk Scores

Climate Hazard	Exposure Score	Sensitivity Score	Adaptive Capacity Score	Vulnerability Score
Temperature and Extreme Heat	N/A	N/A	N/A	N/A
Extreme Precipitation	2	0	0	N/A
Sea Level Rise	N/A	N/A	N/A	N/A

Wildfire	1	0	0	N/A
Flooding	N/A	N/A	N/A	N/A
Drought	N/A	N/A	N/A	N/A
Snowpack Reduction	0	0	0	N/A
Air Quality Degradation	N/A	N/A	N/A	N/A

The sensitivity score reflects the extent to which a project would be adversely affected by exposure to a climate hazard. Exposure is rated on a scale of 1 to 5, with a score of 5 representing the greatest exposure.

The adaptive capacity of a project refers to its ability to manage and reduce vulnerabilities from projected climate hazards. Adaptive capacity is rated on a scale of 1 to 5, with a score of 5 representing the greatest ability to adapt.

The overall vulnerability scores are calculated based on the potential impacts and adaptive capacity assessments for each hazard. Scores do not include implementation of climate risk reduction measures.

6.3. Adjusted Climate Risk Scores

Climate Hazard	Exposure Score	Sensitivity Score	Adaptive Capacity Score	Vulnerability Score
Temperature and Extreme Heat	N/A	N/A	N/A	N/A
Extreme Precipitation	2	1	1	3
Sea Level Rise	N/A	N/A	N/A	N/A
Wildfire	1	1	1	2
Flooding	N/A	N/A	N/A	N/A
Drought	N/A	N/A	N/A	N/A
Snowpack Reduction	1	1	1	2
Air Quality Degradation	N/A	N/A	N/A	N/A

The sensitivity score reflects the extent to which a project would be adversely affected by exposure to a climate hazard. Exposure is rated on a scale of 1 to 5, with a score of 5 representing the greatest exposure.

The adaptive capacity of a project refers to its ability to manage and reduce vulnerabilities from projected climate hazards. Adaptive capacity is rated on a scale of 1 to 5, with a score of 5 representing the greatest ability to adapt.

The overall vulnerability scores are calculated based on the potential impacts and adaptive capacity assessments for each hazard. Scores include implementation of climate risk reduction measures.

6.4. Climate Risk Reduction Measures

7. Health and Equity Details

7.1. CalEnviroScreen 4.0 Scores

The maximum CalEnviroScreen score is 100. A high score (i.e., greater than 50) reflects a higher pollution burden compared to other census tracts in the state.

Indicator	Result for Project Census Tract
Exposure Indicators	—
AQ-Ozone	84.6
AQ-PM	57.8
AQ-DPM	1.07
Drinking Water	87.5
Lead Risk Housing	23.1
Pesticides	26.4
Toxic Releases	38.8
Traffic	4.86
Effect Indicators	—
CleanUp Sites	18.7
Groundwater	61.9
Haz Waste Facilities/Generators	16.6
Impaired Water Bodies	43.8
Solid Waste	88.9
Sensitive Population	—
Asthma	11.0
Cardio-vascular	5.30
Low Birth Weights	15.7
Socioeconomic Factor Indicators	—
Education	43.4
Housing	2.99
Linguistic	2.81
Poverty	39.2
Unemployment	—

7.2. Healthy Places Index Scores

The maximum Health Places Index score is 100. A high score (i.e., greater than 50) reflects healthier community conditions compared to other census tracts in the state.

Indicator	Result for Project Census Tract
Economic	—
Above Poverty	65.59733094
Employed	22.03259335
Median HI	44.10368279
Education	—
Bachelor's or higher	57.08969588
High school enrollment	100
Preschool enrollment	51.87989221
Transportation	—
Auto Access	85.40998332
Active commuting	4.093417169
Social	—
2-parent households	73.98947774
Voting	75.77312973
Neighborhood	—
Alcohol availability	93.4813294
Park access	16.97677403
Retail density	3.592968048
Supermarket access	25.15077634
Tree canopy	89.84986526
Housing	—
Homeownership	81.26523803
Housing habitability	83.93430001
Low-inc homeowner severe housing cost burden	61.94020275
Low-inc renter severe housing cost burden	83.11305017

Uncrowded housing	75.52932119
Health Outcomes	—
Insured adults	62.95393302
Arthritis	0.0
Asthma ER Admissions	90.8
High Blood Pressure	0.0
Cancer (excluding skin)	0.0
Asthma	0.0
Coronary Heart Disease	0.0
Chronic Obstructive Pulmonary Disease	0.0
Diagnosed Diabetes	0.0
Life Expectancy at Birth	22.0
Cognitively Disabled	25.4
Physically Disabled	37.2
Heart Attack ER Admissions	93.6
Mental Health Not Good	0.0
Chronic Kidney Disease	0.0
Obesity	0.0
Pedestrian Injuries	74.1
Physical Health Not Good	0.0
Stroke	0.0
Health Risk Behaviors	—
Binge Drinking	0.0
Current Smoker	0.0
No Leisure Time for Physical Activity	0.0
Climate Change Exposures	—
Wildfire Risk	1.8
SLR Inundation Area	0.0

Children	65.5
Elderly	12.6
English Speaking	92.2
Foreign-born	4.1
Outdoor Workers	37.8
Climate Change Adaptive Capacity	—
Impervious Surface Cover	99.1
Traffic Density	3.6
Traffic Access	0.0
Other Indices	—
Hardship	40.2
Other Decision Support	—
2016 Voting	74.3

7.3. Overall Health & Equity Scores

Metric	Result for Project Census Tract
CalEnviroScreen 4.0 Score for Project Location (a)	10.0
Healthy Places Index Score for Project Location (b)	55.0
Project Located in a Designated Disadvantaged Community (Senate Bill 535)	No
Project Located in a Low-Income Community (Assembly Bill 1550)	No
Project Located in a Community Air Protection Program Community (Assembly Bill 617)	No

a: The maximum CalEnviroScreen score is 100. A high score (i.e., greater than 50) reflects a higher pollution burden compared to other census tracts in the state.

b: The maximum Health Places Index score is 100. A high score (i.e., greater than 50) reflects healthier community conditions compared to other census tracts in the state.

7.4. Health & Equity Measures

No Health & Equity Measures selected.

7.5. Evaluation Scorecard

Health & Equity Evaluation Scorecard not completed.

7.6. Health & Equity Custom Measures

No Health & Equity Custom Measures created.

8. User Changes to Default Data

Screen	Justification
Land Use	per project description
Construction: Construction Phases	Per Project Description
Construction: Off-Road Equipment	per project description
Construction: Architectural Coatings	project description
Operations: Vehicle Data	project description
Construction: Trips and VMT	project description

Appendix D3

Construction Equipment Usage and Workforce

Construction Equipment Usage and Workforce

Tasks/Equipment	Estimated Horsepower	Probable Fuel Type	Equipment Quantity	Estimated Days per Week of Operation	Estimated Hours per Day of Operation	Estimated Duration of Use (weeks)	Estimated Month Start
Smalley Cove Improvements							
Grader			1	2	8	1	August 2028
Backhoe			1	2	8	1	August 2028
Skid-Steer			1	4	8	1	August 2028
Compactor			1	2	8	1	August 2028
Dump Truck			1	1	8	1	August 2028
Work Truck			1	3	8	2	August 2028
Chainsaw			1	2	8	1	August 2028
Construction of Vista Day Use Area (Paved Roadwork, Picnic Sites, Restroom, Bulletin Board, Signage, Paved Parking Area, Iron Ranger, Gates, Fencing, Barriers)							
Grader			1	5	8	1	August 2030
Excavator			1	4	8	1	August 2030
Backhoe			1	4	8	1	August 2030
Skid-Steer			1	5	8	1	August 2030
Compactor			1	5	8	1	August 2030
Paver			1	2	8	1	August 2030
Asphalt Roller			1	2	8	1	August 2030
Dump Truck			2	5	8	2	August 2030
Work Truck			1	5	8	5	August 2030
Trail Segment Reconstruction at Vista Day Use Area							
Crewcab	310	Gas	2	5	8	1	August 2030
Chainshaws			2	5	8	1	August 2030

Tasks/Equipment	Estimated Horsepower	Probable Fuel Type	Equipment Quantity	Estimated Days per Week of Operation	Estimated Hours per Day of Operation	Estimated Duration of Use (weeks)	Estimated Month Start
Installation of One New Flow Gage							
Pickup Truck	250	Gas	1	5	8	2	August 2027
Potential Digger for Conduit Underground (small)			1	5	5	1	August 2027
Backhole (small)			1	5	5	1	August 2027
Upgrade of Two Manual Radial Gates on the Dam							
Boat Ride (5 trips/day for 3 months)			1 boat	4	5	12	September 2028
Helicopter Trip with Equipment			1 ship	4	4	2	September 2028
K1 Powerhouse Proposed Modification/Retirement Actions							
Helicopter (K1 Tunnel Underground)			1 ship	4	4	4	April 2036
Crewcab (K1 Surge Chamber)	310	Gas	1	4	8	2	May 2036
Concrete Truck			1	1	8	1	May 2036
Crewcab (K1 Headworks)	310	Gas	10	4	8	4	June 2036
Crane			1	4	8	1	June 2036
Large Semi to Haul Equipment			1	4	8	1	August 2036
Crewcab (K1 Powerhouse)	310	Gas	5	4	8	2	October 2036
Concrete Truck			1	2	8	1	October 2036

Appendix E

Biological Resources – Terrestrial Data

Appendix E1

IPaC Resources List

Appendix E-1

This summary was prepared to improve document accessibility and compliance with Section 508 of the Rehabilitation Act. It is based on information contained in a longer technical record search report. The summary is intended for informational purposes only and does not replace or supersede the original source document.

To request the source document, please contact:

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This information was developed using the United States Fish and Wildlife Information for Planning and Consultation tool (IPaC).

Biological Resources Record Search Results

E-1.1 INTRODUCTION

This appendix presents the results of biological resources record searches conducted for the proposed project. The purpose of the record search is to identify special-status plant and wildlife species, sensitive natural communities, wetlands, and other regulated biological resources that may occur within or adjacent to the project area and that could be affected by project implementation.

The record search provides a screening-level assessment to inform the environmental impact analysis, identify the need for focused field surveys, and support compliance with applicable federal, state, and local environmental regulations, including the California Environmental Quality Act (CEQA).

E-1.2 PROJECT AREA

The project is located in Fresno and Madera Counties, California. The record search area includes the project footprint and surrounding vicinity where direct or indirect effects could occur as a result of project activities.

Federal biological resources within the project area fall under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS), Sacramento Fish and Wildlife Office.

E-1.3 DATA SOURCES AND METHODS

The biological resources record search was conducted using the following databases and information sources:

- U.S. Fish and Wildlife Service Information for Planning and Consultation (IPaC) system
- California Natural Diversity Database (CNDDDB) and related rare species occurrence records
- National Wetlands Inventory (NWI) mapping
- Other publicly available state and federal biological resource databases

These sources compile known species occurrence records, modeled species ranges, and mapped habitat information. Records may include historic and recent observations and may occur beyond the immediate project footprint.

E-1.4 LIMITATIONS OF RECORD SEARCHES

Biological record searches are subject to the following limitations:

- Records identify potential presence only and do not confirm current on-site conditions.
- Absence of records does not confirm absence of species or habitats.
- Species distributions and site conditions may have changed since records were collected.

Confirmation of biological resources requires site-specific field surveys conducted during appropriate seasons and following agency-approved protocols.

E-1.5 SPECIAL-STATUS WILDLIFE SPECIES

The record search identified numerous special-status wildlife species with potential to occur in the project region. These include species listed or protected under the Federal Endangered Species Act (FESA), California Endangered Species Act (CESA), and other conservation designations.

Federally Listed, Proposed, or Candidate Wildlife Species

Species identified include, but are not limited to:

- California condor (Endangered)
- California red-legged frog (Threatened)
- California tiger salamander (Threatened)
- Foothill yellow-legged frog (Endangered)
- Vernal pool fairy shrimp (Threatened)
- Conservancy fairy shrimp (Endangered)
- Valley elderberry longhorn beetle (Threatened)

Other Special-Status Wildlife Species

Additional species of concern identified in the record search include:

- Northwestern pond turtle (Proposed Threatened)
- Western spadefoot (Proposed Threatened)
- Sierra Nevada red fox (State Threatened and Federally Endangered distinct population segment)
- Pallid bat and other sensitive bat species

Potential occurrence is based on proximity of known records and availability of suitable habitat within the project region.

E-1.6 MIGRATORY BIRDS AND EAGLES

The project area is within the range of migratory birds protected under the Migratory Bird Treaty Act (MBTA), including several Birds of Conservation Concern.

The record search also indicates potential presence of Bald Eagle and Golden Eagle. Both species are protected under the Bald and Golden Eagle Protection Act. Breeding seasons generally occur between January and August, depending on species and environmental conditions.

Project activities occurring during nesting periods may require avoidance buffers or additional coordination with wildlife agencies.

E-1.7 SPECIAL-STATUS PLANT SPECIES

The record search identified numerous special-status plant species with documented occurrences in the region. These include species listed as endangered or threatened and species assigned a California Rare Plant Rank (CRPR).

Examples include:

- Mariposa pussypaws (Federally Threatened)
- Succulent owl's-clover (State and Federally Threatened)
- San Joaquin Valley Orcutt grass (State Endangered and Federally Threatened)
- Abrams' onion
- Tree-anemone

Many identified plant species are associated with chaparral, grassland, woodland, and vernal pool habitats. Presence within the project area would depend on site-specific habitat conditions and survey timing.

E-1.8 WETLANDS AND AQUATIC RESOURCES

National Wetlands Inventory mapping indicates the presence of potential jurisdictional waters in the vicinity of the project area, including:

- Freshwater emergent wetlands
- Freshwater forested and shrub wetlands
- Rivers, streams, and lake features

NWI mapping is approximate and intended for planning purposes only. Formal wetland delineation and jurisdictional determinations would be required to confirm the extent and regulatory status of aquatic resources.

E-1.9 SUMMARY AND RELEVANCE TO CEQA ANALYSIS

The biological resources record search indicates the potential for special-status species, sensitive habitats, and regulated waters to occur within or near the project area. These findings inform:

- The need for focused biological surveys
- Impact assessment under CEQA
- Identification of avoidance, minimization, and mitigation measures
- Coordination with applicable resource agencies

The record search results are incorporated into the Biological Resources section of the Draft Environmental Impact Report and support determinations of significance under CEQA.

Appendix E2

Figures

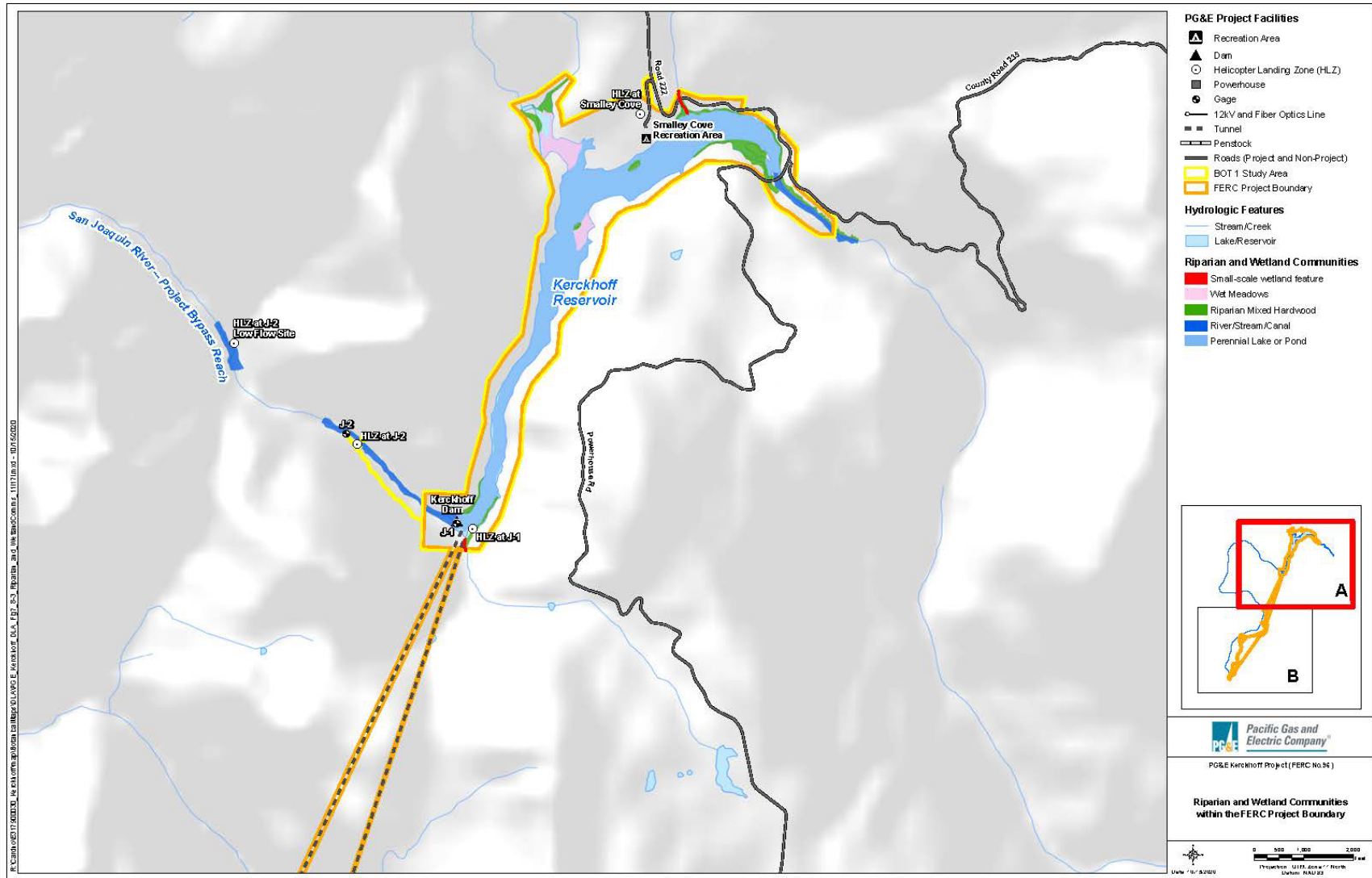


Figure E2-1: Riparian and Wetland Communities within the Existing Hydroelectric Project Boundary (Kerckhoff Reservoir)

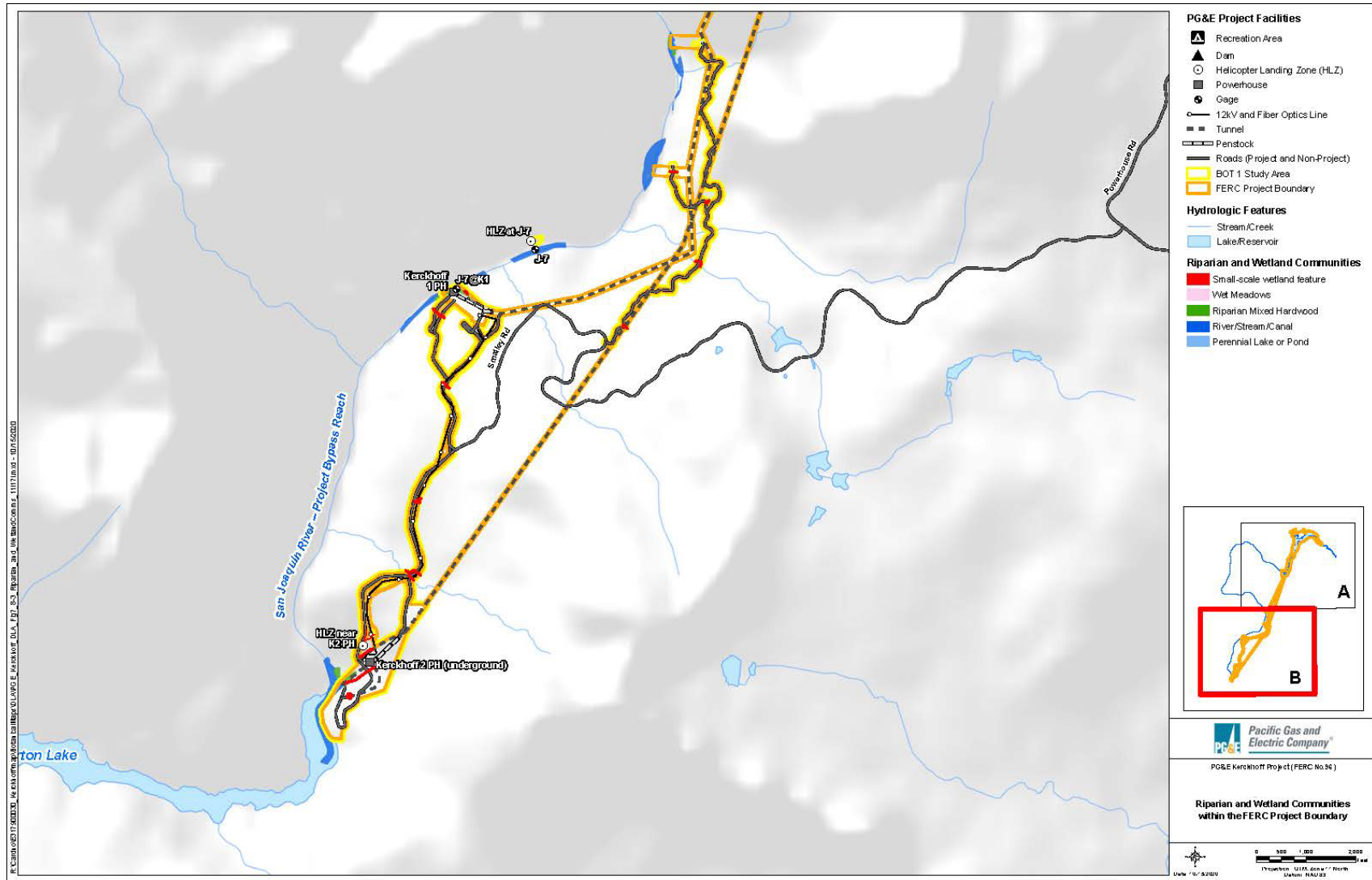


Figure E2-2: Riparian and Wetland Communities within the Existing Hydroelectric Project Boundary (Project Bypass Reach)

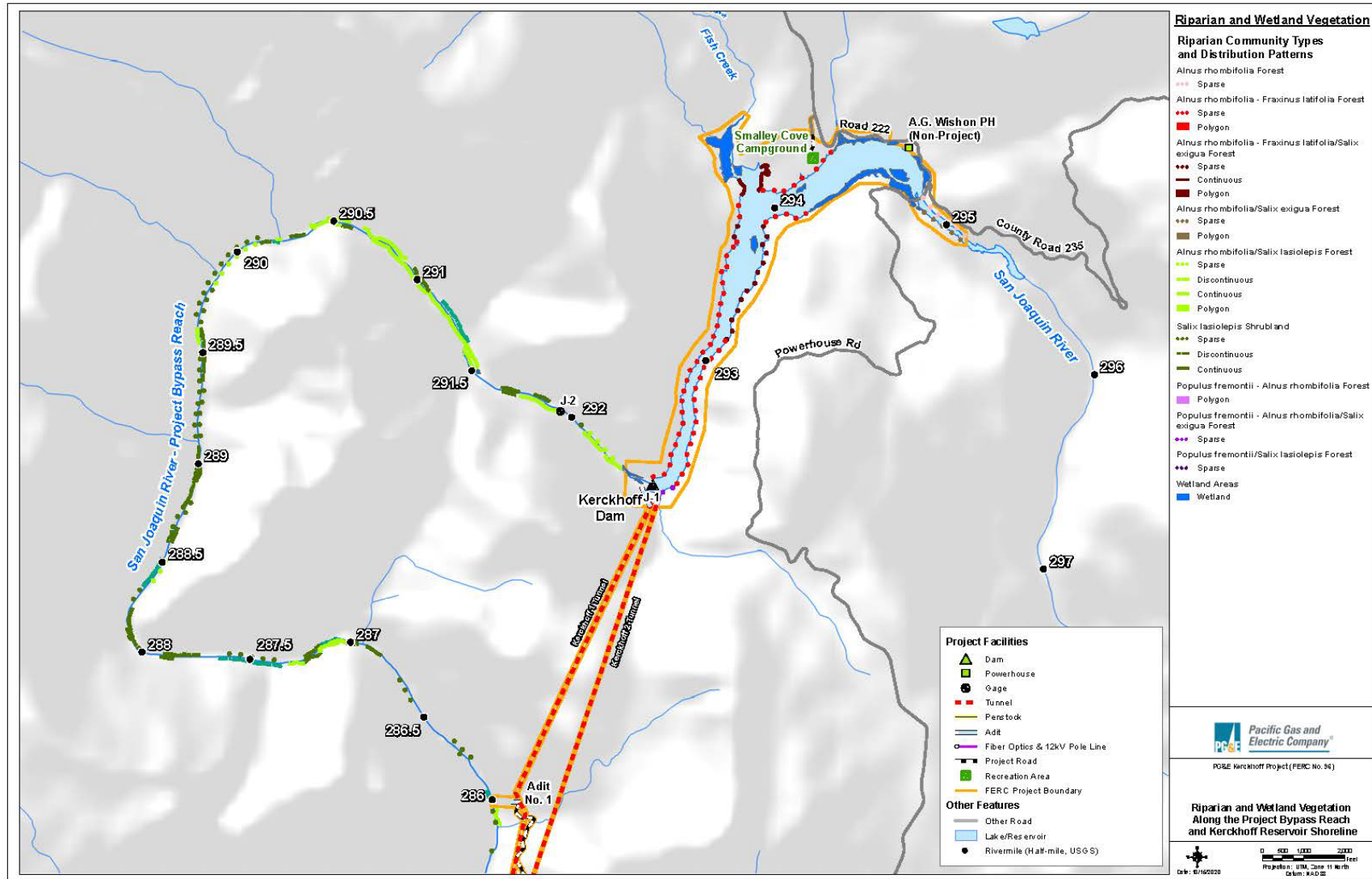


Figure E2-3: Woody Riparian and Wetland Vegetation Along the Kerckhoff Reservoir Shoreline and Northern Portion of the Project Bypass Reach

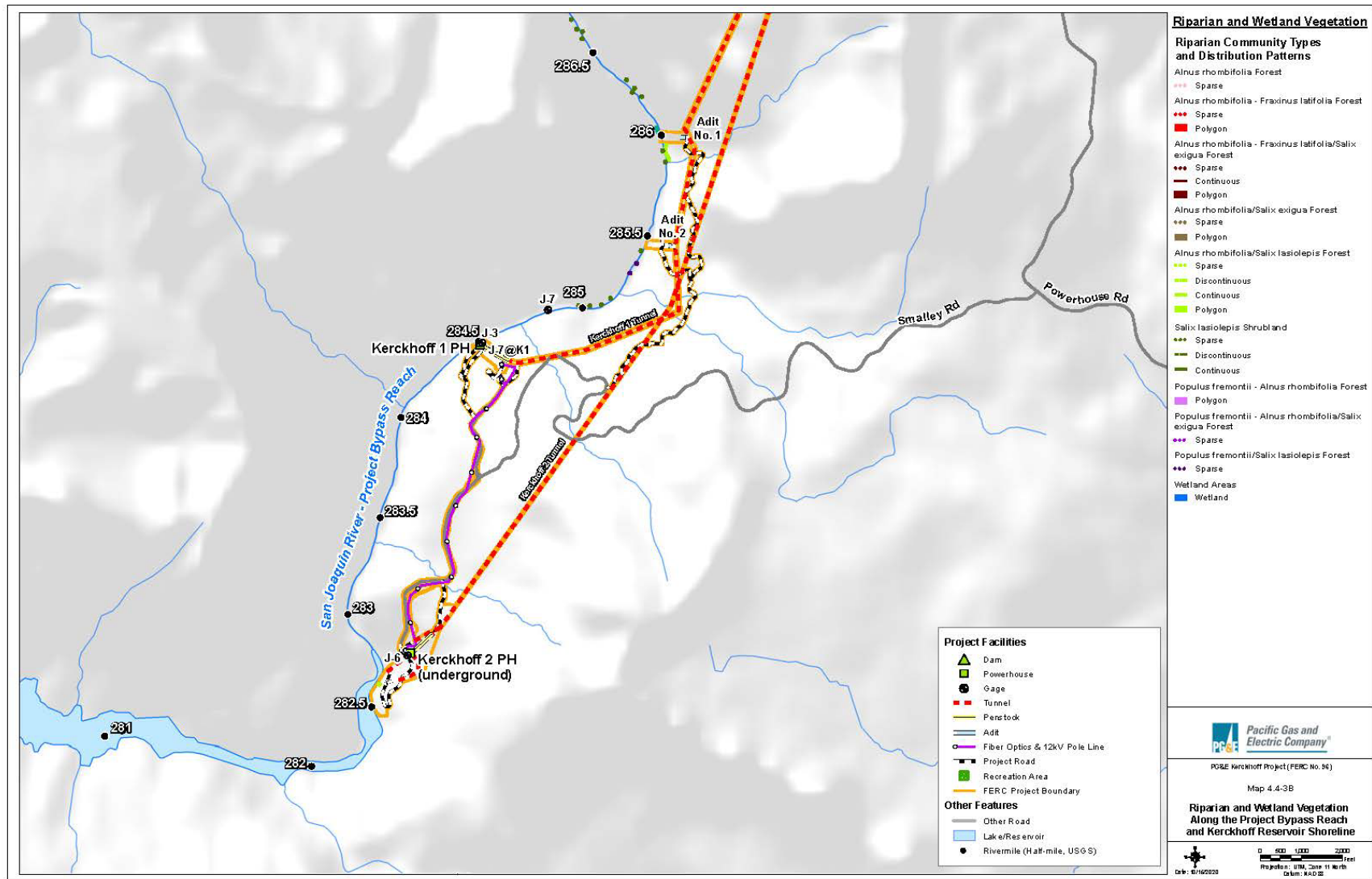


Figure E2-4: Woody Riparian and Wetland Vegetation Along the Southern Portion of the Project Bypass Reach

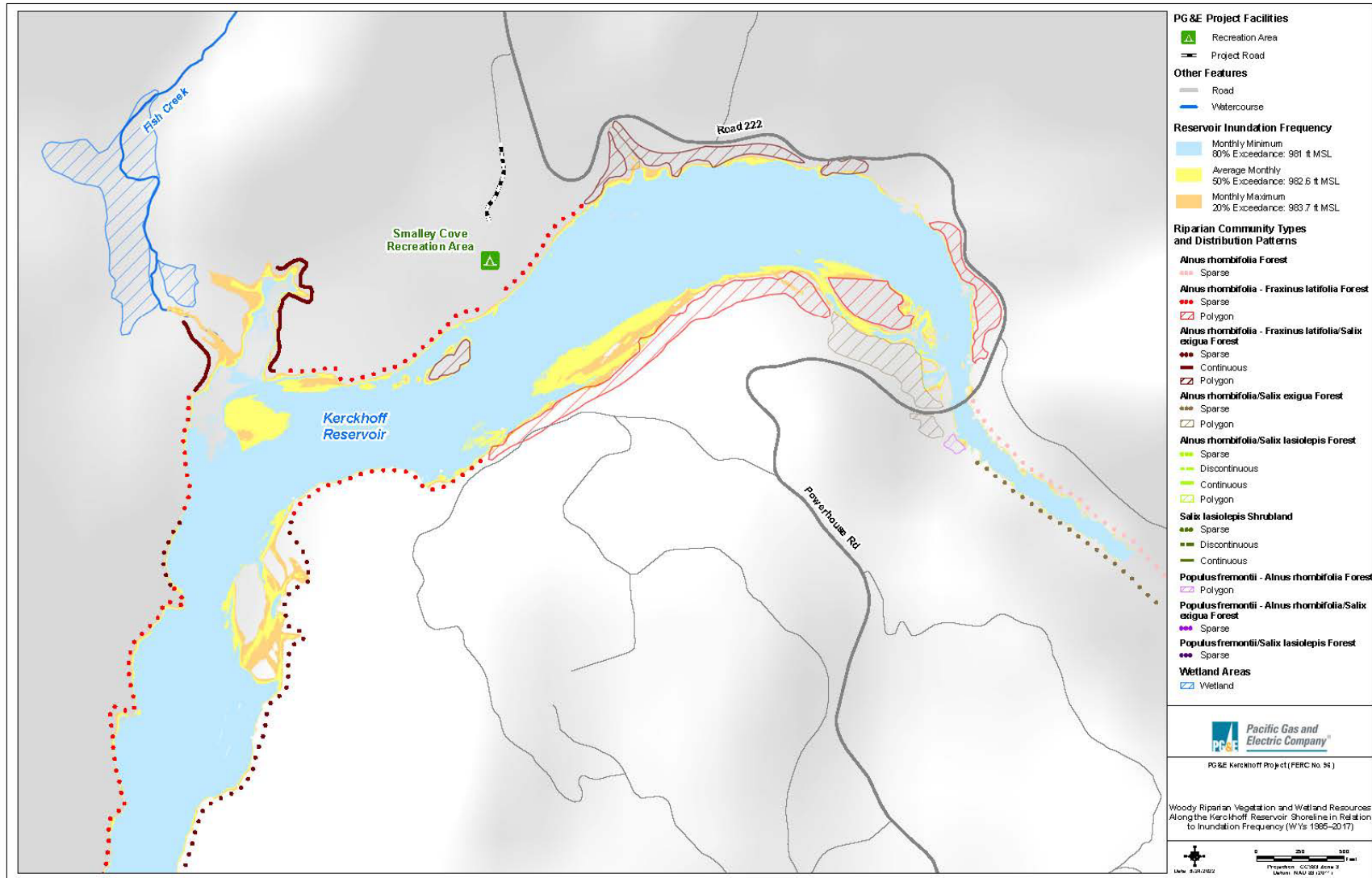


Figure E2-5: Woody Riparian Vegetation and Wetland Resources Along the Kerckhoff Reservoir Shoreline in Relation to Inundation Frequency (Water Years 1985–2017)

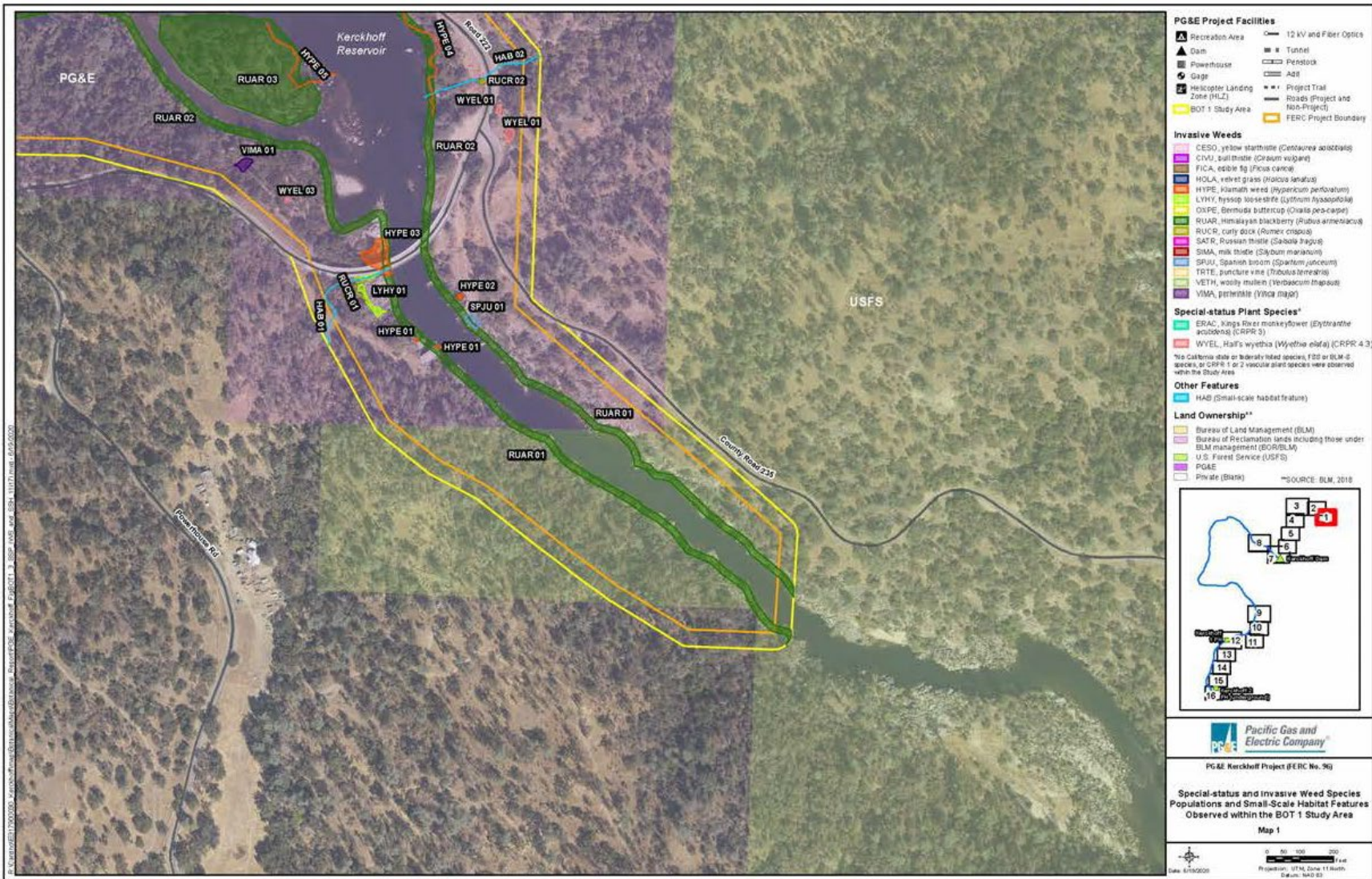


Figure E2-6: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 1)



Figure E2-7: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 2)

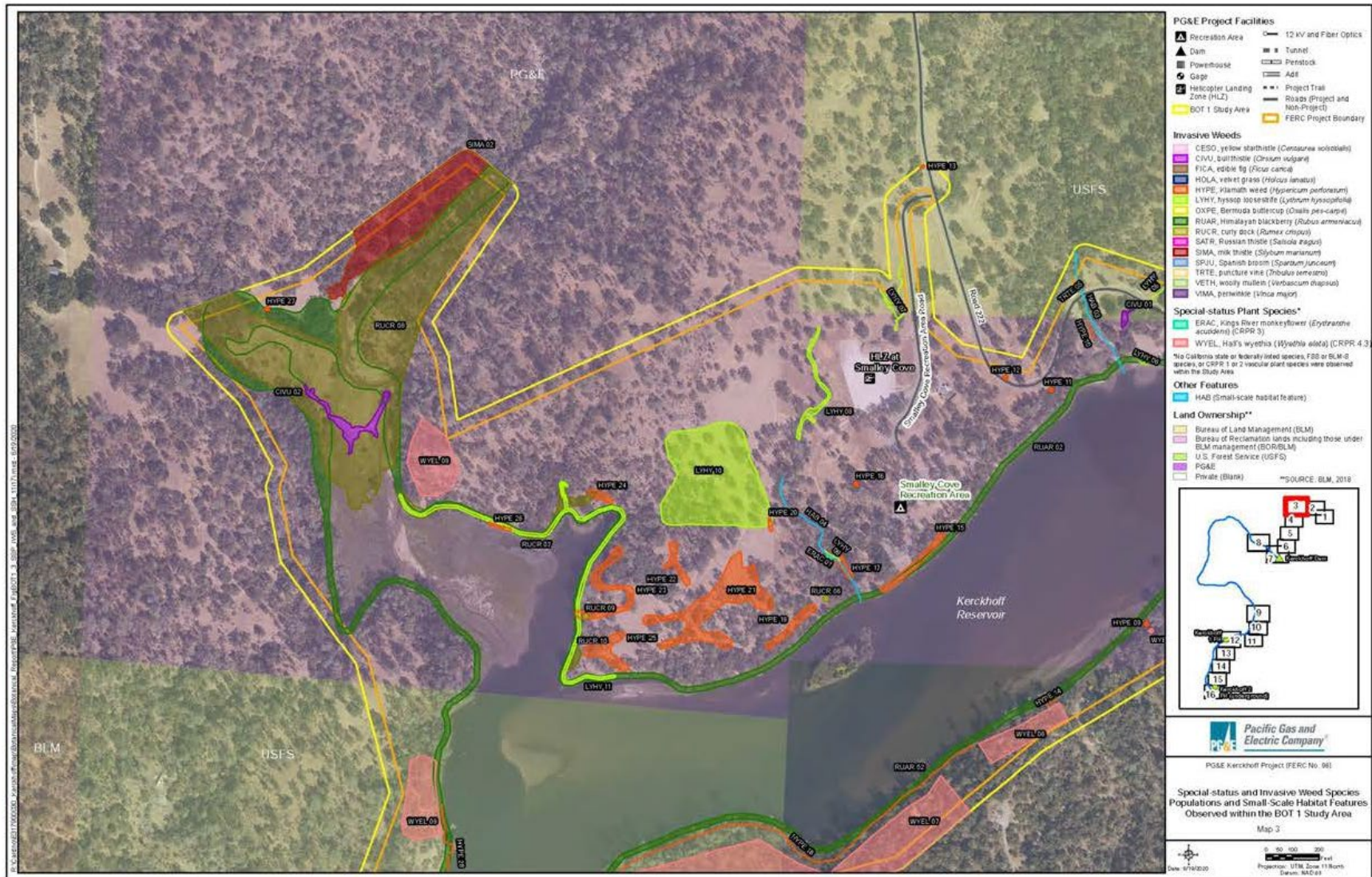


Figure E2-8: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 3)

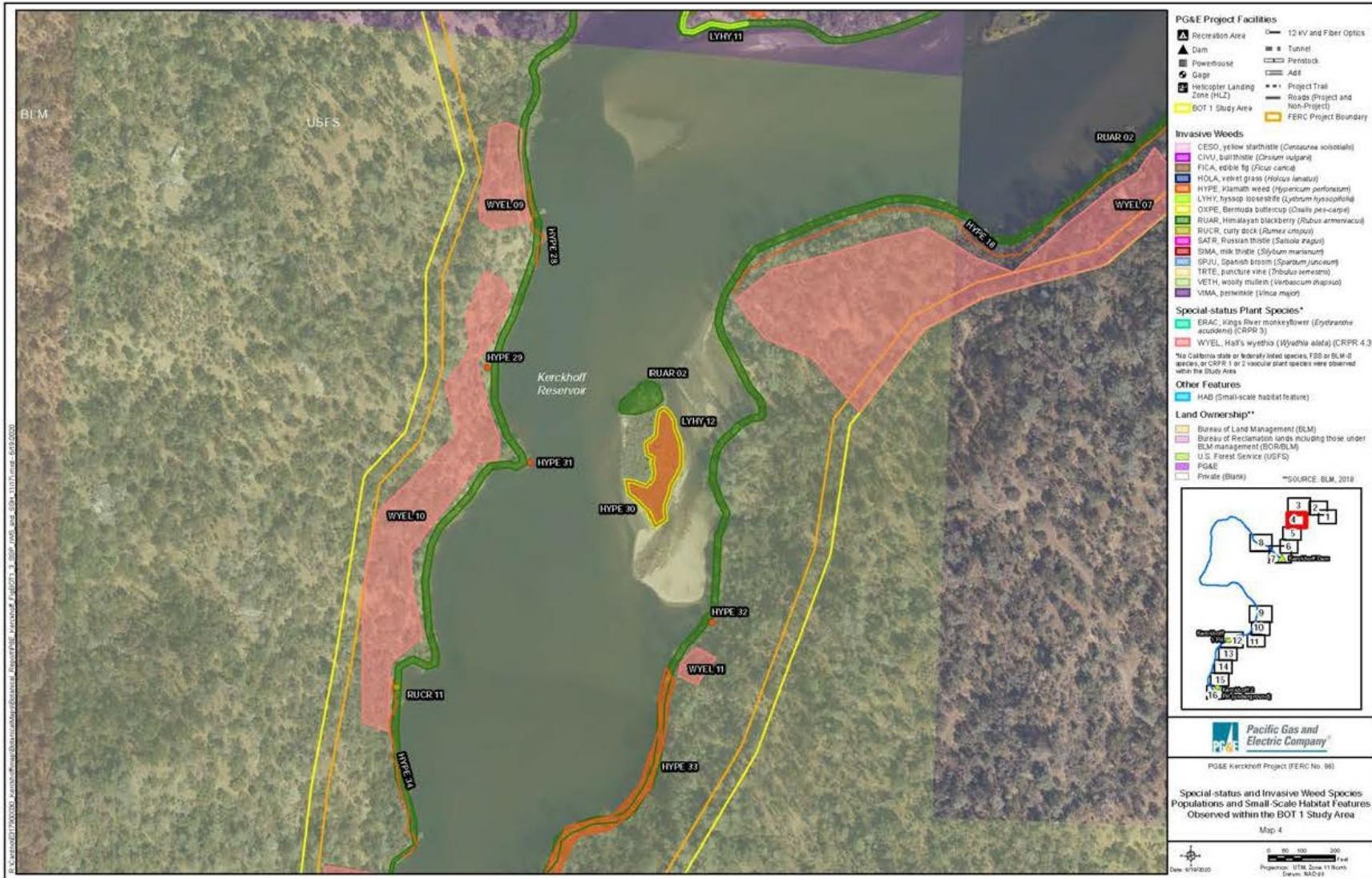


Figure E2-9: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 4)

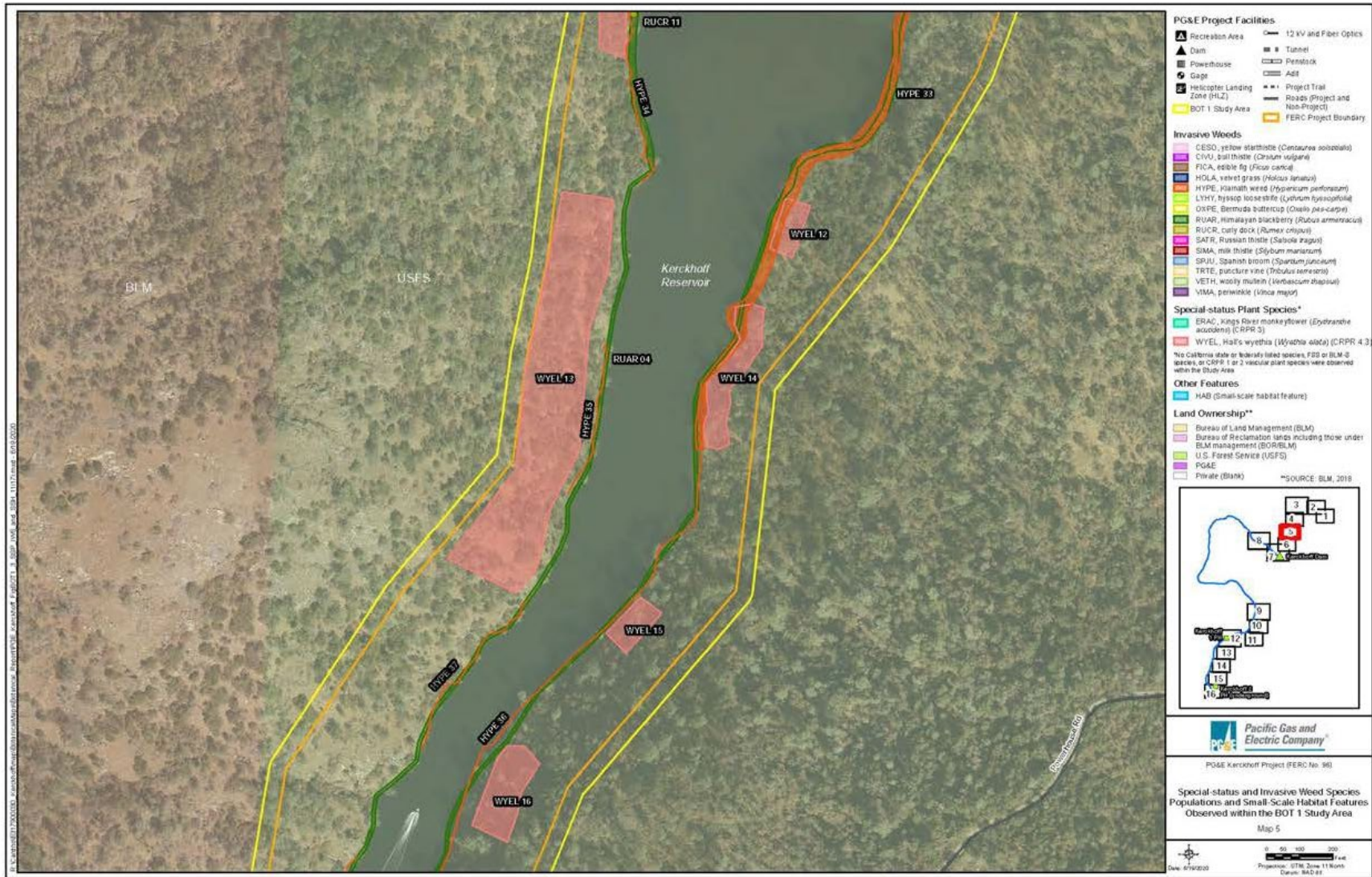


Figure E2-10: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 5)

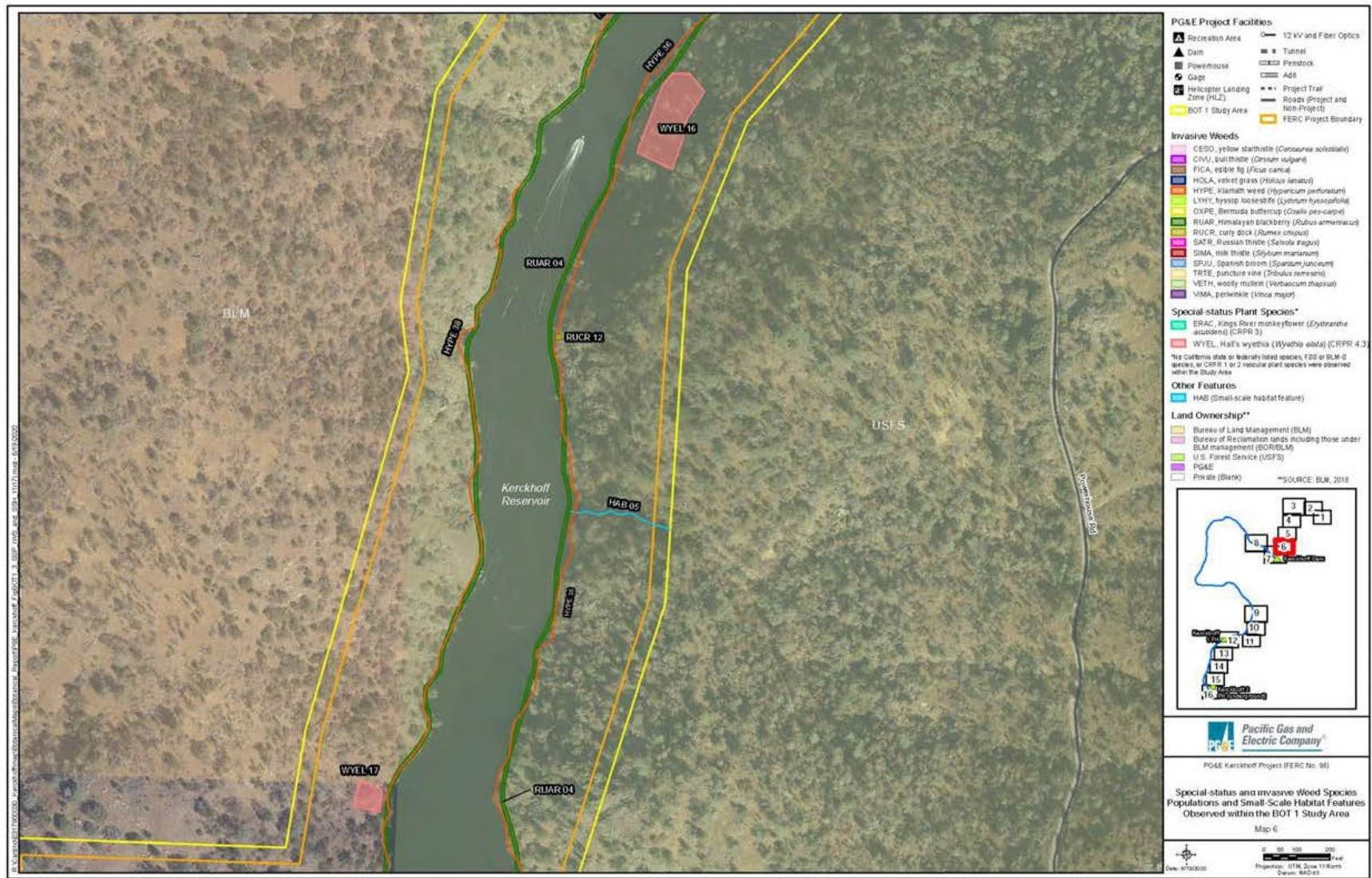


Figure E2-11: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 6)



Figure E2-12: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 7)



Figure E2-13: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 8)

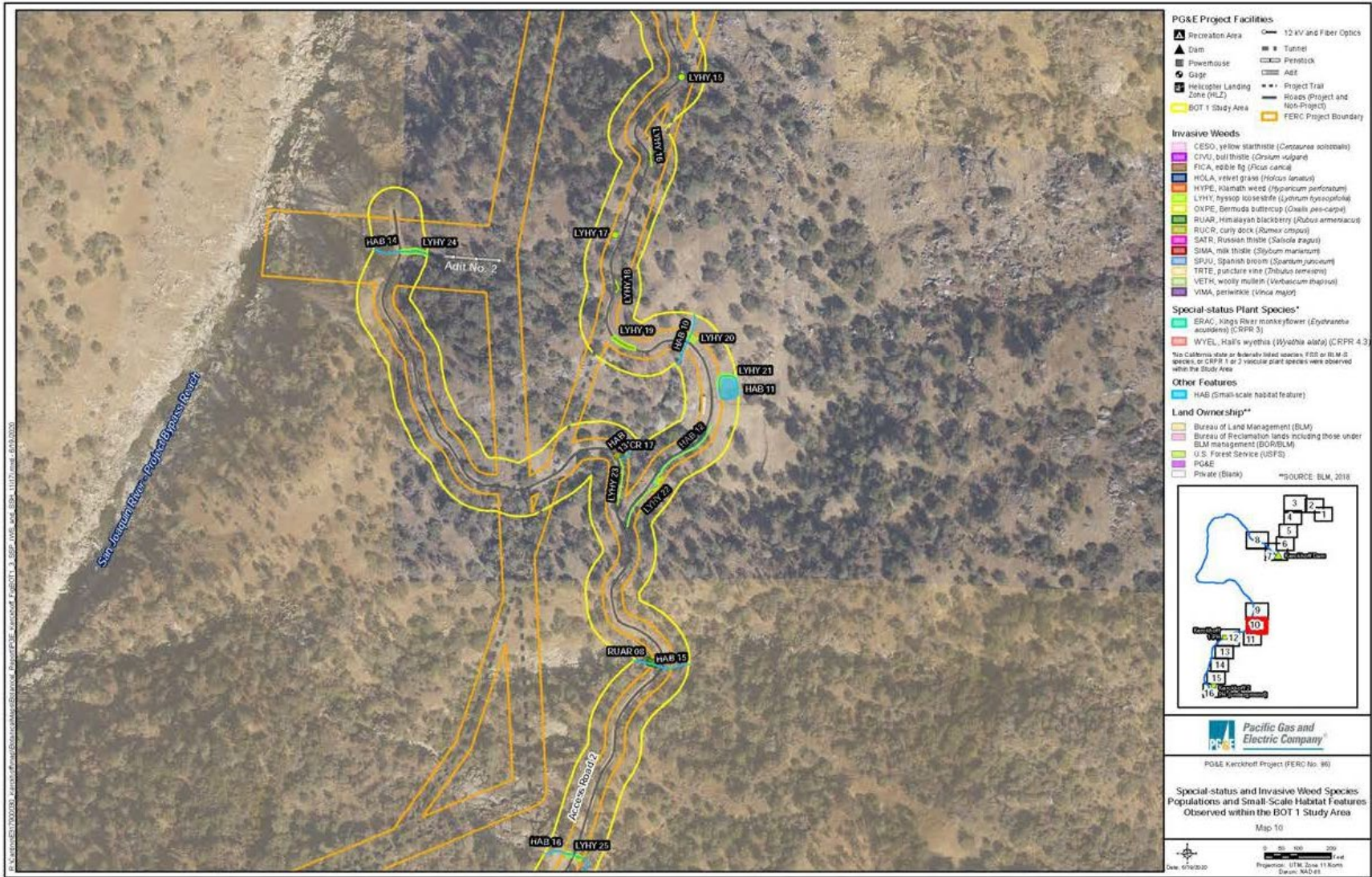


Figure E2-14: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 9)



Figure E2-15: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 10)

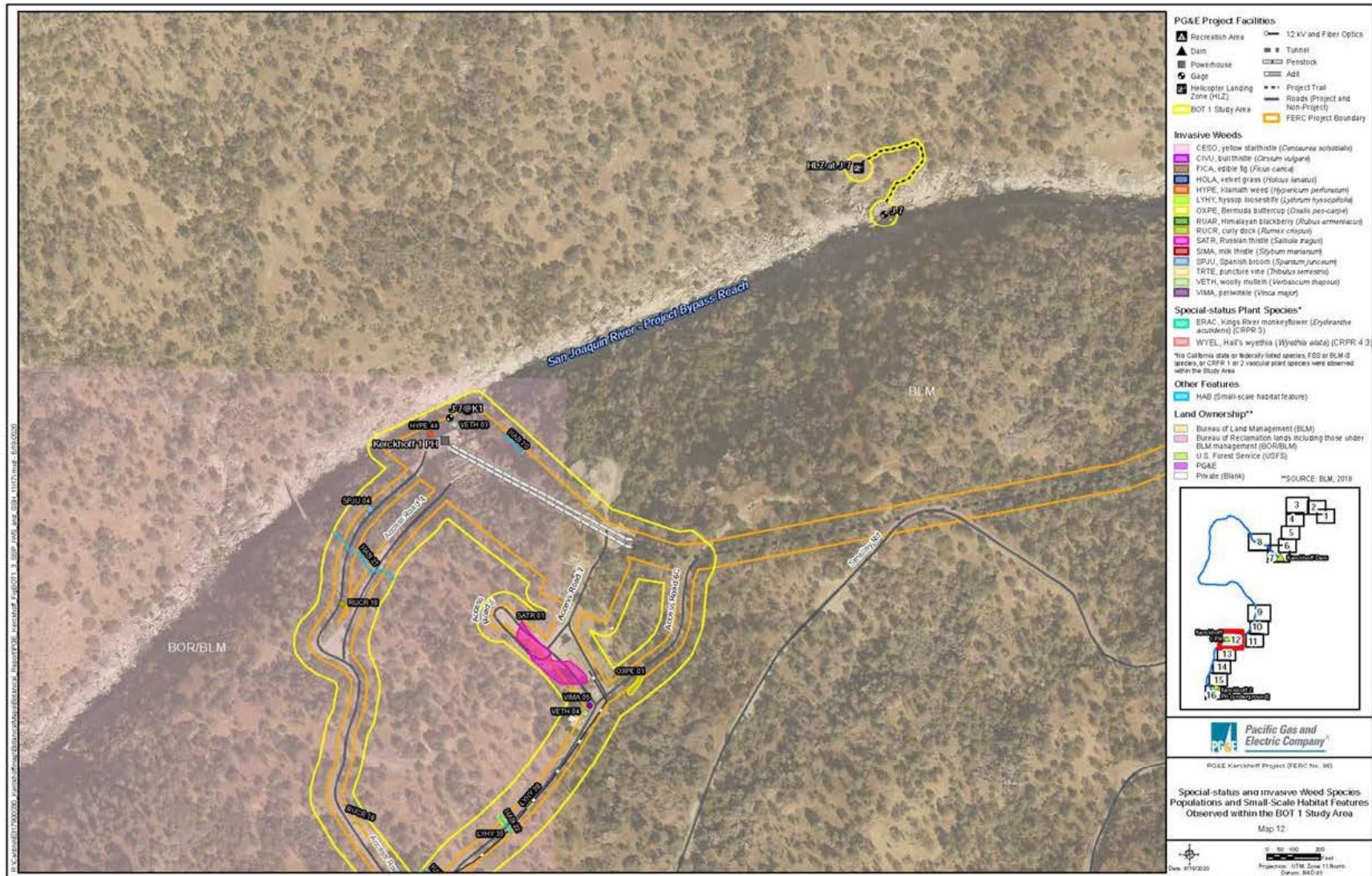


Figure E2-16: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 11)



Figure E2-17: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 12)



Figure E2-18: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 13)

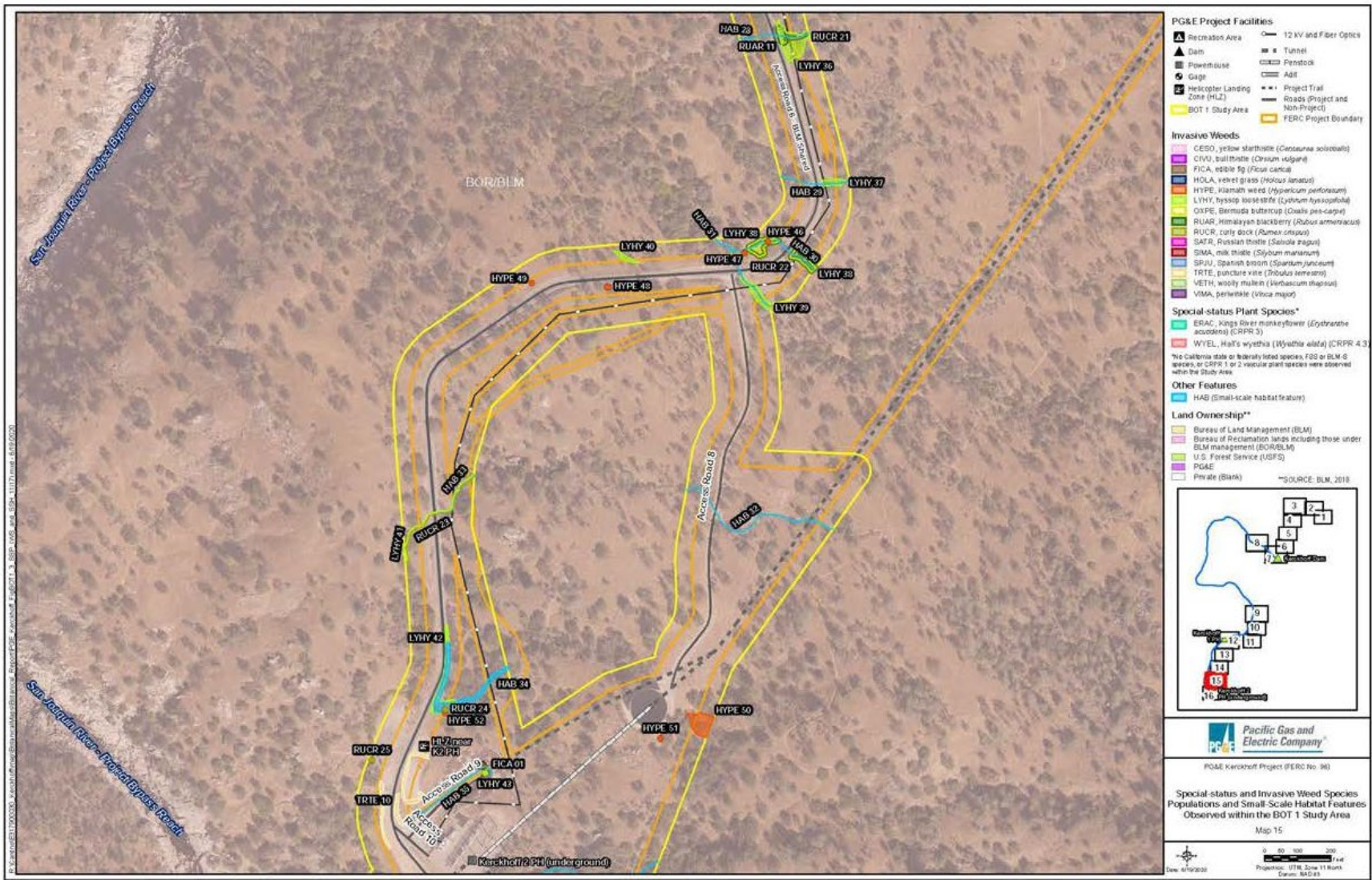


Figure E2-19: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 14)



Figure E2-20: Invasive Species, Rare Plant, and Small-Scale Habitat Features Mapping (Map 15)

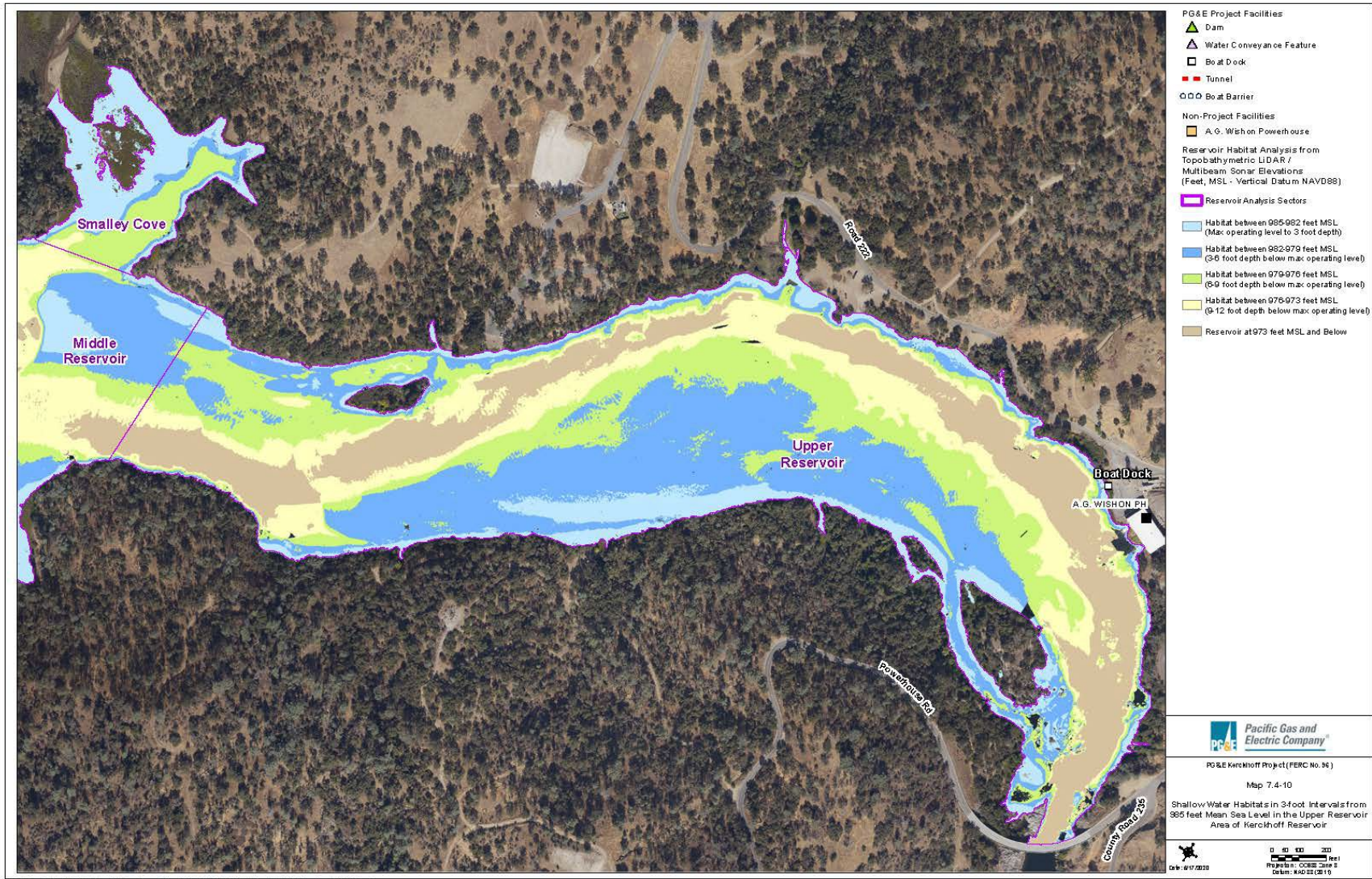


Figure E2-21: Shallow- Water Habitats in 3-Foot Intervals from 985 Feet Mean Sea Level in the Upper Reservoir Area of Kerckhoff Reservoir

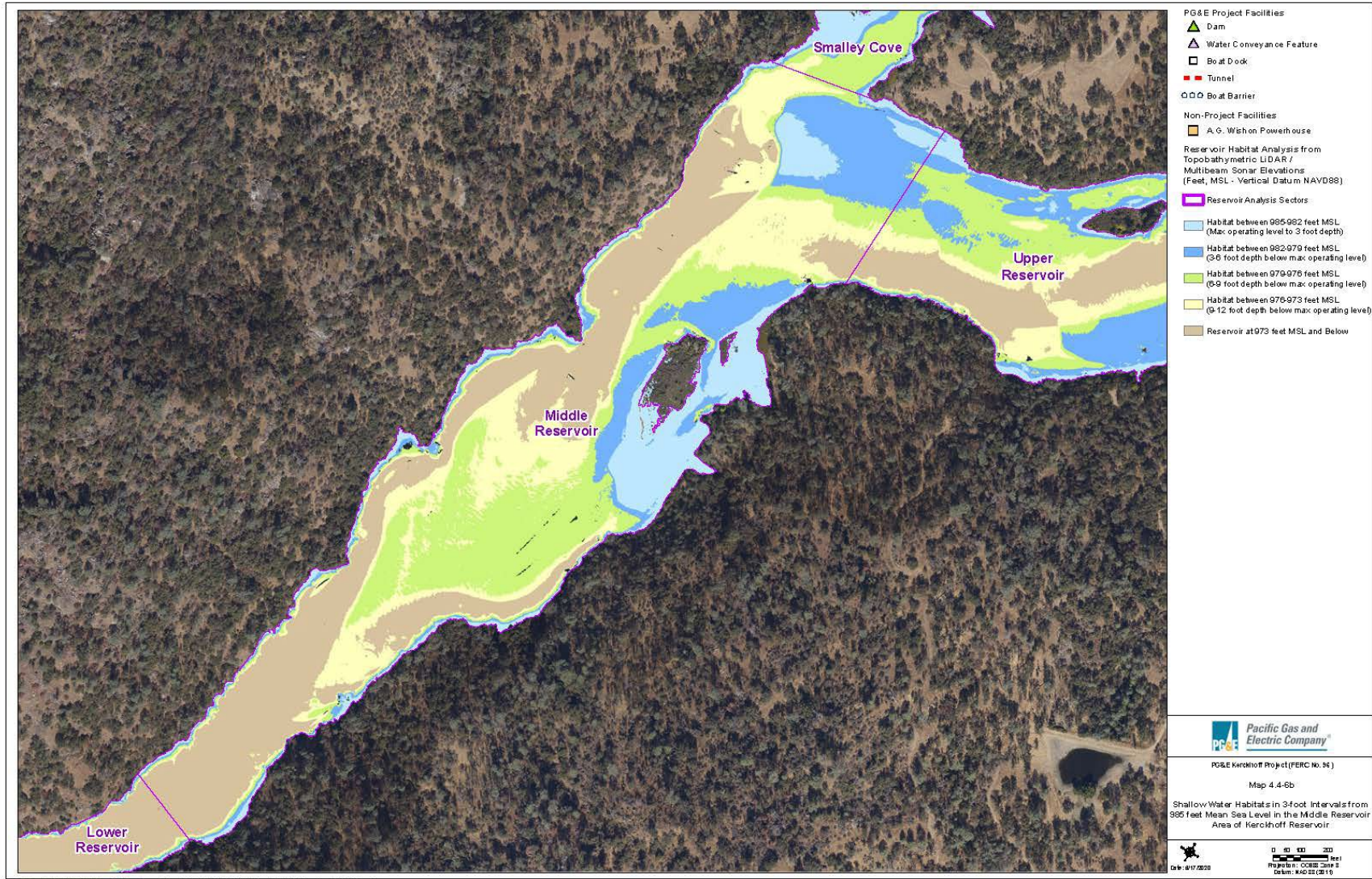


Figure E2-22: Shallow- Water Habitats in 3-Foot Intervals from 985 Feet Mean Sea Level in the Middle Reservoir Area of Kerckhoff Reservoir



Figure E2-23: Shallow- Water Habitats in 3-Foot Intervals from 985 Feet Mean Sea Level in the Lower Reservoir Area of Kerckhoff Reservoir

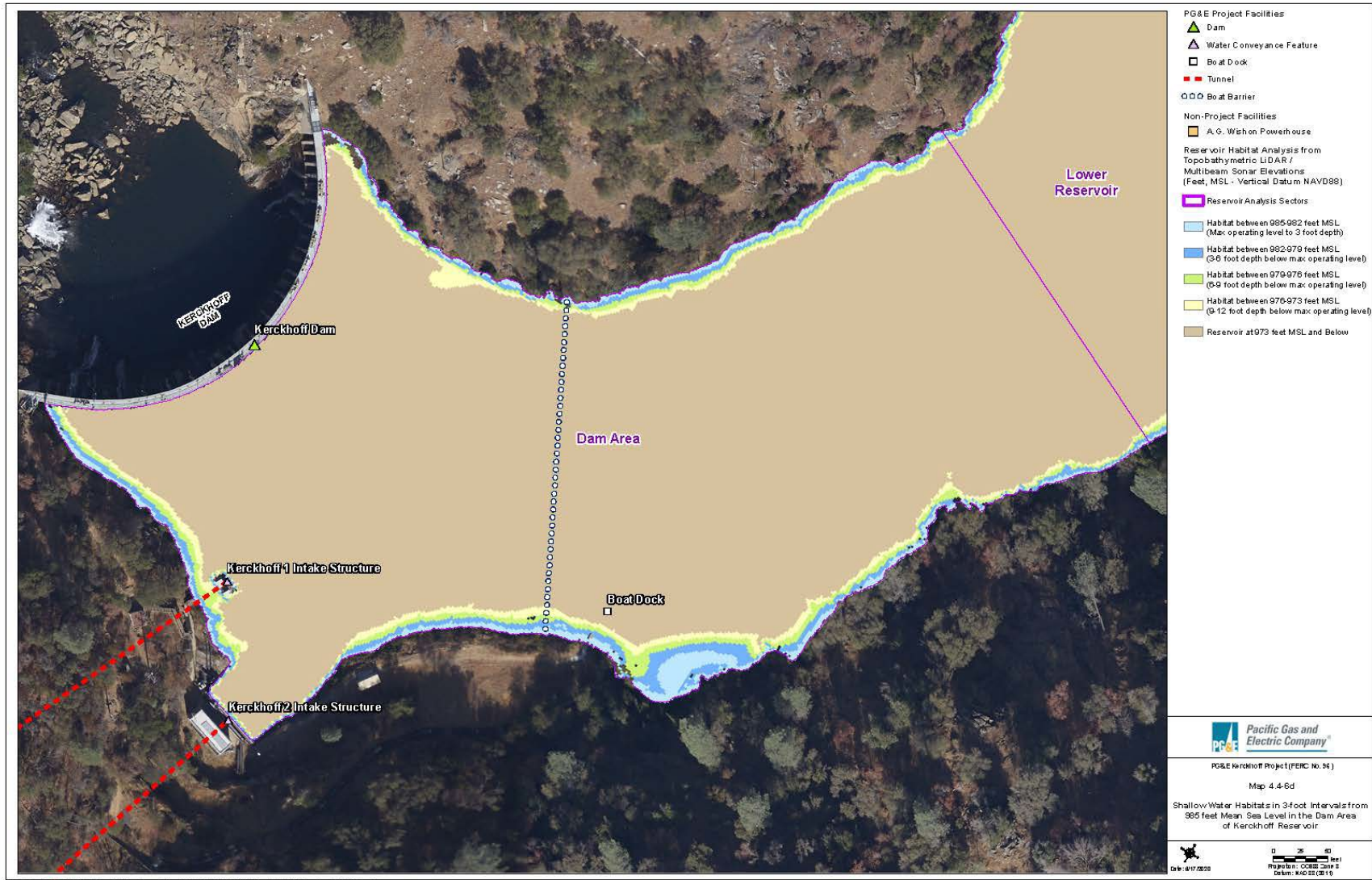
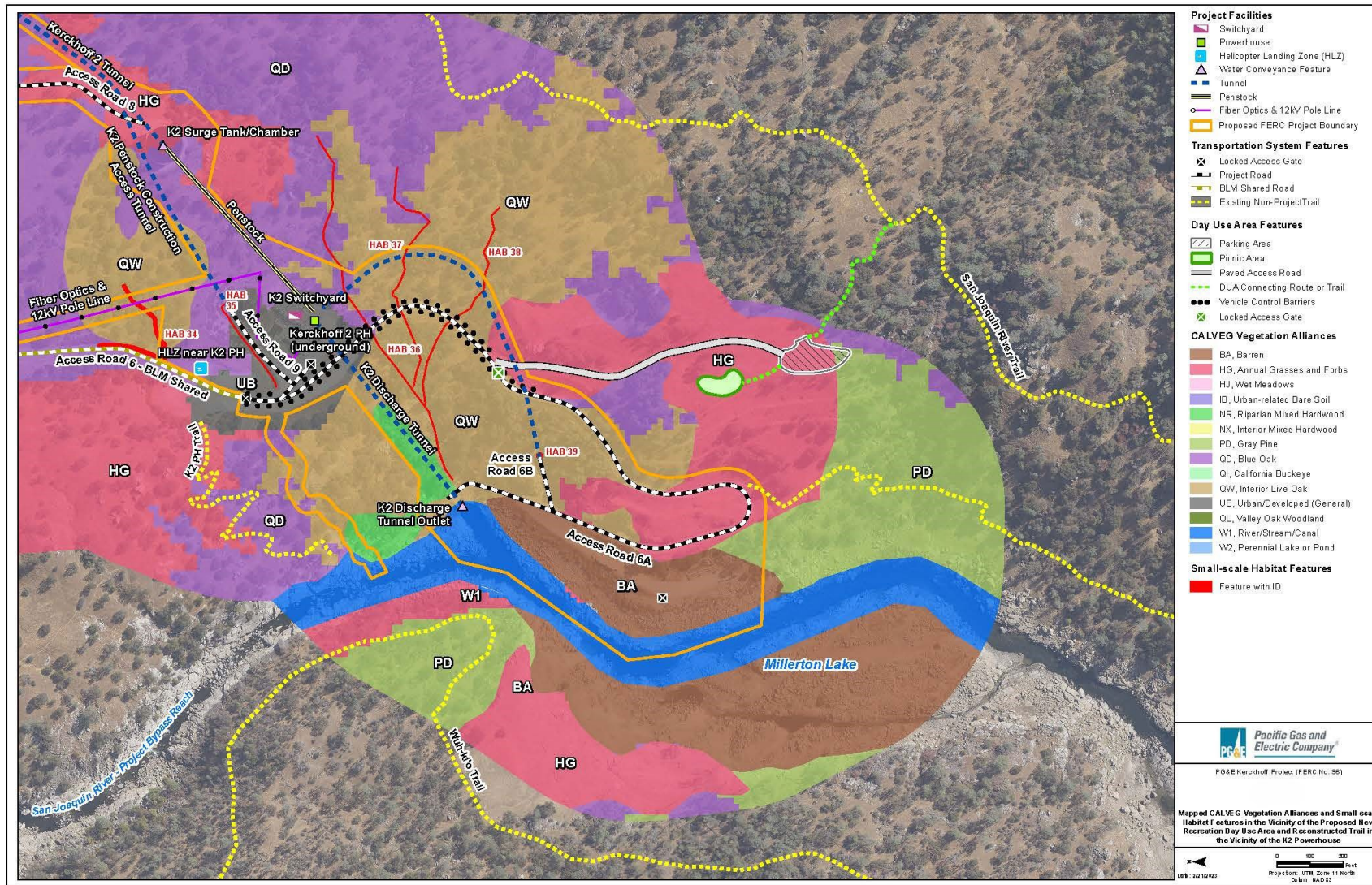


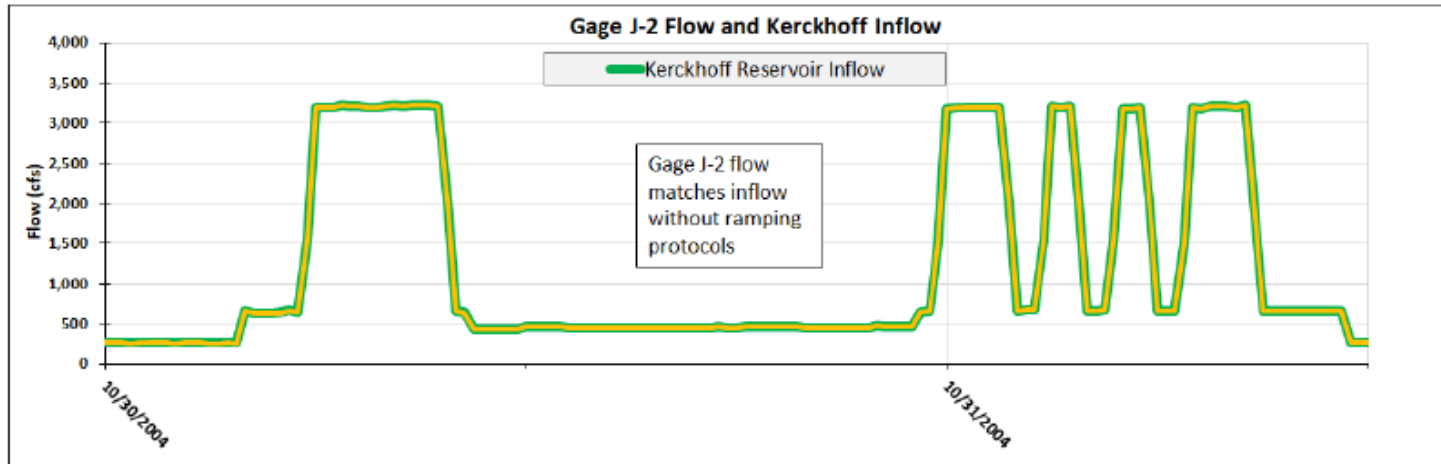
Figure E2-24: Shallow-Water Habitats in 3-Foot Intervals from 985 Feet Mean Sea Level in the Dam Area of Kerckhoff Reservoir



C:\GIS\23780034\Map\TerrestrialMap\PG&E_Kerckhoff_K2\DUA_Veg_SSH_ab_17\11_10.mxd - 2/2/2023

Figure E2-25: CALVEG Vegetation Alliances Mapped within the Botanical Study Area—Vista Day Use Area

No Action Alternative (Current Operations)



Proposed Project with LTOR

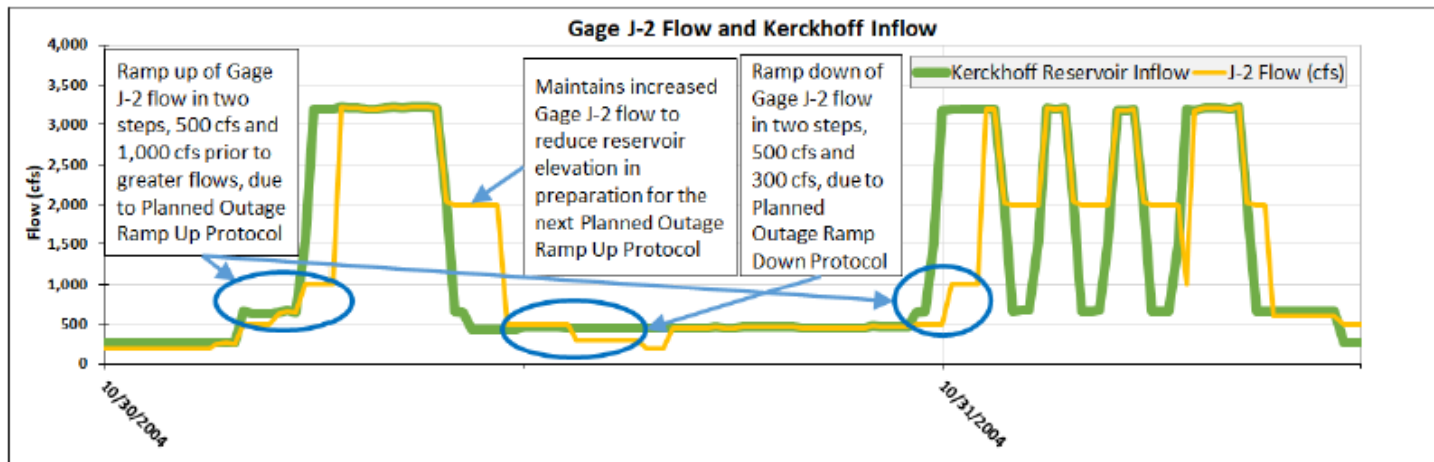


Figure E2-26: Flows Modeled in the Project Bypass Reach at Gage J-2 for Current Operations (Top) and Proposed Project (Bottom) during a Planned Outage of K2 Powerhouse (based on WY 2004)

Appendix E3

Tables

Kerckhoff Hydroelectric Project Special-Status Plant Species Evaluated.

Scientific Name	Common Name	Listing Status (Federal/State/BLM/USFS/CRPR)	Elevation Range (feet) ^a	Bloom Period	Habitat Associations	Potential to Occur in the Study Area
<i>Allium abramsii</i>	Abrams' onion	1B.2	2,900–10,000	May–Jul	Sandy, granitic areas in upper and lower montane coniferous forest	NONE. Study Area is outside the elevation range for the species; 2 recent occurrences (2009) nearby in Alder Springs, Jose Basin
<i>Calycadenia spicata</i>	spicate calycadenia	1B.3	128 – 4,480	May-Sep	Valley and foothill grassland, cismontane woodland. Dry, adobe, clay, gravelly, rocky, disturbed areas, openings, roadsides.	NONE. Study Area lacks suitable clay substrate
<i>Calyptridium pulchellum</i>	Mariposa pussypaws	FT / 1B.1	1,310–3,610	Apr–Jul (Aug)	Sandy or gravelly soils, decomposed granite or metamorphic rocks, chaparral, gray pine, oak woodland, cismontane woodland	LOW. No recent known occurrences; microhabitat (gravel openings or rock outcrops) not likely in the Study Area; Study Area is at the lower end of species' elevation range
<i>Camissonia sierrae</i> ssp. <i>alticola</i>	Mono Hot Springs evening-primrose	FSS / 1B.2	3,396–7,907	May–Aug	Shallow soil on granite outcrops, ponderosa-pine forest; gravel and sand pans and ledges associated with granitic outcrops in chaparral, ponderosa pine, mixed conifer and red fir/lodgepole pine forests	NONE. Study Area is outside the elevation range for the species; suitable habitat not present
<i>Camissonia sierrae</i> ssp. <i>sierrae</i>	Yosemite evening-primrose	FSS / 4.3	1,640–5,397	Apr–Jun	Cismontane woodland and lower montane coniferous forest	MOD. CNPS reports 2 recent occurrences in the vicinity of the Study Area; habitat present in the Study Area; Study Area is just outside of the species' elevation range
<i>Carex praticola</i>	northern meadow sedge	2B.2	0–3,200	May–Jul	Meadows and seeps (mesic)	LOW. No mapped CNDDDB occurrences in Fresno County; CNPS listed in Cascadel Point quadrangle; only marginal habitat present in the Study Area

Scientific Name	Common Name	Listing Status (Federal/State/BLM/USFS/CRPR)	Elevation Range (feet) ^a	Bloom Period	Habitat Associations	Potential to Occur in the Study Area
<i>Carpenteria californica</i>	tree-anemone	ST / BLMS / FSS / 1B.2	1,115–4,395	(Apr) May–Jul	Chaparral, cismontane woodland, usually granitic. Foothill chaparral, foothill woodland, lower ponderosa pine forest. Prefers draws	<i>Carpenteria californica</i>
<i>Castilleja campestris</i> var. <i>succulenta</i>	fleshy owl's-clover	FT / SE / BLMS / 1B.2	160–2,460	Mar (Apr–May)	Vernal pools, often in acidic soils	LOW. Recent occurrences in the area; however, suitable vernal pool habitat is not known to occur in the Study Area
<i>Ceanothus fresnensis</i>	Fresno ceanothus	4.3	2,950–6,900	May–Jul	Openings in cismontane woodland and lower montane coniferous forest	NONE. Study Area is outside the elevation range for the species
<i>Claytonia palustris</i>	marsh claytonia; streambank spring beauty	4.3	3,281–8,202	May–Oct	Meadows, seeps, and other mesic habitats in coniferous forest habitat	NONE. Study Area is outside the elevation range for the species
<i>Claytonia parviflora</i> ssp. <i>grandiflora</i>	streambank spring beauty	4.2	820–3,935	Feb–May	Cismontane woodland; rocky (mesic)	MOD. No recent known occurrences; suitable habitat is present in the Study Area
<i>Collomia rawsoniana</i>	Rawson's flaming-trumpet	FSS / 1B.2	2,559–7,218	Jul–Aug	Lower montane coniferous forest, meadows and seeps, riparian forest, shaded areas near streams in cismontane woodland; mesic	NONE. Study Area is outside the elevation range for the species; no suitable habitat in the Study Area
<i>Cordylanthus rigidus</i> ssp. <i>brevibracteatus</i>	short-bracted bird's-beak	4.3	2,000–8,500	Jul–Aug (Oct)	Chaparral, lower montane coniferous forest, pinyon and juniper woodland, upper montane coniferous forest; openings, granitic	NONE. Study Area is outside the elevation range for the species; 3 historical occurrences (1940, 1955) near Auberry
<i>Cryptantha hooveri</i>	Hoover's cryptantha	1A	30–490	Apr–May	Inland dunes, sandy areas in valley and foothill grassland	NONE. This species is presumed extinct. No occurrences in Fresno County; no suitable habitat in the Study Area
<i>Delphinium hansenii</i> ssp. <i>ewanianum</i>	Ewan's larkspur	4.2	195–1,970	Mar–May	Cismontane woodland and valley and foothill grassland; rocky	HIGH. Known from the area; suitable habitat present in the Study Area
<i>Downingia pusilla</i>	dwarf downingia	2B.2	0–1,460	Mar–May	Mesic areas and vernal pools in valley and foothill grassland	LOW. Only one historical occurrence in Fresno County (1979); vernal pool habitat is not known to occur in the Study Area

Scientific Name	Common Name	Listing Status (Federal/State/BLM/USFS/CRPR)	Elevation Range (feet) ^a	Bloom Period	Habitat Associations	Potential to Occur in the Study Area
<i>Eriastrum tracyi</i>	Tracy's eriastrum	SR / FSS / 3.2	1,030–5,840	May–Jul	Open areas on shale or alluvium in chaparral, cismontane woodland, and valley and foothill grassland	MOD. No mapped occurrences in the vicinity of the Study Area; suitable habitat is present in the Study Area
<i>Eryngium spinosepalum</i>	spiny-sepaled button-celery	1B.2	260–3,200	Apr–Jun	Vernal pools in valley and foothill grassland	LOW. All occurrences in the vicinity of the Study Area are historical (latest is 1994); vernal pool habitat is not known to occur in the Study Area
<i>Erythranthe</i> (=Mimulus) <i>acutidens</i>	Kings River monkeyflower	3	1,000–4,005	Apr–Jul	Cismontane woodland and lower montane coniferous forest	HIGH. Suitable habitat present in the Study Area; CNPS mapped several historical (1995) occurrences in the immediate vicinity of the Study Area (near Smalley Road/New Auberry and near Tollhouse/Black Mountain)
<i>Erythranthe</i> (=Mimulus) <i>gracilipes</i>	slender-stalked monkeyflower	BLMS / FSS / 1B.2	1,640–4,265	Apr–May (Jun)	Chaparral, cismontane woodland, lower montane (ponderosa pine) coniferous forest; disturbed or burned areas, and/or decomposed granite, rock outcrops and associated gravelly and sandy areas	HIGH. Suitable habitat present within the Study Area; CNPS mapped several historical occurrences in Project Vicinity (Auberry, Prather, Tollhouse)
<i>Erythranthe inconspicua</i> (=Mimulus)	small-flowered monkeyflower	4.3	895–2,495	May–Jun	Chaparral, cismontane woodland, and lower montane coniferous forest;	HIGH. Recent occurrences (2013) in the immediate vicinity of the Study Area (Squaw Leap)
<i>inconspicuus</i>)					mesic	and several other historical occurrences in Auberry/Tollhouse; suitable habitat present in the Study Area
<i>Erythranthe laciniata</i> (=Mimulus <i>laciniatus</i>)	cut-leaved monkeyflower	4.3	1,608–8,694	Apr–Jul	Chaparral and montane coniferous forest	MOD. Several historical occurrence at higher elevation near Shaver Lake; suitable habitat is not present in the Study Area

Scientific Name	Common Name	Listing Status (Federal/State/BLM/USFS/CRPR)	Elevation Range (feet) ^a	Bloom Period	Habitat Associations	Potential to Occur in the Study Area
<i>Erythranthe sierrae</i>	Sierra Nevada monkeyflower	4.2	605–7,500	Mar–Jul	Cismontane woodlands and lower montane coniferous forest (openings); vernal wet depressions, swales, streambanks, meadows and seeps (dry); granitic, sandy, or gravelly soils	MOD. Species is included on several checklists in the vicinity of the Study Area, but no mapped occurrences in Fresno County; suitable habitat present in the Study Area
<i>Gratiola heterosepala</i>	Boggs Lake hedgehyssop	SE / BLMS / 1B.2	33–7,792	Apr–Aug	Edges of lakes, marshes, and vernal pools	LOW. Multiple occurrences in the vicinity of the Study Area (2001, 2005; from Table Mountain); however, vernal pool habitat is not known to occur in the Study Area
<i>Hulsea brevifolia</i>	short-leaved hulsea	FSS / 1B.2	4,921–10,499	May–Aug	Montane forest in openings and under canopy in mixed conifer and red fir forest; granitic or volcanic soils, gravelly soils	NONE. Study Area is outside the elevation range for the species; no suitable habitat present in the Study Area
<i>Ivesia unguiculata</i>	Yosemite ivesia	4.2	4,800–9,360	Jun–Sep	Meadows and seeps, subalpine coniferous forest, upper montane coniferous forest. Moist open slopes and meadows.	NONE. Study Area is outside the elevation range for the species; no suitable habitat present in the Study Area
<i>Jensia yosemitana</i>	Yosemite tarplant	3.2	3,937–7,546	(Apr) May–Jul	Meadows and seeps in lower montane coniferous forest	NONE. Study Area is outside the elevation range for the species; suitable habitat is not present in the Study Area
<i>Leptosiphon serrulatus</i>	Madera leptosiphon	FSS / 1B.2	984–4,265	Apr–May (Jun)	Openings in woodland, chaparral; dry slopes in cismontane oak woodland and lower montane coniferous forest. Usually in decomposed granite, one instance on serpentine.	HIGH. USFS considers this a likely species; included on several checklists in the vicinity of the Study Area (CNPS), but only mapped occurrences are outside the Project Vicinity in the Kings River watershed
<i>Lewisia congdonii</i>	Congdon's lewisia	SR / – / FSS / 1B.3	1,641–9,187	Apr–Jun	Chaparral, foothill woodland, red fir forest, yellow pine forest; metamorphic or granitic rock faces, cracks, and ledges; scree and talus, spoil piles of old barite mines	LOW. Most occurrences outside the vicinity of the Study Area in Mariposa County, a few occurrences in Fresno County; only marginal habitat present in the Study Area; USFS reports “unlikely, but include in list of plants to survey”

Scientific Name	Common Name	Listing Status (Federal/State/BLM/USFS/CRPR)	Elevation Range (feet) ^a	Bloom Period	Habitat Associations	Potential to Occur in the Study Area
<i>Lupinus citrinus</i> var. <i>citrinus</i>	orange lupine	BLMS / FSS / 1B.2	1,247–5,577	Apr–Jun (Jul)	Chaparral, cismontane woodland, and lower montane coniferous forest; granitic soils	MOD. Occurrences in the vicinity of the Study Area, but outside the elevation range of the Study Area; USFS reports “remote possibility”
<i>Navarretia nigelliformis</i> ssp. <i>nigelliformis</i>	adobe navarretia	4.2	328–3,281	Apr–Jun	Vernal pools or other mesic habitats in valley and foothill grassland	LOW. Occurrences near Piedra on the Kings River; however, vernal pool habitat is not known to occur in the Study Area
<i>Orcuttia inaequalis</i>	San Joaquin Valley Orcutt grass	FT / SE /BLM S / 1B.1	33–2,477	Apr–Sep	Vernal pools	MOD. Occurrences in the vicinity of the Study Area (Millerton Lake); however, vernal pool habitat is not known to occur in the Study Area
<i>Piperia colemanii</i>	Coleman's rein orchid	4.3	3,840–7,360	June–Aug	Chaparral, lower montane coniferous forest. Often in sandy soils	NONE. Study Area is outside the elevation range for the species
<i>Piperia michaelii</i>	Michael's rein orchid	4.2	10–3,002	Apr–Aug	Chaparral, cismontane woodland, and lower montane coniferous forest	MOD. Occurrences in the vicinity of the Study Area (Black Mountain); suitable habitat (cismontane woodland) present in the Study Area
<i>Plagiobothrys torreyi</i> var. <i>perplexans</i>	chaparral popcorn flower	4.3	3,510–9,006	Apr–Sep	Meadows, seeps, and other mesic habitats on chaparral and coniferous forest	NONE. Study Area is outside the elevation range for the species
<i>Plagiobothrys torreyi</i> var. <i>torreyi</i>	Yosemite popcorn flower	1B.2	3,456–4,448	Apr–Jun	Meadows and seeps, subalpine coniferous forest, upper montane coniferous forest. Moist open slopes and meadows	NONE. Study Area is outside the elevation range for the species and lacks suitable habitat for the species
<i>Pseudobahia bahiifolia</i>	Hartweg's golden sunburst	FE / SE / 1B.1	49–492	Mar–Apr	Cismontane woodland and valley and foothill grassland; clay soils	MOD. Two historical (1986) occurrences in the vicinity of the Study Area (Friant and Friant-Kern Canal); suitable habitat present in the Study Area
<i>Sagittaria sanfordii</i>	Sanford's arrowhead	1B.2	<1,000	May–Oct (Nov)	Freshwater wetlands, marshes, swamps, riparian areas (assorted shallow freshwater); ponds and ditches	LOW. CNPS reports from the vicinity of the Study Area (Friant), but no mapped occurrences; only marginal habitat present in the Study Area

Scientific Name	Common Name	Listing Status (Federal/State/BLM/USFS/CRPR)	Elevation Range (feet) ^a	Bloom Period	Habitat Associations	Potential to Occur in the Study Area
<i>Sidalcea keckii</i>	Keck's checkerbloom	FE / 1B.1	246–2,133	Apr–May (Jun)	Cismontane woodland and valley and foothill grassland; serpentine soils, and clay soils	LOW. No mapped occurrences in the vicinity of the Study Area; suitable habitat (serpentine/clay soils) not present in the Study Area
<i>Streptanthus farnsworthianus</i>	Farnsworth's jewel flower	4.3	1,312–4,593	May–Jun	Cismontane woodland	MOD. Historical occurrences in the vicinity of the Study Area; suitable habitat present in the Study Area
<i>Stylocline masonii</i>	Mason's nest straw	BLMS / 1B.1	330–4,000	Mar–May (Jun)	Shadscale scrub, pinyon-juniper woodland; open loose sand of washes and flats	NONE. Not known from Fresno County, all mapped occurrences are west and south of Kern County; suitable habitat not present within the Study Area
<i>Trifolium dedeckerae</i> (= <i>T. kingii</i> ssp. <i>dedeckerae</i>)	DeDecker's clover	BLMS	6,800–11,500	May–Jun	Lodgepole, red fir, yellow pine forest, pinyon-juniper woodland; subalpine; rock crevices	NONE. Study Area is outside the elevation range for the species; suitable habitat not present in the Study Area
<i>Viburnum ellipticum</i>	oval-leaved viburnum	2B.3	705–4,593	May–Jun	Chaparral, cismontane woodland, and lower montane coniferous forest	HIGH. Known from the vicinity of the Study Area (John Stebbins, independent botanist, in phone conversation with K.A. Colgate, Cardno, in April 2019); suitable habitat (cismontane woodland) present in the Study Area
<i>Viola pinetorum</i> ssp. <i>grisea</i>	grey leaved violet	BLMS / 1B.2	6,500–12,000	Apr–Jul	Mountain peaks, alpine zones	NONE. Study Area is outside the elevation range for the species; suitable habitat not present in the Study Area
<i>Wyethia elata</i>	Hall's wyethia	4.3	1,640–4,590	May–Aug	Cismontane woodland and lower montane coniferous forest	MOD. Study Area is just outside of the elevation range for the species; several occurrences in the vicinity of the Study Area; suitable habitat (cismontane woodland) present in the Study Area
<i>Bruchia bolanderi</i>	Bolander's bruchia	FSS / 4.2	5,577–9,186	N/A	Often in meadows and seeps on damp soils in montane coniferous forest	NONE. Study Area is outside the elevation range for the species

Scientific Name	Common Name	Listing Status (Federal/State/BLM/USFS/CRPR)	Elevation Range (feet) ^a	Bloom Period	Habitat Associations	Potential to Occur in the Study Area
<i>Bryum chryseum</i>	brassy bryum	4.3	160–1,970	N/A	Cismontane woodland, valley and foothill grassland, openings in chaparral habitats	HIGH. Possible mapped occurrence in Fresno/Madera foothills near the Study Area
<i>Didymodon californicus</i>	California beard-moss	4.2	4,511–5,397	N/A	Openings in lower montane coniferous forest	NONE. Study Area is outside the elevation range for the species; suitable habitat not present in the Study Area
<i>Fissidens aphelotaxifolius</i>	brook pocket moss	FSS / 2B.2	6,562–7,218	N/A	Lower montane coniferous forest	NONE. Study Area is outside the elevation range for the species; suitable habitat not present in the Study Area
<i>Meesia triquetra</i>	three-ranked hump moss	4.2	4,265–9,688	Jul	Bogs and fens	NONE. Study Area is outside the elevation range for the species; suitable habitat not present in the Study Area
<i>Mielichhoferia elongata</i>	elongate coper moss	– / – / FSS / 4.3	<3,550	N/A	Seasonally moist sites on metamorphic, sedimentary, limestone, and serpentine rock outcrops, often containing heavy metals	MOD. Collections from lower elevation habitats consistent with the Study Area
<i>Mielichhoferia shevockii</i>	Shevock's copper moss	– / – / FSS / 1B.2	>4,592	N/A	Metamorphic rocks, often along roads. Also in woodlands on gravelly soil among rocks containing heavy metals, often found with <i>Mielichhoferia elongata</i>	MOD. Collections from lower elevation habitats consistent with the Study Area
<i>Plagiobryoides vinosula</i>	wine-colored tufa moss	4.2	98–5,692	N/A	Cismontane woodland	HIGH. Possible mapped occurrence in Fresno/Madera foothills in the vicinity of the Study Area
<i>Peltigera gowardii</i>	Western waterfan lichen	FSS / 4.2	3,494–8,596	N/A	On rocks in cold water creeks with little or no sediment or disturbance in montane coniferous forest	NONE. Study Area is outside the elevation range for the species; suitable habitat not present in the Study Area

Sources: BLM 2014b; BoR 2014; CDFW 2019b, 2019c; GANDA 2015a, 2016b; USFS 2013; USFWS 2013, 2019

a Elevation range for the Kerckhoff Hydroelectric Project is approximately 300–1,000 ft. Notes:

BLM	Bureau of Land Management
CNDDDB	California Natural Diversity Database
CRPR	California Rare Plant Rank
HIGH	High potential to occur is based on recent mapped occurrences from the vicinity of the Project and/or Study Area, and elevation and habitat conditions are present in the Study Area.
KNOWN	Species is currently known from the Study Area based on past survey reports, agency consultation, and/or other literature sources, and elevation and habitat conditions are present in the Study Area.
LOW	Elevation and/or habitat requirements for this species are marginal in the Study Area and/or only few (historical) occurrences are present in the vicinity of the Project.
MOD	Moderate potential to occur is based on known occurrences in the vicinity of the Project, and elevation and habitat requirements being met in the Study Area.
NONE	Elevation and/or habitat requirements for this species are not present in the Project Area, and/or the species has a very specific and limited geographic distribution.
USFS	United States Forest Service.
BLM/USFS Listings:	Listing Status
BLMS	BLM Sensitive
Federal and State Listings:	Listing Status
FT	Federal Threatened
SE	State Endangered
SR	State Rare
ST	State Threatened
CRPR Ratings:	
CRPR 1A	Plants presumed extirpated in California and either rare or extinct elsewhere
CRPR 1B	Plants rare, threatened, or endangered in California and elsewhere
CRPR 2A	Plants presumed extirpated in California, but common elsewhere
CRPR 2B	Plants rare, threatened, or endangered in California, but common elsewhere
CRPR 3	Review List: Plants about which more information is needed
CRPR 4	Watch List: Plants or limited distribution
Threat Ranks:	
1	Seriously threatened in California (over 80% of occurrences threatened/high degree and immediacy of threat)
2	Moderately threatened in California (20–80% of occurrences threatened/moderate degree and immediacy of threat)
3	Not very threatened in California (<20% of occurrences threatened/low degree and immediacy of threat or no current threats known)

Table WILD 1-4.

Special-status wildlife species known to occur or potentially occurring in the Study Area.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
Known to Occur						
Birds						
<i>Aquila chrysaetos</i>	golden eagle	Eagle Act	BLM-S	CFP	Forages in grasslands and early successional stages of forest and shrub habitats at elevations up to 11,500 ft. Nests on secluded cliffs with overhanging ledges or large trees in open areas with unobstructed view.	Known to occur. Suitable nesting and foraging habitat is present within the Study Area. Two individuals were observed incidentally in the Project Bypass Reach during bald eagle helicopter surveys conducted in June 2019. The species is also known to nest southwest of the Study Area on the cliffs above Millerton Lake (BoR 2014).
<i>Haliaeetus leucocephalus</i>	bald eagle	FD, Eagle Act	BLM-S, FSS	SE, CFP	Year-round resident in ice-free regions of California. Foraging areas include regulated and unregulated rivers, reservoirs, lakes, estuaries, and coastal marine ecosystems. Breeding bald eagles require relatively large bodies of water, including reservoirs containing a large standing population of suitable-sized fish. Nests are usually located within 1 mile of foraging habitat.	Known to occur. Suitable foraging and nesting habitat is present within the Study Area. This species was observed nesting on Kerckhoff Reservoir during bald eagle nesting surveys conducted in 2019. Wintering subadults were also observed in the Project Bypass Reach and south of the Kerckhoff 2 Powerhouse at the upper end of Millerton Lake. This species was also observed roosting on Kerckhoff Reservoir during wildlife reconnaissance surveys conducted in 2019, and incidentally at Kerckhoff Reservoir and near the Kerckhoff 2 Powerhouse during other technical studies.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
<i>Setophaga petechia</i>	yellow warbler	—	—	CSC	Breeds in riparian woodlands from coastal and desert lowlands at elevations up to 8,000 ft. in the Sierra Nevada. Also breeds in montane chaparral, open ponderosa pine, and mixed conifer habitats with substantial amounts of brush.	Known to occur. Suitable habitat for this species is present within the Study Area. Singing males were observed during wildlife reconnaissance surveys conducted in May 2019 at three locations: <ul style="list-style-type: none"> • One individual was observed adjacent to the Fiber Optics & 12 kV Pole Line between Kerckhoff 1 Switchyard and Kerckhoff 2 Switchyard, near the Ya-Gub-Weh-Tuh Trailhead parking lot; • Five individuals were observed on the eastern shore of Smalley Cove, adjacent to Smalley Cove Campground; and • One individual was observed on the San Joaquin River, just above the inlet into Kerckhoff Reservoir. Other records of this species are also known from the Project vicinity (BoR 2014).
<i>Strix occidentalis occidentalis</i>	California spotted owl	—	BLM-S, FSS	CSC	In the Sierra Nevada, typically nests in old-growth or mature, multi-layered, dense, mixed-conifer forests. Forages in multi-layered mixed conifer, redwood, Douglas fir, and oak woodland habitats, from sea level to elevations of approximately 7,600 ft., with the majority (86 percent) occurring from 3,000 to 7,000 ft. Foraging habitat is similar to nesting habitat, but owls may also forage in more open canopy	Known to occur. A single individual responded to calls during two nocturnal surveys conducted near Kerckhoff Dam within the Study Area (BoR 2014). However, nesting habitat is marginal in the Study Area. This species was not observed during surveys conducted in support of relicensing.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
Mammals						
<i>Antrozous pallidus</i>	pallid bat	—	BLM-S, FSS	CSC	Occurs in grasslands, shrublands, woodlands, and forests from sea level to 10,000 ft. in elevation. Typically roosts in caves, crevices, or mines. Requires open habitat for foraging.	Known to occur. Suitable roosting and foraging habitat is present within the Study Area. This species was observed during bat surveys conducted for relicensing studies in 2019. Refer to Table WILD 1-9 for specific facilities where this species was observed. Maternal roosts are present south of the Study Area on the cliffs above Millerton Lake (BoR 2014).
<i>Corynorhinus townsendii</i>	Townsend's big-eared bat	—	BLM-S, FSS	CSC	Found in all but alpine and subalpine habitats; most abundant in mesic habitats up to 6,000 ft. in elevation. Requires caves, mines, tunnels, buildings, or other human-made structures for roosting. Extremely sensitive to disturbance and may abandon a roost if disturbed.	Known to occur. Suitable foraging habitat is present within the Study Area, though recent surveys at several Kerckhoff facilities indicated that no potential roosting habitat appears to be present at those Project features (GANDA 2015a, 2016b). This species was detected during bat surveys conducted for relicensing studies in 2019. Refer to Table WILD 1-9 for specific facilities where this species was observed. This species was detected in the Millerton Lake Cave System in the vicinity of the Study Area approximately 0.8 mile north of Big Sandy Creek (BoR 2014).
<i>Myotis evotis</i>	long-eared myotis	—	BLM-S	—	Found predominantly in coniferous forests, typically only at higher elevations in southern areas (between 7,000 and 8,500 ft.). They roost in tree cavities and beneath exfoliating bark in both living trees and dead snags.	Known to occur. Suitable foraging and roosting habitat is present within the Study Area. This species was detected during bat surveys conducted for relicensing studies in 2019. Refer to Table WILD 1-9 for specific facilities where this species was observed.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
<i>Myotis thysanodes</i>	fringed myotis	—	BLM-S, FSS	—	Optimal habitats are pinyon-juniper, valley foothill hardwood, and hardwood-conifer, generally at 4,000 to 7,000 ft. Roosts in caves, mines, buildings, and crevices. Separate day and night roosts may be used. Uses open habitats, early successional stages, streams, lakes, and ponds as foraging areas. This species is migratory, making relatively short, local movements to suitable hibernacula.	Known to occur. Suitable roosting and foraging habitat is present within the Study Area. This species was detected during bat surveys conducted for relicensing studies in 2019. Refer to Table WILD 1-9 for specific facilities where this species was observed.
<i>Myotis yumanensis</i>	Yuma myotis	—	BLM-S	—	Occasionally roosting in mines or caves, these bats are most often found in buildings or bridges. Bachelors also sometimes roost in abandoned cliff swallow nests, but tree cavities are probably the original sites for most nursery roosts. These bats typically forage over water in forested areas.	Known to occur. Suitable foraging and roosting habitat is present within the Study Area. This species was observed during bat surveys conducted for relicensing studies in 2019. Refer to Table WILD 1-9 for specific facilities where this species was observed.
<i>Eumops perotis californicus</i>	western mastiff bat	—	BLM-S	CSC	Found in variety of habitats including desert scrub, chaparral, oak woodland, ponderosa pine, meadows, and mixed conifer forests up to 4,600 ft. in elevation. Distribution is likely limited by availability of significant rock features offering suitable roosting habitat.	Known to occur. Suitable foraging and roosting habitat for this species is present within the Study Area. This species was heard foraging above Kerckhoff Reservoir in 2015 (GANDA 2015a, 2016b). This species is known to roost southwest of the Study Area on the cliffs above Millerton Lake (BoR 2014). This species was not observed during surveys conducted in support of relicensing.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
May Potentially Occur						
Reptiles						
<i>Anniella pulchra</i>	northern California legless lizard	—	—	CSC	Occurs in moist warm loose soil with plant cover. Moisture is essential. Occurs in sparsely vegetated areas of beach dunes, chaparral, pine-oak woodlands, desert scrub, sandy washes, and stream terraces with sycamores, cottonwoods, or oaks. Often can be found under surface objects such as rocks, boards, driftwood, leaf litter, and logs. Elevation range is from sea level to 5,900 ft.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Phrynosoma blainvillii</i>	coast horned lizard	—	BLM-S	CSC	Occurs in valley foothill hardwood, conifer, and riparian habitats, as well as in pine-cypress, juniper, and annual grassland habitats. The elevational range extends up to 4,000 ft. in the Sierra Nevada foothills and up to 6,000 ft. in the mountains of southern California.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Lampropeltis zonata</i>	California mountain kingsnake	—	BLM-S	—	A habitat generalist, found in diverse habitats including coniferous forest, oak-pine woodlands, riparian woodland, chaparral, manzanita, and coastal sage scrub. Wooded areas near a stream with rock outcrops, talus, or rotting logs that are exposed to the sun are good places to find this snake. Elevation range is from 1,500 to 8,000 ft.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
Birds						
<i>Ammodramus savannarum</i>	grasshopper sparrow	—	—	CSC	Inhabits moderately open grasslands, grassland-shrub areas, and ruderal areas with patchy bare ground. An uncommon and local summer resident and breeder in the foothills and lowlands west of the Cascade-Sierra Nevada crest. Occurs in dry, dense grasslands, especially those with a variety of grasses and tall forbs and scattered shrubs for singing perches.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Asio flammeus</i>	short-eared owl	—	—	CSC	Prefers open areas with few trees, such as annual and perennial grasslands, prairies, dunes, meadows, irrigated lands, saline and fresh emergent wetlands. Needs elevated sites for perching and dense vegetation for roosting.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Circus hudsonicus</i>	northern harrier	—	—	CSC	Occurs in a variety of habitats at elevations up to 10,000 ft. Forages in open areas such as meadows, wetlands, and grasslands. Breeding habitat is up to 5,700 ft. in the Sierra Nevada, in areas with shrubby vegetation near foraging habitat.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Elanus leucurus</i>	white-tailed kite	—	BLM-S	CFP	Prefers coastal and lowland valleys; often associated with farmlands, meadows with emergent vegetation, and grasslands.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Falco peregrinus anatum</i>	American peregrine falcon	FD	—	SD, CFP	Very uncommon breeding resident and uncommon as a migrant. Breeds in woodlands, forests, coastal habitats, and riparian areas near wetlands, lakes, rivers, or other water on high cliffs, banks, dunes, or mounds. Active nesting sites are known along the coast, in the Sierra Nevada, and in the mountains of northern California. Migrants occur along the coast and the western Sierra Nevada in spring and fall.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
<i>Lanius ludovicianus</i>	loggerhead shrike	—	—	CSC	Usually found in open areas with few trees, such as annual and perennial grasslands, prairies, dunes, meadows, irrigated lands, and saline and freshwater emergent wetlands.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Progne subis</i>	purple martin	—	—	CSC	An uncommon, local summer resident in wooded, low-elevation habitats. Found in valley foothill, montane hardwood, montane hardwood-conifer, and riparian habitats. Nests in tall, old trees near an open body of water, and occasionally in residential areas.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
Mammals						
<i>Bassariscus astutus</i>	ringtail	—	—	CFP	Found in most forest and shrub habitats in close association with rocky and/or riparian areas, usually not more than 0.6 mile from water. Dens in hollow trees, snags, or other cavities.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Euderma maculatum</i>	spotted bat	—	BLM-S	CSC	Ranges from arid deserts and grasslands through mixed conifer forests up to elevations of 10,600 ft. in southern California. Prefers sites with adequate roosting habitat, such as cliffs. Often limited by the availability of cliff habitat. Feeds over water and along marshes.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Lasiurus blossevillii</i>	western red bat	—	—	CSC	Roosts in forests and woodlands from sea level up through mixed mesic conifer forests in coastal ranges and the Sierra Nevada. Forages in a variety of habitats including croplands, grasslands, shrublands, and open woodlands and forests. Prefers solitary roosts in trees and occasionally shrubs.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Myotis ciliolabrum</i>	western small-footed myotis	—	BLM-S	—	Found in a wide variety of habitats, primarily in relatively arid wooded and brushy uplands near water. Elevation range is from 0 to 8,900 ft.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
<i>Perognathus xanthonotus</i>	San Joaquin pocket mouse	—	BLM-S	—	Occurs in dry, open grasslands with fine-textured soils in the Central and Salinas Valleys from elevation 1,000 to 2,000 ft.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
<i>Taxidea taxus</i>	American badger	—	—	CSC	Occurs throughout most of the state in areas with dry, friable soils. It is most abundant in drier open stages of most shrub, forest, and herbaceous habitats up to 12,000 ft. in elevation.	May potentially occur. Suitable habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing.
Unlikely to Occur						
Invertebrates						
<i>Branchinecta conservatio</i>	Conservancy fairy shrimp	FE	—	—	Found in large, turbid vernal and playa pools.	Unlikely to occur. There is no suitable habitat for this species within the Study Area. There are no documented CNDDDB occurrences within the Study Area.
<i>Branchinecta lynchi</i>	vernal pool fairy shrimp	FT	—	—	Inhabits primarily vernal pools, but also occurs in other seasonal wetlands such as alkaline rain pools, ephemeral drainages, rock outcrop pools, ditches, stream oxbows, stock ponds, and vernal swales.	Unlikely to occur. There is no suitable habitat for this species within the Study Area. There are no documented CNDDDB occurrences within the Study Area. Critical habitat for this species is approximately 0.9 mile west of the FERC Project Boundary.
<i>Desmocerus californicus dimorphus</i>	valley elderberry longhorn beetle	FT	—	—	Elderberry shrubs are host; generally, found in riparian areas and floodplains, and also open hillsides and rocky outcrops.	Unlikely to occur. Although elderberry shrubs are present within the Study Area, USFWS has revised the species' range and neither Madera nor Fresno County is within the current range for this species (personal communication, Timothy Ludwick, USFWS, 2017). There are no documented CNDDDB occurrences within the Study Area.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
<i>Lepidurus packardii</i>	vernal pool tadpole shrimp	FE	—	—	Occurs in a variety of seasonal habitats: vernal pools, ponded clay flats, alkaline pools, ephemeral stock tanks, and roadside ditches.	Unlikely to occur. There is no suitable habitat for this species within the Study Area. There are no documented CNDDDB occurrences within the Study Area. Critical habitat for this species is approximately 0.9 mile west of the FERC Project Boundary.
Amphibians						
<i>Batrachoseps regius</i>	Kings River slender salamander	—	FSS	—	Found along stream corridors and moist wooded canyons in valley foothill riparian, blue oak woodland, and Sierra mixed conifer woodlands. Found only on the southern and eastern sides of the North Fork of the Kings River, Summit Meadow in the South Fork Kings River drainage, and the middle fork of the Kaweah River. Found at elevations between 1,100 and 8,100 ft.	Unlikely to occur. The Study Area is outside the geographic range of this species.
Reptiles						
<i>Gambelia sila</i>	blunt-nosed leopard lizard	FE	—	SE, CFP	Found in sparsely vegetated alkali scrub and desert habitats below 2,400 ft. in the San Joaquin Valley and adjacent foothills. USFWS has not designated critical habitat for this species.	Unlikely to occur. The Study Area is outside the geographic range of this species.
Birds						
<i>Accipiter gentilis</i>	northern goshawk	—	BLM-S, FSS	CSC	Forages and nests in middle- to high-elevation, mature, dense conifer forests. Wintering habitat includes foothills, northern deserts in pinyon-juniper woodland, and low-elevation riparian habitats.	Unlikely to occur. There is no suitable habitat for this species within the Study Area. There are no documented CNDDDB occurrences within the Study Area.
<i>Agelaius tricolor</i>	tricolored blackbird	—	BLM-S	ST, CSC	Nests near fresh water, emergent wetland with cattails or tules, and Himalayan blackberry; forages in grasslands, woodland, and agriculture in the Central Valley and Coast Ranges.	Unlikely to occur. Suitable nesting habitat for this species is very limited within the Study Area. Study Area is higher in elevation than preferred valley floor habitats.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
<i>Asio otus</i>	long-eared owl	—	—	CSC	Uncommon resident throughout the state, except for the Central Valley and Southern California deserts. Requires riparian habitat, and uses oak thickets or other dense stands of trees. Forages in open areas in woodland and forested habitats.	Unlikely to occur. Suitable habitat is minimal within the Study Area. There are no documented CNDDB occurrences of this species within the Study Area.
<i>Athene cunicularia</i>	burrowing owl	—	BLM-S	CSC	Suitable habitat throughout their breeding range typically includes open, treeless areas within grassland, steppe, and desert biomes. They generally inhabit gently sloping areas, characterized by low, sparse vegetation.	Unlikely to occur. Suitable habitat is minimal within the Study Area. There are no documented CNDDB occurrences of this species within the Study Area.
<i>Buteo swainsonii</i>	Swainson's hawk	—	BLM-S	ST	Uncommon breeding resident and migrant in the Central Valley, Klamath Basin, Northeastern Plateau, Lassen County, and Mojave Desert. Nests in riparian woodlands, juniper-sage flats, and oak woodlands. Forages in grasslands and agricultural areas.	Unlikely to occur. This species prefers open grassland and agricultural land for foraging and nests in tall riparian trees, often sycamores or cottonwoods. Suitable nesting and foraging habitat for this species is minimal within the Study Area. This species does not venture far from California's Central Valley. There are no documented CNDDB occurrences of this species within the Study Area.
<i>Charadrius montanus</i>	mountain plover	—	BLM-S	CSC	Breeds on open plains at moderate elevations in the intermountain West. Winters in short-grass plains and fields, plowed fields, and sandy deserts in the western United States. In California, found mostly in the Central Valley, foothills west of San Joaquin Valley, Imperial Valley, and along the central Colorado River valley.	Unlikely to occur. The Study Area is outside the geographic range of this species.
<i>Empidonax traillii</i>	willow flycatcher	—	FSS	SE	Found in wet meadow and montane riparian habitats from 2,000 to 8,000 ft. Most often occurs in broad, open river valleys or large mountain meadows with lush growth of shrubby willows.	Unlikely to occur. Wet meadow habitat within the Study Area does not support dense thickets of riparian vegetation (BoR 2014). There are no documented CNDDB occurrences of this species within the Study Area.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
<i>Gymnogyps californianus</i>	California condor	FE	—	SE, CFP	Endangered, permanent resident of the semi-arid, rugged mountain ranges surrounding the southern San Joaquin Valley, including the Coast Ranges from Santa Clara County south to Los Angeles County, the Transverse Ranges, Tehachapi Mountains, and southern Sierra Nevada. Forages over wide areas of open rangelands, roosts on cliffs and in large trees and snags.	Unlikely to occur. Potentially suitable foraging habitat is present within the Study Area; however, this species was not observed during surveys conducted in support of relicensing and the Study Area is outside of the current condor range. GPS tracking by USFWS detected a single condor south of Auberry in 2013 (USFWS 2013), outside the Study Area. No condor locations have been recorded within the Study Area or vicinity from current USFWS tracking data (2003 – 2016).
<i>Icteria virens</i>	yellow-breasted chat	—	—	CSC	Found in dense riparian thickets of willows, vine tangles, and dense brush associated with streams, swampy ground, and the borders of small ponds.	Unlikely to occur. Suitable habitat for this species is minimal within the Study Area. There are no documented CNDDB occurrences of this species within the Study Area.
<i>Riparia riparia</i>	bank swallow	—	BLM-S	ST	Found in lowland and riparian habitats during spring and fall. During the breeding season, restricted to riparian, lacustrine, and coastal areas that have vertical banks, bluffs, and cliffs in which to nest. Nests colonially and almost always near open water.	Unlikely to occur. Suitable nesting habitat is not present within the Study Area. There are no documented CNDDB occurrences of this species within the Study Area.
<i>Strix nebulosa</i>	great gray owl	—	FSS	SE	Nests in old-growth coniferous forests and forages in montane meadows and occasionally annual grasslands. Distribution includes the high elevations of the Sierra Nevada and Cascade ranges, from 4,500 to 7,500 ft. in elevation.	Unlikely to occur. The Study Area is outside the typical elevation range for this species. There are no documented CNDDB occurrences of this species within the Study Area.
<i>Vireo bellii pusillus</i>	least Bell's vireo	FE	—	SE	Summer resident below 2,000 ft. in Santa Barbara, Ventura, San Bernardino, Riverside, San Diego, Imperial, and Inyo counties. Prefers willows and other low, dense valley-foothill riparian habitat in the lower portion of canyons for breeding.	Unlikely to occur. Suitable riparian habitat for this species is limited in size, distribution, and structure. This species is not known to nest in the Study Area (BoR 2014). There are no documented CNDDB occurrences of this species within the Study Area.

Scientific Name	Common Name	Federal Status	Other Status	State Status	Habitat	Potential for Occurrence in Study Area ^a
Mammals						
<i>Dipodomys nitratooides exilis</i>	Fresno kangaroo rat	FE	—	SE	The range of this species encompasses arid grasslands (with friable, sandy soils) in the San Joaquin and adjacent valleys, from the valley floor in Merced County, south of the Merced and San Joaquin rivers, to the southern edge of the valley, and the Panoche Valley in eastern San Benito County), the Carrizo Plain (San Luis Obispo County), and the upper Cuyama Valley (San Luis Obispo and Santa Barbara counties), at elevations of 100 to 2,700 ft. USFWS has designated critical habitat for this species.	Unlikely to occur. The Project is not within the geographic range of this species. The closest critical habitat designated for this species is in western Fresno County. There are no documented CNDDDB occurrences of this species in the Study Area.
<i>Martes caurina sierrae</i>	Sierra marten	--	FSS	--	Mixed evergreen forests with more than 40% crown closure along Sierra Nevada and Cascade mountains between 4,000 and 10,600 feet. Needs variety of different-aged stands, particularly old-growth conifers and snags which provide cavities for dens/nests.	Unlikely to occur. Study Area is below the typically elevation range for this species.
<i>Pekania pennanti</i>	fisher – Southern Sierra Nevada DPS	FE	BLM-S, FSS	ST (S. Sierra Nevada ESU), CSC	Found in large areas of mature, dense forest red fir, lodgepole pine, ponderosa pine, mixed conifer, and Jeffrey pine forests with snags and greater than 50% canopy closure. Also found in montane riparian corridors within the aforementioned habitats. Historically known from elevations of sea level to 8,000 ft.; in the Sierra Nevada, typically restricted to above 2,000 ft. in elevation.	Unlikely to occur. Study Area is below the typically elevation range for this species. Suitable habitat is limited within the Study Area. There are no documented CNDDDB occurrences of this species in the Study Area.

^a Sources: BLM 2014b; BoR 2014; CDFW 2019b, 2019c; GANDA 2015a, 2016b; USFS 2013; USFWS 2013, 2019

Federal Status	
FC	Federal Candidate
FD	Federally Delisted
FC	Federal Candidate
FE	Federal Endangered
FPD	Federal Proposed for Delisting
FPE	Federally Proposed Endangered
FPT	Federally Proposed Threatened
FT	Federally Threatened
Eagle Act	Protected under Bald and Golden Eagle Protection Act
USDA-FS Status	
FSS	U.S. Forest Service Sensitive – Sierra National Forest
State Status	
CFP	California Fully Protected
CSC	California Species of Special Concern
SCE	California Candidate Endangered
SCT	California Candidate Threatened
SD	California Delisted
SE	California Endangered
ST	California Threatened
BLM Status	
BLM-S	Bureau of Land Management Sensitive (Bakersfield Office)

Appendix F

Biological Resources – Aquatics and Fisheries

Data

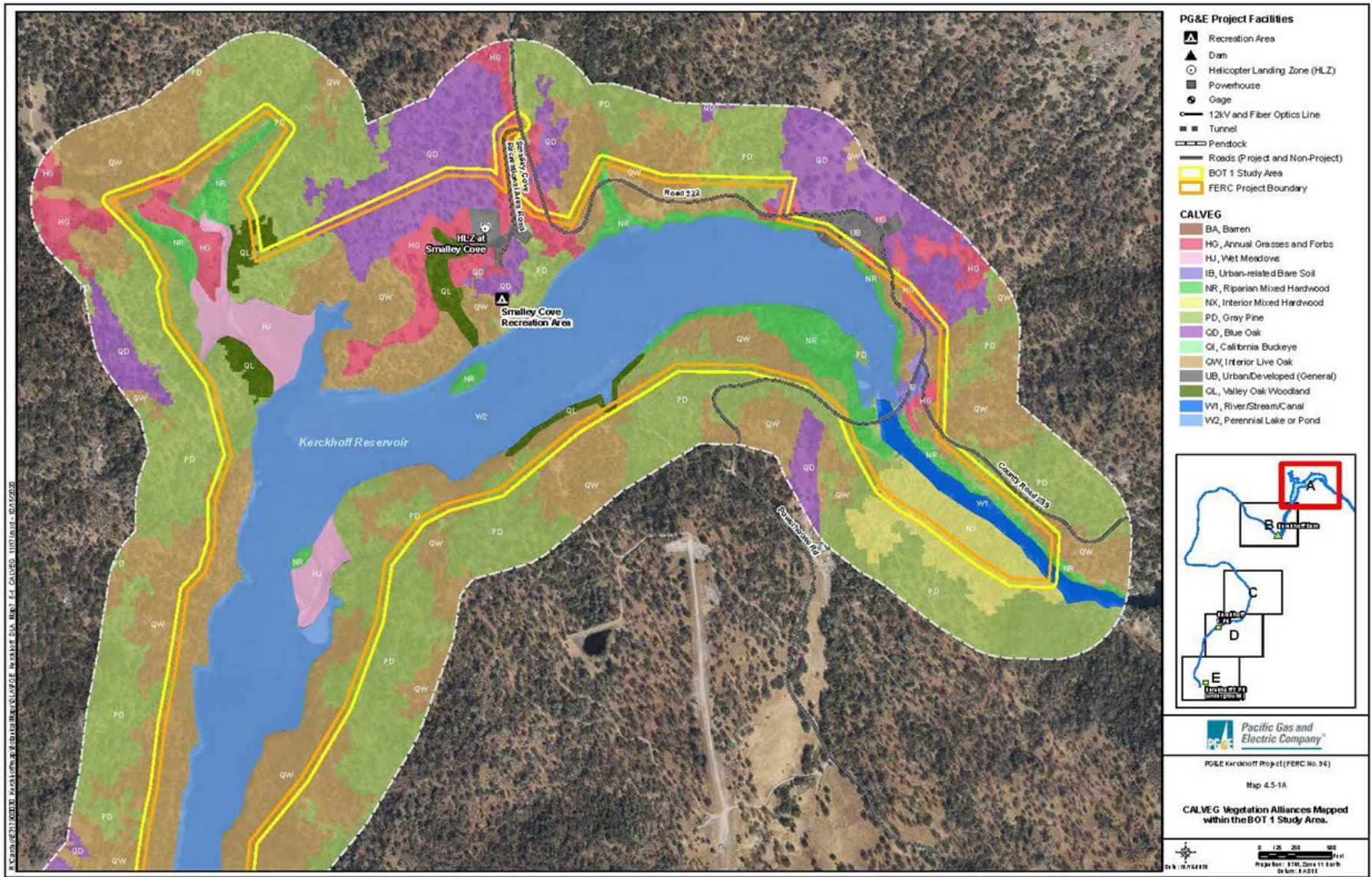


Figure F-1: CALVEG Vegetation Alliances Mapped within the Botanical Study Area—Section A

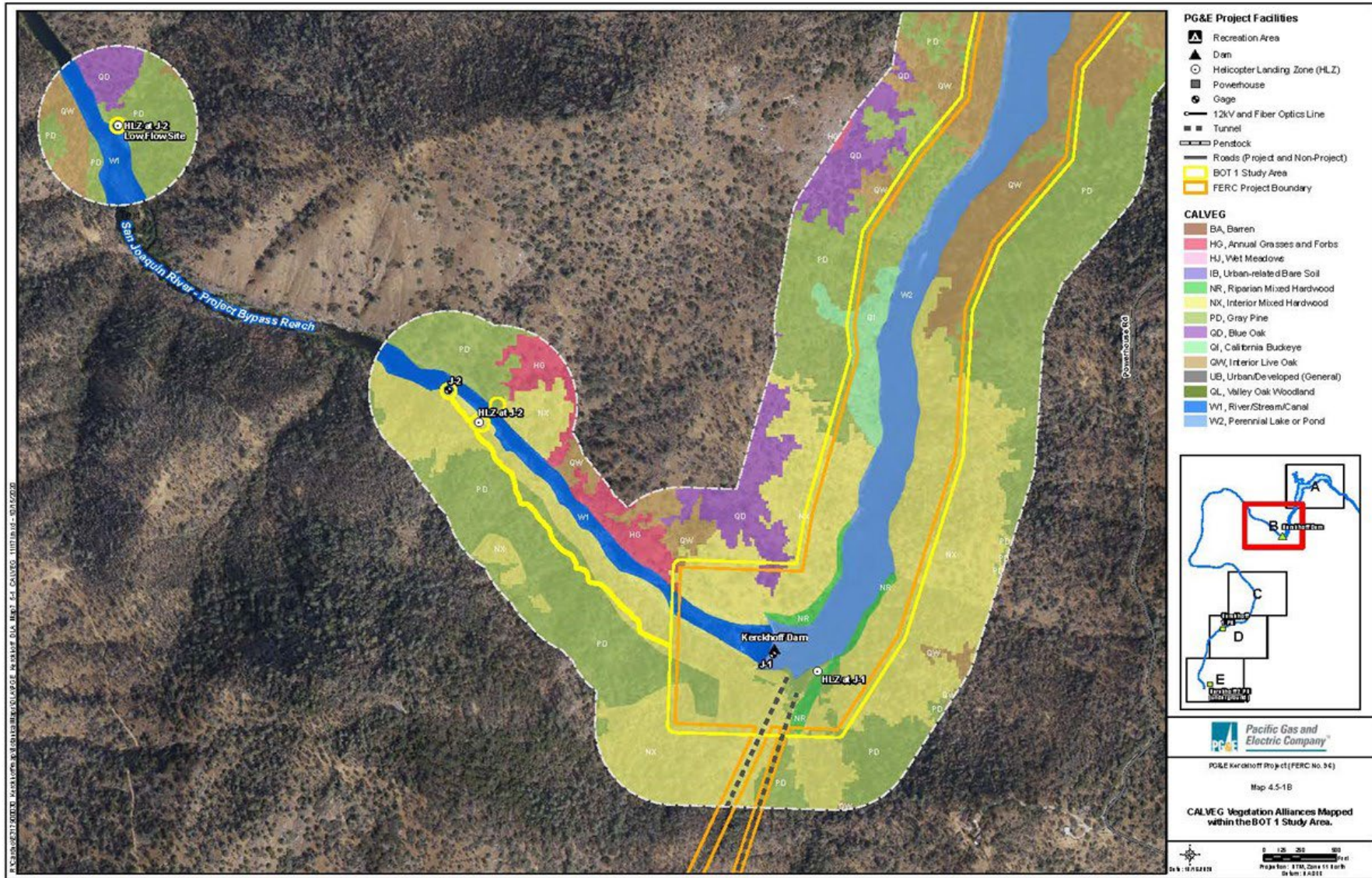


Figure F-2: CALVEG Vegetation Alliances Mapped within the Botanical Study Area—Section B

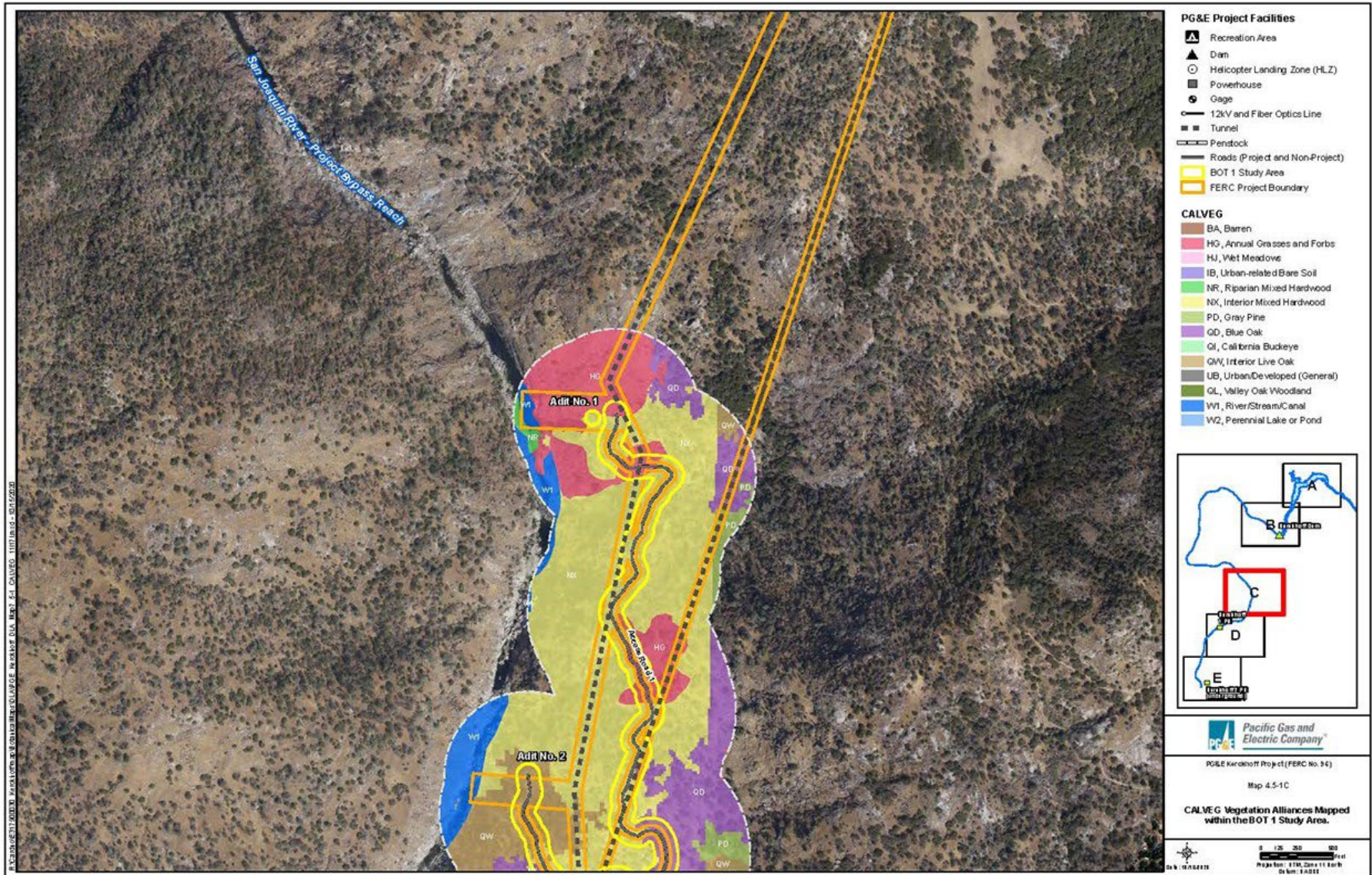


Figure F-3: CALVEG Vegetation Alliances Mapped within the Botanical Study Area—Section C

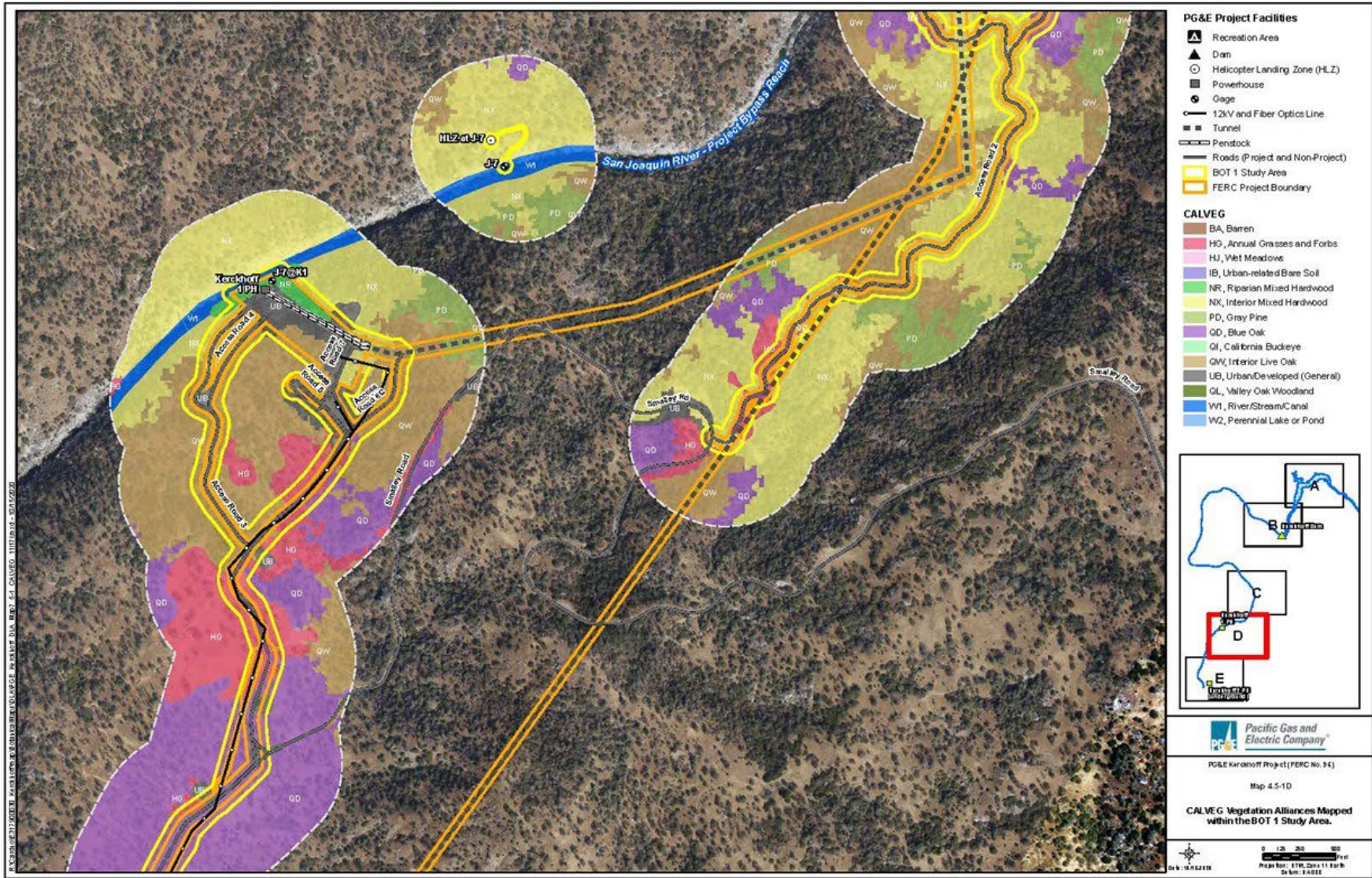


Figure F-4: CALVEG Vegetation Alliances Mapped within the Botanical Study Area—Section D

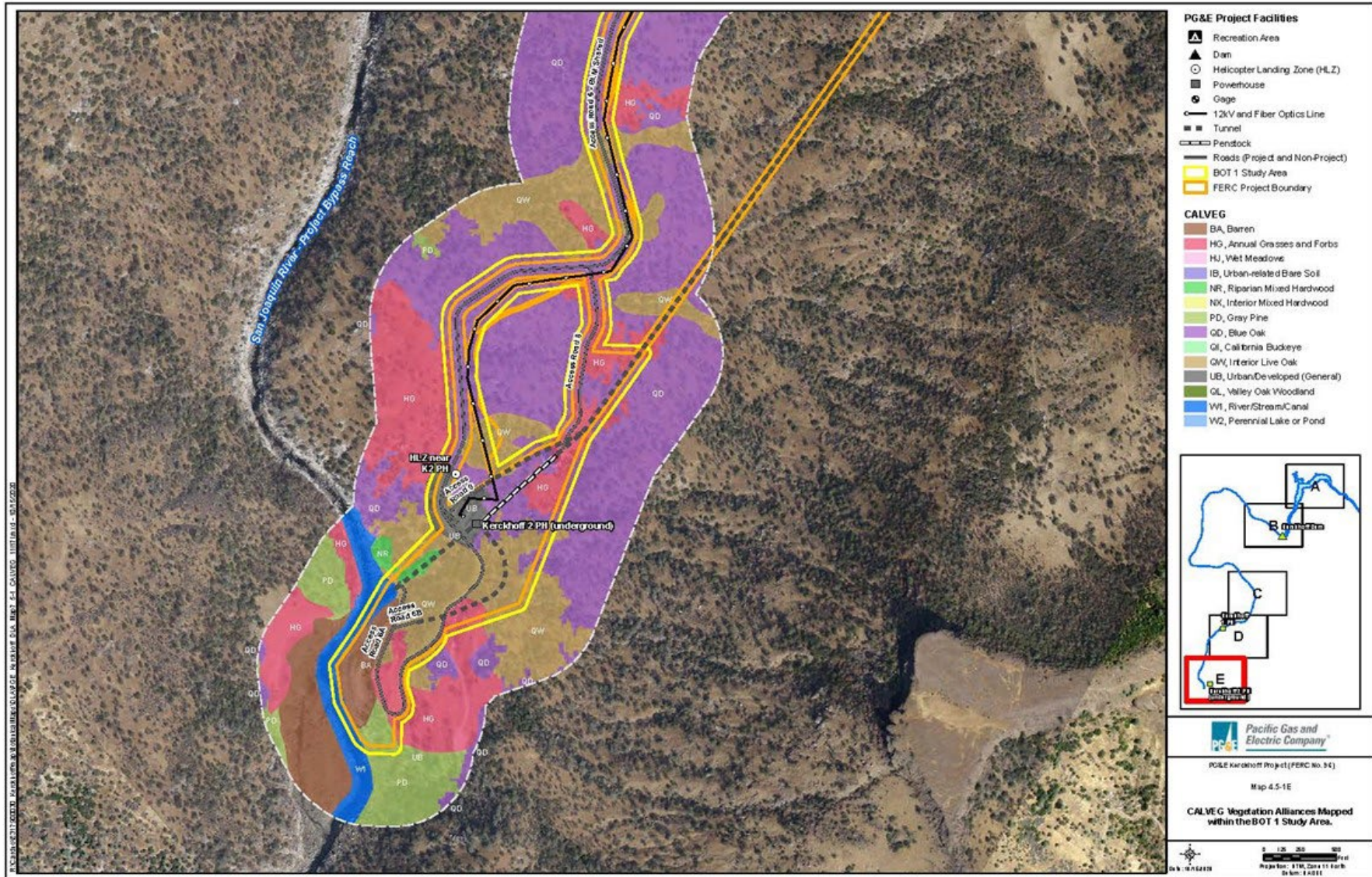


Figure F-5: CALVEG Vegetation Alliances Mapped within the Botanical Study Area—Section E

Appendix G

Project Operations Model – CEQA Alternatives 1 and 2

PROJECT OPERATIONS MODEL – CEQA ALTERNATIVES 1 & 2

KERCKHOFF HYDROELECTRIC PROJECT

FERC No. 96-048

Prepared for:

**California State Water Resources
Control Board**

Prepared by:

Kleinschmidt Associates

April 2026

Kleinschmidt

EXECUTIVE SUMMARY

In November 2020, Pacific Gas and Electric Company (PG&E, or the Applicant) submitted a new license application to the Federal Energy Regulatory Commission (FERC) for the Kerckhoff Hydroelectric Project (FERC No. 96-048). As part of the FERC Ready for Environmental Analysis process, the U.S. Department of the Interior (DOI) issued comments, recommendations, preliminary terms and conditions, and preliminary fishway prescriptions in 2024 (DOI 2024), with revisions issued in 2025 (DOI 2025) under Sections 4(e), 10(a), 10(j), and 18 of the Federal Power Act (FPA). Two of the DOI conditions directly affect how the Kerckhoff Hydroelectric Project would be operated:

1. United States Bureau of Land Management (BLM) FPA 4(e) Condition No 4
2. BLM FPA 4(e) Condition No. 5

Because these measures would change Kerckhoff Hydroelectric Project operations, California State Water Resources Control Board staff and Kleinschmidt Associates fully implemented and evaluated the 2024 BLM FPA 4(e) Condition No 4, a modified version of the 2024 BLM FPA 4(e) Condition No. 5 (Alternative 1 Ramp Up Measure), and the 2025 Revised BLM 4(e) Conditions Nos. 4 and 5 in PG&E's Hydrologic Engineering Center's Reservoir Simulation (HEC-ResSim) Operations Model (PG&E 2025a). This report evaluates the measures described above under two alternatives: California Environmental Quality Act (CEQA) Alternative 1, which reflects the 2024 BLM FPA 4(e) Condition No 4 and the Alternative 1 Ramp Up Measure; and CEQA Alternative 2, which reflects the revised 2025 DOI Revised BLM 4(e) Conditions Nos. 4 and 5. Both alternatives were simulated across the full hydrologic period of record from Water Year (WY) 2003 and WYs 2005–2017.

The Operations Model (ResSim Version 3.3, PG&E 2025a) simulates reservoir inflows, spillway and outlet hydraulics, powerhouse capacity and constraints, and required environmental releases. Several higher priority operational rules were already in place and remained active under both alternatives. These include minimum instream flow requirements, fish-related flow and temperature measures, Kerckhoff 2 (K2) Powerhouse deratings, powerhouse outages, and other operational constraints. These background rules affect how well new spill and ramping measures can be carried out while keeping the reservoir near its normal operating range. The normal operating range is defined in the model using a guide curve, which is a seasonal rule that shows the preferred target

water levels in a reservoir throughout the year to balance hydropower, environmental, and societal needs. The guide curve provides operators with a reference line for when to store water and when to release it during changing hydrologic conditions.

CEQA ALTERNATIVE 1

2024 BLM 4(E) CONDITION 4 – SPILL YEAR BOATING FLOWS AND DOWN RAMPING OF SPILL FLOWS RESULTS SUMMARY

Under Alternative 1, water-year-specific ramp down schedules (Schedules AB, BC, and D) were applied to all spill events. All schedules were completed successfully; however, the high starting flows and long step durations consistently caused the reservoir level to infringe on K2 Powerhouse operational constraints, built into the original PG&E Operations Model (PG&E 2025a). One such constraint is the minimum reservoir elevation for operating the K2 Powerhouse, which is 981.5 feet above mean sea level (msl) in the model, as described in Table 2.3 of Appendix B of the Second Supplemental Information Filing in Support of Final Application for New License (PG&E 2023). Other constraints also impose limitations on K2 operations as reservoir levels drop and depend on inflow rates, reservoir level, and other operational rules with higher priority. Furthermore, if the reservoir elevation drops to 981.5 feet msl or lower, the Kerckhoff Hydroelectric Project can no longer divert water into the K2 Powerhouse in the model. The K2 Powerhouse operational constraints relative to the minimum operating reservoir elevation are collectively referred to in this report as the encroachment toward the K2 Powerhouse's minimum operating reservoir elevation. This encroachment caused frequent over-cycling of the K2 Powerhouse as the model attempted to both maintain the required spill flows and keep the reservoir above the minimum operating elevation of the K2 Powerhouse.

Powerhouse over-cycling refers to repeated increases and decreases in powerhouse releases as the model responds to competing operational goals. In the model, this resulted in rapid oscillations in both powerhouse flow and reservoir elevation over brief periods (15 minutes to 2 hours, typically). This behavior is considered unrealistic and operationally undesirable. The encroachment toward the K2 Powerhouse's minimum operating reservoir elevation generally leads to powerhouse over-cycling, primarily around the large Rough Operating Zone (ROZ), especially when the prescribed spillway flows are large compared to inflows.

Non-spill-year whitewater boating flows were only possible when reservoir inflows were high enough to support two consecutive days of releases between 2,500 and 1,600 cubic feet per second (cfs), followed by the required ramp down. Across six non-spill years, only 28.6 percent of boating flow attempts were fully successful; WY 2014 was an exception, as inflows were sufficient to support most weekend boating events.

The Stranding Protection Down Ramping schedule, which uses lower flows and shorter durations, performed well. It resulted in far fewer reservoir-level conflicts and minimal powerhouse over-cycling. The September – October Ramp Down was also completed successfully in all applicable years, although it occasionally caused the encroachment toward the K2 Powerhouse’s minimum operating elevation due to typically low fall inflows, which led to a brief instance of powerhouse over-cycling in WY 2007.

MODIFIED BLM 4(E) CONDITION 5 – ALTERNATIVE 1 RAMP UP MEASURE RESULTS SUMMARY

The Alternative 1 Ramp Up Measure limits spill ramp up rates to no more than one foot per hour of stage increase at Gage J-2 (United States Geologic Survey Gage Number: 11246700) for spill initiations between minimum instream flow and 4,000 cfs. Using a stage-discharge rating curve developed from historical United States Geological Survey data at Gage J-2, the model applied stepped hourly increases equal to one foot of stage rise.

Out of 42 spill events requiring ramp up, the model successfully met this requirement 97.6 percent of the time. No encroachment toward the K2 Powerhouse’s minimum operating reservoir elevation or powerhouse over-cycling occurred. The main operational sensitivities were the need for advance notice of incoming inflows (typically one to five hours) and proper timing by operators. Starting ramp up earlier generally provided more flexibility and reduced the risk of exceeding the reservoir guide curve.

CEQA ALTERNATIVE 2 – REVISED DOI CONDITIONS

2025 REVISED BLM 4(E) CONDITION 4– MODIFIED END-OF-SPILL FLOW RECESSION AND WHITewater FLOW RELEASES AND SUBSEQUENT SPILL RAMP DOWN SCHEDULE RESULTS SUMMARY

Modified End-of-Spill Flow Recession and Whitewater Flow Releases (Modified EOS Flow Recession Measure) schedules were applied to the largest spill event in each WY between

May 1 and August 31. While all Modified EOS Flow Recession schedules were completed successfully, the higher initial flows and relatively long step durations resulted in the encroachment toward the K2 Powerhouse's minimum operating reservoir elevation and K2 Powerhouse over-cycling in all cases. In practice, operators would likely need to extend step durations to better match actual inflow recession rates, which is feasible as the measure's flow steps only require minimum amounts of time that a down ramp step must be implemented.

The Subsequent Spill Ramp Down schedule, which uses shorter steps and lower flows, performed efficiently with minimal reservoir drawdown and no meaningful powerhouse cycling.

2025 REVISED BLM 4(E) CONDITION 5 – MODIFIED SPILL SEASON FLOW MEASURE AND THE MODIFIED PLANNED OUTAGE MEASURE INITIAL RELEASE PROTOCOL RESULTS SUMMARY

The Modified Spill Season Flow Measure was triggered 30 times during the period of record and was implemented successfully in all cases. Its lower flow ranges and short step durations prevented the encroachment toward the K2 Powerhouse's minimum operating reservoir elevation and avoided powerhouse over-cycling. The Planned Outage Measure (POM) Ramp Down performed similarly, although it often caused substantial reservoir drawdown.

In contrast, the POM Initial Release Protocol created significant operational challenges. Attempting to release spill at 3:30 a.m. in anticipation of forecast inflows consistently caused the reservoir to drop toward the K2 Powerhouse's minimum operating reservoir elevation before inflows arrived. Without consistent inflows the goal of the protocol, which was to have initial spill associated with an outage begin the previous night or early morning so that spill arrives downstream near the K1 Powerhouse by 8:30 a.m. could not be completed. This led to secondary spill increases later in the day once the reservoir was at full capacity to match reservoir inflows. These secondary increases produced stage rise rates ranging from approximately 1.2 feet to as much as 11.7 feet at downstream monitoring locations.

Stage-discharge rating curves used to evaluate these changes were developed by PG&E as part of a prior study and are valid up to flows of 3,500 cfs (Cardno 2021). Stage changes at higher flows were not evaluated but could be larger.

RESERVOIR PERFORMANCE, STAGE BEHAVIOR, AND OPERATIONAL FEASIBILITY (UNDER ALTERNATIVES 1 AND 2)

Across all simulations, Kerckhoff Reservoir remained well above the inactive pool elevation of 960 feet msl. Most ramp down measures caused reservoir drawdown because required spill releases exceeded inflow during execution. Measures with high flows and long durations—such as Schedules AB, BC, D, and Modified EOS Flow Recession—consistently led to the encroachment toward the K2 Powerhouse’s minimum operating reservoir elevation and K2 Powerhouse over-cycling. In actual operations, operators would likely reduce powerhouse generation to avoid repeated cycling.

Short-term drops in inflow occurred frequently in the inflow dataset. When matched by spill gate adjustments, these drops caused rapid stage decreases followed by sharp increases in the Project Bypass Reach (PBR). Modeled stage changes exceeded 11 feet at some study sites. Travel time from the dam to these sites was not analyzed, and these effects appear to reflect inflow data characteristics rather than failures of the evaluated measures.

OVERALL FINDINGS

- **Alternative 1 Ramp Up Measure** (stage-limited ramp up) is highly effective, operationally feasible, and does not create reservoir or powerhouse conflicts. However, operators at Kerckhoff Dam would need advanced notification from upstream projects of the timing and amount of incoming flows (typically one to five hours) in order to effectively implement ramp up by beginning ramp up prior inflows arriving.
- **Alternatives 1 and 2 high-flow, long-duration ramp downs** (Schedules AB, BC, D, Modified EOS Flow Recession) are technically achievable but consistently force the system into the encroachment toward the K2 Powerhouse’s minimum operating reservoir elevation and K2 Powerhouse over-cycling. However Alternative 2’s encroachment toward the K2 Powerhouse’s minimum operating reservoir elevation and powerhouse over-cycling were less in occurrence and magnitude compared to Alternative 1.
- **Moderate, short-duration schedules** (Stranding Protection Down Ramping, Subsequent Spill Ramp Down, Modified Spill Season Flow Measure, Modified POM Ramp Down) perform well with minimal operational conflicts.
- **Non-spill year boating flows** remain highly constrained by limited inflows and rarely achieved their intended purpose of providing consistent boating flows for recreationists.
- **POM Initial Release Protocol** could not be properly implemented without sustained inflows to the reservoir and consistently lowered to reservoir without adequate inflows. Once inflows picked up later in the day, Kerckhoff Dam would be forced into spill once Kerckhoff Reservoir reached capacity and without the Project being able to divert through the K2 Powerhouse. This caused secondary flow spikes that created large stage increases in the PBR. The stage increase amount was dependent on the amount of inflow from upstream hydroelectric projects

Overall, the evaluated measures could be implemented within the existing operational framework. However, several measures create operational side effects—primarily the encroachment toward the K2 Powerhouse’s minimum operating reservoir elevation and powerhouse over-cycling—that would require real-time operator judgment to manage safely and effectively.

The following table presents a qualitative assessment of the success of CEQA Alternatives 1 and 2 measures from the period of record simulations. The success rate provides a percentage of time the measure was successfully completed. The percentage of time the application of the measure caused K2 Powerhouse over-cycling is also presented.

CEQA Alternatives 1 and 2 performance.

Measure	Count	Success Rate (%)	K2 Powerhouse Over-Cycling (%)
Alternative 1 Ramping Conditions			
Spill Year Schedule Boating Flows and Down Ramping of Spill Flows	12	100	91.7
Non-Spill Year Boating Flows and Down Ramping	28	28.6	4.6
Stranding Protection Down Ramping	8	100	12.5
September – October Down Ramp	4	100	0**
Alternative 1 Ramp Up	42	97.6	0
Alternative 2 Ramping Conditions			
Modified EOS Flow Recession	10	100	100
Subsequent Spill Ramp Down	5	100	0
Modified Spill Season Flow Measure	30	100	0
POM Initial Release Protocol	12	0	0
Modified POM Ramp Down	12	100	0

*Success would depend on the operator’s ability to accurately predict the optimal initiation time of the ramp up.

**K2 Powerhouse Over-Cycling in WY 2007 is not included here because it was very brief.

MODEL ASSUMPTIONS AND LIMITATIONS

The HEC-ResSim model provided by PG&E (PG&E 2025a), and augmented to include the CEQA 1 and 2 Alternatives, simulates reservoir operations using fixed, rule-based logic applied at set time intervals. Reservoir inflows are provided as input and assumed to be accurate. Storage and flow release behavior is based on predefined rating curves. The model does not account for real-time operator judgment, hydrologic feedback, or processes that occur within a single time step. Model results are intended to compare operational scenarios and are not meant to predict exact real-world operations. Key assumptions and limitations are as follows:

- **Inflows are prescribed.** Reservoir inflows are provided as external time series and are assumed accurate. The model does not generate runoff or adjust inflows based on operations.
- **Physical relationships are fixed.** Stage–storage, stage–discharge, and outlet capacity relationships are assumed constant over time and do not reflect sedimentation, debris, or structural changes.
- **Operations are rule based.** All operational decisions are controlled by predefined rules and priorities using built-in rules-based logic or scripted rules. Operator discretion and real-time adjustments are not represented.
- **Discrete time steps.** Operational changes occur only at the model time step (15 minutes). Changes within a time step are not simulated.
- **Simplified hydraulics.** Each reservoir is modeled as a single, well-mixed pool with level pool flow routing (meaning the reservoir raises and lowers as a level pool). Backwater, tailwater, and downstream flow routing effects are omitted (i.e., “null” routing).
- **Facilities are assumed available.** Spillways, outlet works, and powerhouses are assumed fully operational unless outages are specifically modeled (e.g., POM).
- **Results are comparative.** Model results are intended to compare alternatives and operating strategies, not to reproduce or forecast exact observed operations.
- **Adaptation from original PG&E Operations Model.** Aside from the newly implemented Alternatives 1 and 2, operational rules and physical properties of the dam and reservoir were adopted from the original model.

MODEL DATA SOURCES

The model data sources all appear on the references listed in Section 6.0 and are listed here for convenience:

- Cardno. 2021. Kerckhoff Hydroelectric Project Stage-Discharge Investigation. September 13, 2021.
- Pacific Gas and Electric Company (PG&E). 2023. Second Supplemental Information Filing in Support of Final Application for New License, FERC Project No. 96-048. March 31. [includes Appendix B, Operations Simulation Model]
- Pacific Gas and Electric Company (PG&E). 2025a. Kerckhoff Project ResSim Model – No Action 15-minute LTOR inflow. HEC-ResSim Model Files.

- Pacific Gas and Electric Company (PG&E). 2025b. PGE_Supplemental_FLA_15Min_Model. HEC-ResSim Model Files.
- United States Department of the Interior (DOI). 2024. Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions on the Federal Energy Regulatory Commission Ready for Environmental Analysis Notice for the Kerckhoff Hydroelectric Project, Federal Energy Regulatory Commission Project No. P-96-048, San Joaquin River, Fresno and Madera Counties, California. United States Department of the Interior, September 24, 2024.
- United States Department of the Interior (DOI). 2025. Revised Conditions and Recommendations for the Kerckhoff Hydroelectric Project, Federal Energy Regulatory Commission Project No. P-96-048, San Joaquin River, Fresno and Madera Counties, California. United States Department of the Interior, May 11, 2025.

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Appendix A Storage Presented in Monthly Minima, Averages, and Maxima

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Operations Modeling Report-Final_Rev4.docx

ACRONYMS AND ABBREVIATIONS

A

AA	Above Average
Applicant	Pacific Gas and Electric Company

B

BA	Below Average
BLM	United States Bureau of Land Management

C

CEQA	California Environmental Quality Act
cfs	cubic feet per second

D

DLA	Draft License Application
DOI	United States Department of the Interior

F

FERC	Federal Energy Regulatory Commission
FLA	Final License Application
FPA	Federal Power Act

G

guide curve	A seasonal rule that shows the preferred target water levels in a reservoir throughout the year to balance hydropower, environmental, and societal needs. It provides operators with a reference line for when to store water and when to release it during changing hydrologic conditions
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H

HEC	Hydrologic Engineering Center
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K

K1	Kerckhoff 1 (Powerhouse)
K2	Kerckhoff 2 (Powerhouse)

L

LTOR	Long-term Operating Rules
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Table of Contents (Cont'd)

M

MIF	minimum instream flow
Modified EOS Flow Recession	Modified End-of-Spill Flow Recession and Whitewater Releases
msl	above mean sea level

P

PBR	Project Bypass Reach
PG&E	Pacific Gas and Electric Company
POM	Planned Outage Measure

R

rating curve	A relationship between a hydraulic structure's capacity to pass flow and water surface elevation
REA	Notice of Application Accepted for Filing, Soliciting Motions to Intervene and Protests, Ready for Environmental Analysis and Soliciting Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions
ResSim	Reservoir Simulation Software
ROZ	rough operating zone

S

SCE	Southern California Edison
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U

USGS	United States Geological Survey
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W

WY	Water Year
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1.0 INTRODUCTION

In November 2020, Pacific Gas and Electric Company (PG&E or Applicant) filed a new license application for the Kerckhoff Hydroelectric Project (Federal Energy Regulatory Commission [FERC] No. 96-048). In response, FERC published “Notice of Application Accepted for Filing, Soliciting Motions to Intervene and Protests, Ready for Environmental Analysis and Soliciting Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions” (REA) in June 2024. This led to a review by the United States Department of the Interior (DOI), which included participation from the United States Fish and Wildlife Service, United States Bureau of Land Management (BLM), United States National Park Service, and United States Bureau of Reclamation. The review and the subsequent comments, recommendations, preliminary terms and conditions, and preliminary fishway prescription for operation of the Kerckhoff Hydroelectric Project based on Section 4(e), 10(j), 10(a), and 18 Authorities are included in a document provided by the DOI on September 24, 2024 (DOI 2024). A follow-up document provides revisions to Section 4(e) and 10(a) recommendations (DOI 2025).

This report discusses the development and evaluation of two new operations alternatives in PG&E’s existing United States Army Corps of Engineers Hydrologic Engineering Center’s (HEC) Reservoir Simulation Software (ResSim) Operations Model. While there are several recommendations provided in the original and revised documents, two recommendations are applicable to the Operations Model and would be implemented:

- BLM Federal Power Act (FPA) Section 4(e) Condition No. 4 – Passage of Southern California Edison’s (SCE) Long-term Operating Rules (LTOR) flows through the Kerckhoff Bypass Reach of the San Joaquin River (Project Bypass Reach, or PBR) (Condition 4)
- Modified BLM FPA Section 4(e) Condition No. 5 –Alternative 1 Ramp Up Measure

These two conditions make up Alternative 1, implemented into the ResSim Operations Model for the Kerckhoff Hydroelectric Project for comparison to existing conditions.

The revisions to these two conditions, as presented in DOI (2025), make up Alternative 2, also implemented into the ResSim Operations Model for the Kerckhoff Hydroelectric Project for comparison to existing conditions and Alternative 1. The following operational

rules that satisfy both California Environmental Quality Act (CEQA) Alternative 1 and CEQA Alternative 2 are discussed in detail in the succeeding sections.

- **CEQA Alternative 1**

- *BLM FPA Section 4(e) Condition No. 4 – Passage of Southern California Edison’s (SCE) Long-term Operating Rules (LTOR) flows through the Kerckhoff Bypass Reach of the San Joaquin River (Condition 4)*
 - Spill Year Schedule Boating Flows and Down Ramping of Spill Flows – Spill Year Schedules A or B Low Storage (AB), B High Storage or C (BC), and D.
 - Non-Spill Year Boating Flows and Down Ramping
 - Stranding Protection Down Ramping
 - September – October Down Ramp
- *Modified BLM FPA Section 4(e) Condition No. 5 – Alternative 1 Ramp Up Measure*
 - Alternative 1 Ramp Up

- **CEQA Alternative 2**

- *BLM FPA Section 4(e) Condition No. 4 (Condition 4 – Revised)*
 - Modified End-of-Spill Flow Recession and Whitewater Flow Releases Measure (Modified EOS Flow Recession)
 - Subsequent Spill Ramp Down Measure
- *BLM FPA Section 4(e) Revised Condition No. 5 – Deterrence Flows for Protection of Public Safety and Aquatic Life (Condition 5 – Revised)*
 - Modified Spill Season Flow Measure
 - Modified Planned Outage Measure (POM)

2.0 EXISTING CONDITIONS OPERATIONS MODEL

PG&E's Operations Model for the existing Kerckhoff Hydroelectric Project (FERC No. 96-048) (Kerckhoff Hydroelectric Project) was developed with ResSim. The modeling domain spans from the upper end of Kerckhoff Reservoir to the Kerckhoff 2 (K2) Powerhouse discharge into the San Joaquin River.

The ResSim model is composed of several elements to describe the system connectivity as well as inflow and outflow points, routing reaches, and the reservoir. The reservoir contains both physical and operational data for the Kerckhoff Hydroelectric Project. This model is optimized for ResSim Version 3.3 and will not work with more recent versions of ResSim under its current configuration.

2.1 Model Schematic

The model is composed of several elements to describe the system connectivity as shown in Figure 2-1.

Inflows to the system are added at the San Joaquin River Inflow to Kerckhoff Reservoir Junction. Kerckhoff Reservoir is included as a reservoir element in the model. The reservoir element includes a capacity curve that describes the relationship between water surface elevation and storage/area. Evaporation is assigned to the reservoir element and is based on monthly averages in units of inches. Two diversions are included with the reservoir that divert controlled releases via tunnels to the Kerckhoff 1 (K1) and K2 powerhouses. The reservoir element also includes a dam, which consists of two outlets: a low-level outlet and a gated spillway. Rating curves are entered into the model to define the hydraulic capacity of each outlet.

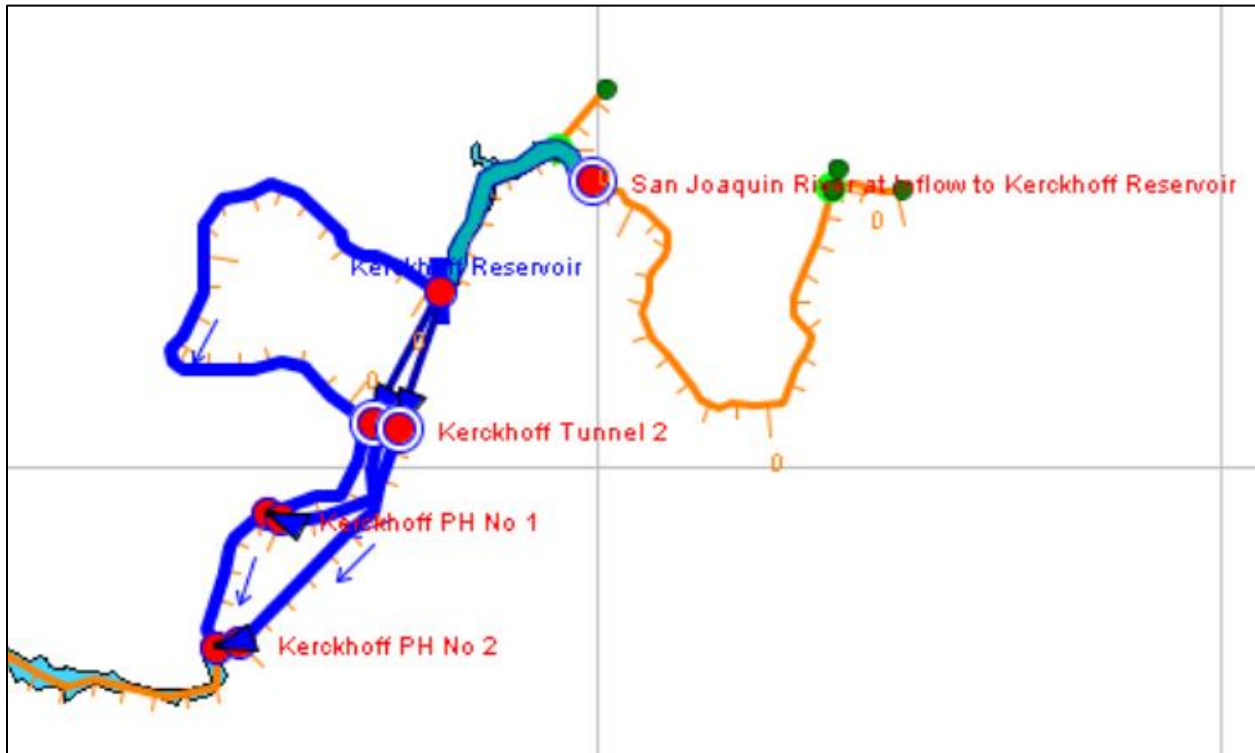


Figure 2-1 Model schematic.

The model includes the K1 Powerhouse, but that powerhouse is kept offline for all simulations to reflect the current offline status of K1 and K1's retirement for the purposes of power generation or diversion under the Proposed Project and Alternatives. The PBR from Kerckhoff Dam to the K2 Powerhouse discharge is also included as a routing reach but with Null Routing, meaning it is a pass-through reach assuming no travel time (i.e., inflow equals outflow for a given computational time step).

2.2 Hydrologic Data

The current configuration of the model includes 15-minute inflow data spanning Water Years (WYs) 2003 and 2005 through 2017. This inflow dataset is based on historical observed flows from the following sources. The following data were provided by PG&E in their Operations Model:

- SCE's Big Creek No. 4 Project (FERC No. 2017) at Dam 7 (Redinger Lake), United States Geological Survey (USGS) San Joaquin River above Willow Creek, near Auberry, California (USGS Gage No. 11242000), approximately seven miles upstream of Kerckhoff Reservoir

- Big Creek Powerhouse No. 4 near Auberry, California, USGS Gage No. 11246530, approximately one mile upstream of Kerckhoff Reservoir
- Willow Creek Mouth, USGS Gage No. 11246500, approximately six and a half miles upstream of Kerckhoff Reservoir
- San Joaquin A.G. Wishon Powerhouse near Auberry, California, USGS Gage No. 11246610, located at the headwaters of Kerckhoff Reservoir

The inflow data were adjusted to estimate what flow releases would have been under the LTOR prescription. These LTOR estimates were developed by PG&E for the existing Operations Model (PG&E 2023). The original 15-minute LTOR data included flows for WYs 2003 and 2005-2017 (PG&E 2023). For WY 2004, 15-minute data were not available. However, the existing conditions Operations Model provided by PG&E (PG&E 2025a) did have a complete 15-minute inflow record from WYs 2003-2017, but WY 2004 is contained in the modeling simulation only for continuity in the modeling simulation and was omitted from analysis.

The inflow data indicate many instances of sudden and significant drops in flow over a single time step (flow dips). An example of this is shown in Figure 2-2 over a three-day period in July 2005. However, these flow dips occurred frequently throughout the LTOR dataset. They are characterized by drops in flow data, sometimes as much as 2,000 cfs or more over a 15-minute time step. The cause of this anomaly is unknown, but it is likely either measurement error or an artifact of the modeling software used to compute the LTOR flows. It is highly unlikely that upstream projects release flows in this way. Fortunately for the modeling effort discussed in this report, their effect on reservoir levels and spill at Kerckhoff Dam is minimal, most notably because the duration of these flow dips is so short (15 minutes).

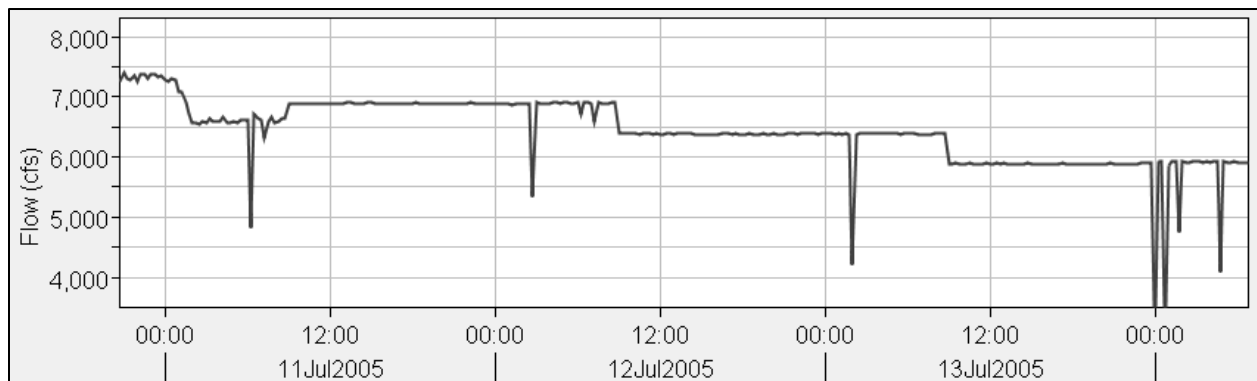


Figure 2-2 Example of flow dips in the LTOR inflow dataset.

2.3 Reservoir Operations Data

The primary function of a ResSim model is the ability to simulate operations at a reservoir through period of record flows. There are several operational rules implemented into the Kerckhoff Reservoir element in the current model configuration that simulate the existing conditions that Kerckhoff Reservoir operates within. This is referred to as the “No Project Alternative,” and in the ResSim model it is named “Generic PH Outages,” which represents existing conditions.

2.3.1 Zones

Three zones are defined for Kerckhoff Reservoir in the model: Inactive, Conservation, and Flood Control. These zones allow the specification of different rules for different operational pool level ranges. Inactive typically refers to the pool elevation below which any kind of operation is not possible (i.e., below the lowest operable discharge outlet). Conservation represents the pool elevation range where normal operations apply. Flood control represents the pool elevation range where operations specific to common flood events apply. The Operations Model uses a duplicate set of operational rules for both the Conservation zone and the Flood Control zone. The model is built to attempt to maintain the Kerckhoff Reservoir within the Conservation zone, which is between 980 feet and 984.5 feet above mean sea level (msl). Physical constraints can interrupt operational rules when near the boundaries of the Conservation zone. Examples include if an operation directs a certain amount of spill discharge but the pool elevation is so low it physically cannot discharge that amount of spill, or if an operation directs a small amount of spill but the inflow to the reservoir is so large that a project must spill more to prevent exceeding the Flood Control zone. These are both common reasons prescriptive operations can be overridden during the simulation and happens for both the No Project Alternative and the two CEQA Alternatives.

2.3.2 Operational Rules

The following operation rules are implemented for the No Project Alternative in the current ResSim model based on conditions implemented through current FERC licenses and other standard operational procedures. The rules are listed here in order of priority, meaning if during the simulation there is a conflict between actions taken by two or more rules, the highest priority rule would take precedence over the others. The rules and priority order below were implemented by PG&E into their existing Operations Model utilized for this modeling effort and were not changed.

1. Minimum Instream Flow (MIF) Requirements Below Kerckhoff Dam
2. American Shad (*Alosa sapidissima*) Spawning Flow Releases
3. 1980 Fishery Agreement for Smallmouth Bass (*Micropterus dolomieu*) Water Temperature Releases
4. K2 Powerhouse Derating
5. Powerhouse Maintenance Outages
6. K2 Powerhouse Constraints

Implementation of these conditions as rules in the ResSim model is described in the following sections. Detailed descriptions of these conditions have been provided in Appendix B (“Operations Simulation Model”) of the March 2023 Final License Application (FLA) (PG&E 2023).

2.3.2.1 Minimum Instream Flow Requirements Below Kerckhoff Dam

This condition follows the MIF requirements regulated under the Kerckhoff Hydroelectric Project’s current FERC license. This rule separates a given WY into two categories: Normal and Dry. A Dry WY is defined as a year with a forecasted April through July inflow to Millerton Lake that is less than or equal to 45 percent of the average April to July inflow to Millerton Lake. For a Normal WY, Kerckhoff Reservoir would release a minimum of 25 cubic feet per second (cfs) to the San Joaquin River at all times for that WY. For a Dry WY, Kerckhoff Reservoir would release a minimum of 15 cfs to the San Joaquin River at all times for that WY. The model is set to “over-release” 4.5 cfs in Dry WYs and 7.5 cfs in Normal WYs to match releases that are needed from the Kerckhoff Hydroelectric Project in actual operations. Consequently, the model releases 32.5 cfs for Normal WYs and 19.5 cfs for Dry WYs.

This rule is implemented in the ResSim model using a time series (Location Name: **MIFR_TS**) of releases that was constructed to follow the historically designated WY Type. The time series implemented in the model indicates Normal conditions with an MIF release of 32.5 cfs throughout the 2003–2017 simulation except for the following periods, which were set to the Dry WY MIF release of 19.5 cfs:

- April 1, 2007 – January 31, 2008
- May 1, 2013 – January 31, 2016

This rule is titled "Minimum Flow below Kerckhoff Dam" in the model and is described in detail in Section 2.2.4.5 of Appendix B in the FLA (PG&E 2023).

- Notes:

The condition specifies the minimum release for an entire WY. It is unclear why the date ranges set for Dry releases do not follow WY dates.

2.3.2.2 American Shad Spawning Flow Releases

This condition requires a minimum flow release through either the K1 or K2 powerhouse from May 15 to June 30 as a function of the Millerton Lake elevation. Because the K1 Powerhouse is retired in the model, the releases are only implemented for the K2 Powerhouse. The following rule is applied:

- When the Millerton Lake elevation is at or above 545 feet msl, releases shall include:
 - 1,200 cfs from the K2 Powerhouse from 10 p.m. to 2 a.m.
 - 775 cfs from the K2 Powerhouse all other hours
- When the Millerton Lake elevation is below 545 feet msl, releases shall include:
 - 775 from the K2 Powerhouse from 10 p.m. to 2 a.m.
 - 400 cfs from the K2 Powerhouse all other hours

A 2015 American Shad spawning flow release variance was granted and is included in the model, so for WY 2015, no attempt is made by the model to meet these flow requirements.

This rule is implemented in the ResSim model using a time series of flow releases at the K2 Powerhouse based on historical required releases for American Shad (Location Name: **SHAD_Req_Flow**).

This rule is titled "1993 Shad Order" in the model and is described in detail in Section 2.2.4.6 of Appendix B in the FLA (PG&E 2023).

- Notes:

When the Millerton Lake elevation is less than 545 feet msl, the condition requires a minimum of 400 cfs be released from 2 a.m. to 10 p.m. However, the model is set to a minimum release of 580 cfs under this scenario. This is because the K2 Powerhouse has a minimum flow requirement of 580 cfs to operate. If the minimum American Shad requirement is less than 580, then this operation rule step-increases to 580 cfs to meet the minimum K2 operational requirement.

2.3.2.3 1980 Fishery Agreement for Smallmouth Bass Water Temperature Releases

This condition requires stream temperatures in the San Joaquin River upstream of the K1 Powerhouse to be at or below 27 degrees Celsius (81 degrees Fahrenheit). Instead of implementing temperature modeling measures, PG&E developed a “rule of thumb” that relates temperature to a minimum flow release from Kerckhoff Dam. Through an analysis of historic water temperature and stream flow data, PG&E estimated that a minimum of 50 cfs is required throughout the month of July in Dry WYs to meet this requirement. From WYs 2003 to 2012, there was only one designated Dry WY (2007) when the minimum 50 cfs was required. From WYs 2013 to 2016, summer stream gage data were used for water temperature releases to meet the Fishery Agreement for those years in place of the rule-of-thumb 50 cfs minimum flow. Minimum flow releases ranged from 18 cfs to 50 cfs for the months of June, July, and August for those years (PG&E 2023).

This rule is implemented in the ResSim model using a time series of flow releases at Kerckhoff Dam based on water temperature minimum flow requirements (Location Name: **Water_Temp_Reqs**).

This rule is titled “Dry Year Release for Water Temp” in the model and is described in detail in Section 2.2.4.7 of Appendix B in the FLA (PG&E 2023).

- Notes:

While Appendix B (PG&E 2023) indicates that summer stream gage data for water temperature releases were used in place of the 50 cfs rule of thumb for WYs 2013 to 2016, the model appears to use this method for WY 2012 also.

2.3.2.4 K2 Powerhouse Derating

This condition represents a constraint on powerhouse operations for the K2 Powerhouse based on the Millerton Reservoir elevation. Millerton Reservoir high pool elevations create a high tailwater condition at the K2 Powerhouse, which interferes with operation of the powerhouse at high throughput levels. A relationship between the Millerton Reservoir elevation and the maximum flow release from the K2 Powerhouse was developed by PG&E and is implemented in the model.

This rule is implemented in the ResSim model using a time series of maximum flow releases at the K2 Powerhouse based on the Millerton Reservoir elevation (Location Name: **Millerton Elevation**).

This rule is titled "Millerton WSE Derating" in the model and is described in detail in Section 2.2.4.4 of Appendix B in the FLA (PG&E 2023).

2.3.2.5 Powerhouse Maintenance Outages

Each fall, the K2 Powerhouse goes down for maintenance. The start date, length, and frequency of maintenance outage is shown in Table 2-1.

Table 2-1 K2 Powerhouse outage schedule.

Maintenance Outage	Start Date	Outage Length (days)	Occurrence
Regular Annual Maintenance Outage	October 23	20	Every year
Extended Outage	October 23	75	Every 4 years
Turbine Work Outage	October 23	150	Every 15 years

This rule is implemented in the ResSim model using a time series of maximum flow releases at the K2 Powerhouse based on maintenance outage flows (Location Name: **K2_Generic_Maintenance_Outage**). In summary, the maximum flow in the time series is set to 5,100 cfs but brought to 0 cfs during the outage periods shown in Table 2-1.

This rule is titled "K2 Generic Outage" in the model and is described in detail in Section 2.2.4.3 of Appendix B in the FLA (PG&E 2023).

2.3.2.6 K2 Powerhouse Constraints

This condition represents constraints on powerhouse operations for the K2 Powerhouse as follows:

- K2 Minimum Operation Flow. A minimum flow of 580 cfs is required to operate the K2 Powerhouse. When inflow to the reservoir is not sufficient to meet higher priority demands with at least 580 cfs left for the K2 Powerhouse, then it will shut down
- K2 Rough Operating Zone. The K2 Powerhouse has a flow range of 1,744 cfs to 3,117 cfs that causes excessive wear to equipment. The model is set up to avoid operating the K2 Powerhouse with between 1,744 cfs and 3,117 cfs

- K2 Start and Stop Limitation. The K2 Powerhouse is limited to two stops and restarts per day
- K2 Powerhouse Derating. This is discussed in Section 2.3.2.4 and implemented as its own rule set

This rule is implemented in the ResSim model using a time series of flow releases to Tunnel No. 2 using a series of If-Else-Then conditionals following the prescription in Table 2-2. Implementing the powerhouse operations into the model is complicated and broken up into two separate rules called "K2 Generation Limits 2" and "K2 Generation Limits," ordered in that priority. This is discussed in greater detail in Section 2.2.4.4 of Appendix B in the FLA (PG&E 2023).

Table 2-2 Modeled K2 Powerhouse constraints.

Rule Priority	Modified Inflow¹	Reservoir Elevation	K2 Powerhouse Flow
1	<580	>=984	580 cfs
2	<580	<981.5	0 cfs
3	<580	>981 and <984	Equal to the K2 Powerhouse flow in the last time-step
4	>=1,744 and <3,117	>=984	3,117 cfs
5	>=1,744 and <3,117	<984	1,744 cfs
6	Otherwise		Equal to Modified Inflow ²

^{1.} Modified Inflow is equal to the reservoir inflow minus minimum flows (*including 1980 Fishery Agreement for Smallmouth Bass Water Temperature Release*) below Kerckhoff Dam.

^{2.} Up to the maximum flow or derated flow depending upon Millerton Lake elevation.

2.3.2.7 Meteorological Data

The only meteorological data included in the model are evaporation data at Kerckhoff Reservoir. Evaporation is included as monthly totals (in inches), applied to each WY for the length of the simulation. The evaporation totals are shown in Table 2-3.

Table 2-3 Evaporation totals.

Month	Evaporation (inches)
January	1.30
February	1.30
March	2.70
April	4.30
May	6.10
June	8.90

Month	Evaporation (inches)
July	10.90
August	10.00
September	8.30
October	5.70
November	2.80
December	1.70

3.0 PROPOSED CEQA ADDITIONS TO PG&E'S OPERATIONS MODEL FOR EXISTING CONDITIONS

3.1 CEQA Alternative 1 Implementation

Alternative 1 consists of the original BLM 4(e) Conditions 4 (DOI 2024) and Alternative 1 Ramp Up Measure.

3.1.1 2024 BLM 4(e) Condition 4 – Spill Year Schedule Boating Flows and Down Ramping of Spill Flows

Condition 4 fully replaces PG&E's proposed EOS Flow Recession Measure and the Subsequent Spill Ramp Down Measure. It also replaces the down ramping components of PG&E's proposed Spill Season Flow Measure. Neither of these proposed operations are included in the existing conditions operations model. Condition 4 also uses LTOR flows and incorporates the following features:

- Varied length of down ramping from spill based on WY Type
 - Wetter years have a longer down ramping schedule than drier years
 - Variation allows down ramping of spills to better mimic the natural hydrograph while also providing whitewater boating opportunities
 - Variation reduces potential of fish stranding occurrences
- "Spill Year" Type as identified by SCE; notification given no later than May 1 each year
- WY Type schedules

The WY Type schedules are defined in Table 3-1.

Table 3-1 WY Type schedules.

Schedule	Criteria
A	April Forecast of Friant Natural Runoff during April-July not more than 650,000 acre-feet
B (Low Storage)	April Forecast of Friant Natural Runoff during April-July more than 650,000 acre-feet and WY Forecast Runoff not more than 1,200,000 acre-feet, with a September aggregate storage requirement less than 325,000 acre-feet
B (High Storage)	April Forecast of Friant Natural Runoff during April-July more than 650,000 acre-feet and WY Forecast Runoff not more than 1,200,000 acre-feet, with a

Schedule	Criteria
	September aggregate storage requirement greater than or equal to 325,000 acre-feet
C	April Forecast of Friant Natural Runoff during WY more than 1,200,000 acre-feet but not more than 1,600,000 acre-feet
D	April Forecast of Friant Natural Runoff during WY more than 1,600,000 acre-feet

3.1.1.1 Water Year Type

Implementation of this alternative first requires the definition of the WY Type, which is based on the April Forecast of Friant Runoff, WY Forecast Runoff, and SCE’s September aggregate storage requirement. The WY type designation under this schedule would be provided to PG&E by SCE no later than May 1 each year. For the purpose of model implementation, the WY Type is based on historic runoff over the period of record flows. Once the WY Type is established for a given WY, that WY is assigned to one of three ramp down schedules:

- Schedule A or B Low Storage (AB)
- Schedule B (High Storage) or C (BC)
- Schedule D

WY Types for the period of record (2003–2017) were provided by SCE in a presentation slide deck from April 25, 2018, and are shown in Table 3-2.

Table 3-2 WY Types by year, A-D classification.

WY	WY Type	WY	WY Type
2003	C	2011	D
2005	D	2012	No Spill
2006	D	2013	No Spill
2007	No Spill	2014	No Spill
2008	B-Low	2015	No Spill
2009	C	2016	C
2010	D	2017	D

3.1.1.2 Spill Year Schedule Boating Flows and Down Ramping of Spill Flows

From May 1 to August 31 of each WY, the following down ramping schedule is implemented for the declining limb of spill(s) after SCE has identified when they will start

down ramping of spill flows and while there is still sufficient water available¹ to meet the respective schedule’s requirements. Implementation of the down ramping schedules is accomplished in the model using operational conditionals and rules scripting. Scripting allows for the complexity required by the down ramping schedules. Table 3-3, Table 3-4, and Table 3-5 provide examples of Schedule D, Schedule C or B (High Storage), and Schedule B (Low Storage) or A, respectively.

Table 3-3 Schedule D.

Day 1	Maintain the flow within a range of 3,500–3,000 cfs
Day 2	Reduce the flow within a range of 3,000–2,500 cfs
Day 3	Reduce the flow within a range of 2,500–2,000 cfs
Day 8	Reduce the flow within a range of 2,000–1,600 cfs
Day 10	Reduce the flow within a range of 1,600–1,300 cfs
Day 12	Reduce the flow within a range of 1,300–1,000 cfs
Day 14	Reduce the flow within a range of 1,000–750 cfs
Day 16	Reduce the flow within a range of 750–500 cfs
Day 18	Reduce the flow within a range of 500–250 cfs
Day 20	Reduce the flow within a range of 250–100 cfs
Day 21	Reduce the flow within a range of 100 cfs – MIF

Table 3-4 Schedule B (High Storage) or C (BC).

Day 1	Maintain the flow within a range of 3,500–3,000 cfs
Day 2	Reduce the flow within a range of 3,000–2,500 cfs
Day 3	Reduce the flow within a range of 2,500–2,000 cfs
Day 5	Reduce the flow within a range of 2,000–1,600 cfs
Day 6	At 6 p.m., reduce the flow within a range of 1,600–1,200 cfs
Day 7	At 2 a.m., reduce the flow within a range of 1,200–800 cfs
Day 7	At 12 p.m., reduce the flow within a range of 800–600 cfs
Day 7	At 5 p.m., reduce the flow within a range of 600–400 cfs
Day 7	At 10 p.m., reduce the flow within a range of 400–200 cfs
Day 8	At 3 a.m., reduce the flow within a range of 200 cfs – MIF

Table 3-5 Schedule A or B (Low Storage) (AB).

Day 1	Maintain the flow within a range of 2,500–2,000 cfs
Day 3	At 6 p.m., reduce the flow within a range of 2,000–1,600 cfs
Day 4	At 2 a.m., reduce the flow within a range of 1,600–1,200 cfs
Day 4	At 12 p.m., reduce the flow within a range of 1,200–800 cfs

¹ Sufficient water availability is dependent on combined accessible volume of water from inflow and storage within Kerckhoff Reservoir.

Day 4	At 5 p.m., reduce the flow within a range of 800–600 cfs
Day 4	At 10 p.m., reduce the flow within a range of 600–400 cfs
Day 5	At 3 a.m., reduce the flow within a range of 400–200 cfs
Day 5	At 8 a.m., reduce the flow within a range of 200 cfs – MIF

3.1.1.3 Non-Spill Year Boating Flows and Down Ramping

Between May 15 and June 15 of a non-spill year that begins on a Saturday, the Applicant must provide scheduled boating flows and a gradual ramp down. These flows are based on the Applicant’s forecast of water availability. The Applicant must give 10 days’ advance notice per the Whitewater Notification and Access Measure. Water is released from Kerckhoff Dam for two days of whitewater boating, from 9 a.m. to 6 p.m. each day. On the first day, target flows range from 2,500 to 2,000 cfs, and on the second day from 2,000 to 1,600 cfs. After the second day, flows ramp down to the minimum instream flow. The boating flow and ramp down schedule will follow the Non-Spill Year Boating Flows and Down Ramping schedule in Table 3-6:

Table 3-6 Non-Spill Year Boating Flows and Down Ramping schedule.

Day 0	Flows ramped up to the Day 1 release level during the night, before 9 a.m.
Day 1	At 9 a.m., maintain the flow within an hourly avg. range of 2,500-2,000 cfs
Day 1	After min. 9 hours, reduce flow within an hourly avg. range of 2,000-1,600 cfs
Day 2	After min. 24 hours, reduce flow within an hourly avg. range of 1,600-1,200 cfs
Day 3	After min. 10 hours, reduce flow within an hourly avg. range of 1,200-800 cfs
Day 3	After min. 5 hours, reduce flow within an hourly avg. range of 800-600 cfs
Day 3	After min. 5 hours, reduce flow within an hourly avg. range of 600-400 cfs
Day 3	After min. 5 hours, reduce flow within an hourly avg. range of 400-200 cfs

3.1.1.4 Stranding Protection Down Ramping

From May 1 to August 31, the Applicant must begin reducing spill flows from Kerckhoff Dam once the average daily flow drops below 1,600 cfs, following the Stranding Protection Down Ramping schedule (Table 3-7). The Applicant should make a good faith effort to start this reduction before average hourly flows fall below 1,200 cfs.

Table 3-7 Stranding Protection Down Ramping schedule.

Step 1	Maintain flow within a range of 1,600–1,200 cfs for 10 hours
Step 2	Reduce the flow within a range of 1,200–800 cfs for 10 hours
Step 3	Reduce the flow within a range of 800–600 cfs for 5 hours
Step 4	Reduce the flow within a range of 600–400 cfs for 5 hours
Step 5	Reduce the flow within a range of 400–200 cfs for 5 hours

Step 6	Reduce the flow within a range of 200 cfs – MIF
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3.1.1.5 September – October Down Ramp

From September 1 to October 31 in all WY Types, once average daily flow declines below 1,600 cfs, the down ramping schedule in Table 3-8 is implemented:

Table 3-8 September 1 to October 31 down ramping schedule.

Step 1	Maintain flow within a range of 1,600–1,200 cfs for 2 hours
Step 2	Reduce the flow within a range of 1,200–800 cfs for 2 hours
Step 3	Reduce the flow within a range of 800–600 cfs for 2 hours
Step 4	Reduce the flow within a range of 600–400 cfs for 2 hours
Step 5	Reduce the flow within a range of 400–200 cfs for 2 hours
Step 6	Reduce the flow within a range of 200 cfs – MIF

3.1.2 Modified BLM 4(e) Condition 5 – Alternative 1 Ramp Up Measure

The Modified 2024 BLM 4(e) Condition 5 (Alternative 1 Ramp Up Measure) replaces the ramp up components of PG&E’s proposed Spill Season Flow Measure and POM. It puts limits on the rate increase of stage as measured at Gage J-2:

- Gage J-2:² A maximum stage change of 1 foot or less per hour for inflows between MIF and 4,000 cfs, provided there is sufficient³ storage and powerhouse capacity to meet this requirement

Gage J-2 is located within the PBR. This reach is implemented as a null routing reach, meaning the flow at Gage J-2 is assumed equal to the flows leaving Kerckhoff Dam (combined spill flow and low-level outflow flow). However, the model tracks flow through routing reaches, not stage. To fulfill the stage limit component of Alternative 1 Ramp Up Measure, a rating curve is required to establish a relationship between stage and flow. A rating curve was developed using historic gage data provided at Gage J-2 (USGS Gage No. 11246700) and is presented in Figure 3-1. The best fit curve follows this equation:

$$Q(H) = 49.3297(H-4.1169)^{2.2921}$$

²Gage J-2 is owned and operated by PG&E, with its location being approximately a half mile downstream of Kerckhoff Dam (USGS Gage No. 11246700).

³ Sufficient storage and powerhouse capacity is dependent on combined volume of water from inflow and storage within Kerckhoff Reservoir and flow through the K2 Powerhouse.

Where Q(H) is discharge and H is stage. This allows the script written for Alternative 1 Ramp Up Measure to limit the increase in spill discharge to maintain no more than one foot of rise at Gage J-2.

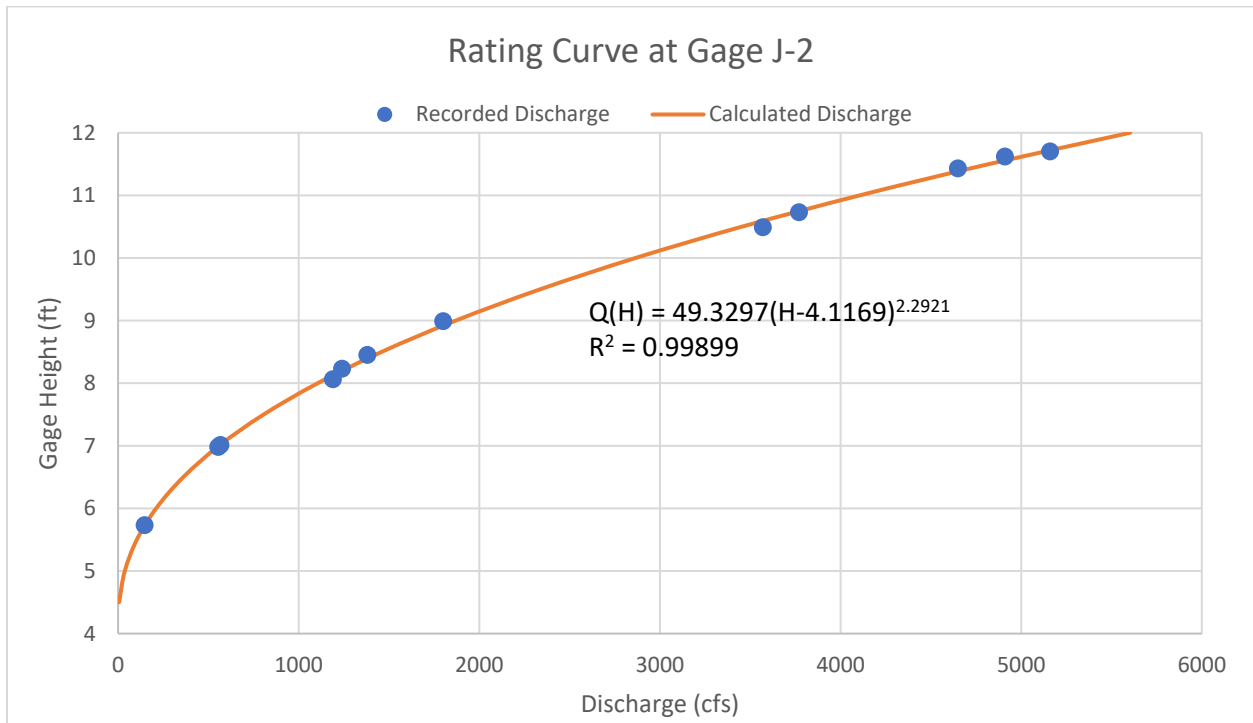


Figure 3-1 Gage J-2 rating curve.

3.2 CEQA Alternative 2 Implementation

Alternative 2 includes revisions to the implementation of Conditions 4 and 5 as described in DOI (2025) and presented in the following sections.

3.2.1 2025 Revised BLM 4(e) Condition 4 - Modified EOS Flow Recession

The 2025 revised BLM 4(e) Condition 4 replaces the original 2024 BLM 4(e) Condition 4 by implementing the Modified EOS Flow Recession Measure and the original PG&E Subsequent Spill Ramp Down Measure as presented in Appendices 3 and 4 of DOI (2025).

For Alternative 2, WYs are categorized into Above Average (AA) and Below Average (BA) based on the following criteria presented in Table 3-9:

Table 3-9 WY description for implementation of Condition 4 (Revised).

Schedule	Criteria
Above Average (AA)	April 1 forecast of San Joaquin River below Friant Unimpaired Runoff during April-July is predicted to be equal to or more than 1,200,000 acre-feet based on publication in Department of Water Resources Bulletin B120 or future equivalent. If the May 1 forecast alters the below Friant Unimpaired Runoff during April-July to a different WY classification, that WY classification would be used as soon as feasible following its publication.
Below Average (BA)	April 1 forecast of San Joaquin River below Friant Unimpaired Runoff during April-July is predicted to be less than 1,200,000 acre-feet based on publication in Department of Water Resources Bulletin B120 or future equivalent. If the May 1 forecast alters the below Friant Unimpaired Runoff during April-July to a different WY classification, that WY classification would be used as soon as feasible following its publication.

WY Types for the period of record (2003–2017) were provided by PG&E and are presented in Table 3-10:

Table 3-10 WY Types by year, AA-BA classification.

WY	WY Type	WY	WY Type
2003	BA	2011	AA
2005	AA	2012	BA
2006	AA	2013	BA
2007	BA	2014	BA
2008	BA	2015	BA
2009	BA	2016	BA
2010	AA	2017	AA

In the implementation of Modified EOS Flow Recession, the model will increase optimal whitewater boating opportunities and functional flows in AA years with the ramp down operational releases in Table 3-11:

Table 3-11 AA years down ramping schedule

Day 1 (9 a.m.)	2,500–2,000 cfs for minimum 9 hours, boating flow
Day 1 (6 p.m.)	2,000–1,600 cfs for minimum 48 hours, boating flow
Day 3 (6 p.m.)	1,600–1,200 cfs for minimum 10 hours, ramp down
Day 4 (4 a.m.)	1,200–800 cfs for minimum 5 hours
Day 4 (9 a.m.)	800–600 cfs for minimum 5 hours
Day 4 (2 p.m.)	600–400 cfs for minimum 5 hours
Day 4 (7 p.m.)	400–200 cfs for minimum 5 hours
Day 5 (12 a.m.)	200 cfs – MIF

For BA years, the ramp down operational releases in Table 3-12 will be followed:

Table 3-12 BA years down ramping schedule

Day 1 (9 a.m.)	2,500–2,000 cfs for minimum 9 hours, boating flow
Day 1 (6 p.m.)	2,000–1,600 cfs for minimum 24 hours, boating flow
Day 2 (6 p.m.)	1,600–1,200 cfs for minimum 10 hours, ramp down
Day 3 (4 a.m.)	1,200–800 cfs for minimum 5 hours
Day 3 (9 a.m.)	800–600 cfs for minimum 5 hours
Day 3 (2 p.m.)	600–400 cfs for minimum 5 hours
Day 3 (7 p.m.)	400–200 cfs for minimum 5 hours
Day 4 (12 a.m.)	200 cfs – MIF

The Subsequent Spill Ramp Down schedule appears in Table 3-13:

Table 3-13 Subsequent Spill Ramp Down Measure releases.

Step 1	Maintain flow within a range of 1,600–1,200 cfs for 2 hours
Step 2	Reduce the flow within a range of 1,200–800 cfs for 2 hours
Step 3	Reduce the flow within a range of 800–600 cfs for 2 hours
Step 4	Reduce the flow within a range of 600–400 cfs for 2 hours
Step 5	Reduce the flow within a range of 400–200 cfs for 2 hours
Step 6	Reduce the flow within a range of 200 cfs – MIF

3.2.2 2025 Revised BLM 4(e) Condition 5

The 2025 revised BLM 4(e) Condition 5 replaces the modified BLM (4(e) Condition 5 (Alternative 1 Ramp Up Measure) by implementing the Modified Spill Season Flow Measure and the POM as presented in Appendices 1 and 2 of DOI (2025). Condition 5 (Revised) uses the same WY designation as Condition 4 (Revised) as presented in Table 3-9 The 2025 revised BLM 4(e) Condition 5 Down Ramping schedule includes its own set of conditions to maintain compliance during down ramping. These conditions are described in detail in Appendices 1 and 2 of DOI (2025). The conditions will be implemented using a combination of rules conditionals and Jython scripting as needed.

3.2.2.1 Modified Spill Season Flow Measure

Schedule AA:

When sustained spills measured at Gage J-2 are 1,000 cfs⁴ or more for at least 5 hours of continuous duration and neither the Modified EOS Flow Recession Measure nor the

⁴ Flows are expressed as hourly average flows unless otherwise specified.

Subsequent Spill Ramp Down Measure is being implemented, subject to sufficient water availability,⁵ the model will initiate the protocol prior to average hourly flow declining below 800 cfs. Flows (Appendix 1 of DOI 2025) will be released as shown in Table 3-14:

Table 3-14 AA years down ramping schedule – Modified Spill Season Flow Measure.

Step 1	Maintain hourly average flow within a range of 1,200–800 cfs for a minimum of 4 hours
Step 2	Reduce the flow within a range of 600–400 cfs for 4 hours
Step 3	Reduce the flow within a range of 400–200 cfs for 4 hours
Step 4	Reduce the flow within a range of 200 cfs – MIF

Schedule BA:

When sustained spills measured at Gage J-2 are 500 cfs or more for at least 5 hours of continuous duration and neither the Modified EOS Flow Recession Measure nor the Subsequent Spill Ramp Down Measure is being implemented, the model will initiate the protocol prior to average hourly flow declining below 400 cfs. Flows will be released as shown in Table 3-15:

Table 3-15 BA years down ramping schedule – Modified Spill Season Flow Measure.

Step 1	Maintain hourly average flow within a range of 600–400 cfs for a minimum of 4 hours
Step 2	Reduce the flow within a range of 400–200 cfs for 4 hours
Step 3	Reduce the flow within a range of 200 cfs – MIF

Both Schedules AA and BA are predicated on sufficient water availability.

3.2.2.2 Modified Planned Outage Measure

3.2.2.2.1 Planned Outage Measure Initial Release Protocol

At the initiation of a spill event that falls within a planned K2 Powerhouse outage, the initial spill would be released ahead of the inflow starting at 3:30 a.m., subject to sufficient water availability. The model mimics the ramp up rate to the spill flow exactly as it would

⁵ Sufficient water availability is dependent on combined accessible volume of water from inflow, storage within the normal operating range of Kerckhoff Reservoir, or current powerhouse diversions to complete the specified ramp down to minimum flow without decreasing below 980 feet msl water surface elevation in Kerckhoff Reservoir.

enter Kerckhoff Reservoir, only it shifts the initiation time to earlier in the day. To accomplish this in reality, an operator would have to base the 3:30 a.m. spill initiation on a forecast of incoming flows. This applies for spills expected to exceed a daily average flow of 1,000 cfs for AA WYs and 500 cfs for BA WYs.

3.2.2.2.2 Modified Planned Outage Measure Ramp Down

AA WYs:

When sustained spills measured at Gage J-2 are 1,000 cfs or more for at least 4 hours of continuous duration subject to sufficient water availability, PG&E shall release flows below Kerckhoff Dam as shown in Table 3-16:

Table 3-16 AA years down ramping schedule – POM.

Step 1	Maintain hourly average flow within a range of 1,200–800 cfs for as long as sufficient water is available
Step 2	Reduce the flow within a range of 600–400 cfs for minimum 4 hours
Step 3	Reduce the flow within a range of 400–200 cfs for minimum 4 hours
Step 4	Reduce the flow within a range of 200 cfs – MIF

BA WYs:

When sustained spills measured at Gage J-2 are 500 cfs or more for at least 4 hours of continuous duration subject to sufficient water availability, PG&E shall release flows below Kerckhoff Dam as shown in Table 3-17:

Table 3-17 BA years down ramping schedule – POM.

Step 1	Maintain hourly average flow within a range of 600–400 cfs for as long as sufficient water is available
Step 2	Reduce the flow within a range of 400–200 cfs for minimum 4 hours
Step 3	Reduce the flow within a range of 200 cfs – MIF

4.0 RESULTS

Operations modeling results from the period of record simulations are presented herein for the CEQA Alternatives 1 and 2.

4.1 CEQA Alternative 1 Results

4.1.1 2024 BLM 4(e) Condition 4

4.1.1.1 Spill Year Schedule Boating Flows and Down Ramping of Spill Flows

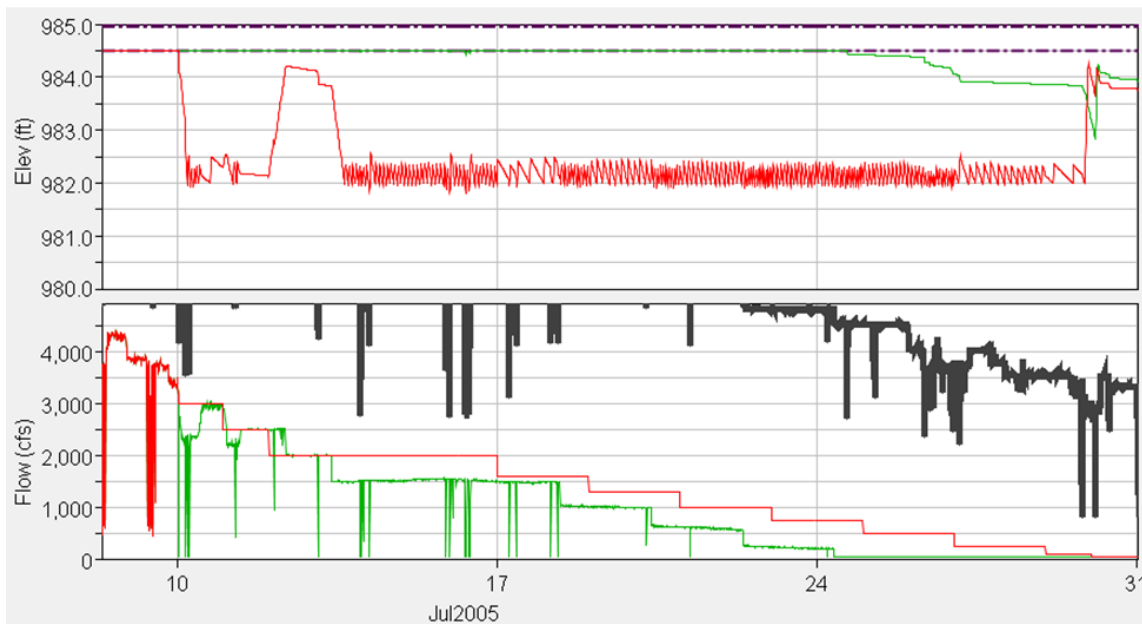
Standard down ramping for end of spills in WYs A, B (low storage), B (high storage), C, and D was implemented in the model for the period of record. The model demonstrated that for all WYs, the hydroelectric project is able to accommodate the prescribed Spill Year Schedule Boating Flows and Down Ramping of Spill Flows, including the extended boating flows. All schedules were completed successfully; however, the high starting flows and long step durations consistently caused the reservoir level to infringe on K2 Powerhouse operational constraints, built into the original PG&E Operations Model (PG&E 2025a). One such constraint is the minimum reservoir elevation for operating the K2 Powerhouse, which is 981.5 feet msl as described in Table 2.3 of Appendix B of the Second Supplemental Information Filing in Support of Final Application for New License (PG&E 2023). Other constraints also impose limitations on K2 operations as reservoir levels drop and depend on inflow rates, reservoir level, and other operational rules with higher priority. Furthermore, if the reservoir elevation drops to 981.5 feet msl or lower, the Kerckhoff Hydroelectric Project does not divert water into the K2 Powerhouse. The K2 Powerhouse operational constraints relative to the minimum operating reservoir elevation are collectively referred to in this report as the encroachment toward the K2 Powerhouse's minimum operating reservoir elevation. This encroachment caused frequent over-cycling of the K2 Powerhouse as the model attempted to both maintain the required spill flows and keep the reservoir above the minimum operating elevation of the K2 Powerhouse.

Figure 4-1 shows the major spill event in the summer of WY 2005, which begins around May 31 and terminates around June 16. The WY Type for WY 2005 is "D." The green lines represent existing conditions, the red lines represent Alternative 1 conditions (Spill Year Schedule Boating Flows and Down Ramping of Spill Flows), and the black line represents inflows to Kerckhoff Reservoir. This presents a common consequence of many of the down ramping schedules presented in this report, which is K2 Powerhouse cycling around the rough operating zone (ROZ). The ROZ is a range of flows (1,744 cfs to 3,117 cfs) for which

the turbine units would experience excessive wear, so the hydroelectric project avoids this range, as discussed in Section 2.3.2.6.

The Schedule D ramp down begins on July 10 and is able to follow Schedule D perfectly. However, notice once Schedule D begins that because the combination of spill flows and K2 Powerhouse flows exceed inflows to Kerckhoff Reservoir, the reservoir elevation drops very close to the K2 Powerhouse's minimum operating reservoir elevation of 980.0 feet msl. As the reservoir approaches the K2 Powerhouse's minimum operating reservoir elevation, in order to be able to maintain the Schedule D spill flows, the K2 Powerhouse cycles above and below the ROZ, while also trying to meet other K2 operational constraints, in an attempt to keep the reservoir high enough to stay above the minimum operating elevation for the K2 Powerhouse. The K2 Powerhouse cycling frequency is anywhere from half an hour to two hours, which likely represents an unrealistic operating scenario. Based on the documented operational constraints, any operation that requires K2 to dwell in the ROZ is considered infeasible due to excessive cavitation and vibration impacts and the associated maintenance and outage consequences. That means operating strategies that would require repeated short interval oscillations across the ROZ are not considered feasible, because they can increase cycling wear and raise reliability/maintenance risk even if each individual crossing is brief (personal email communication, J. Hartman and C. McCormick, March 5, 2026).

Therefore, while the spill is able to successfully complete Schedule D here, it is only able to do so under an unfeasible powerhouse operation. It is more likely that an operator would keep the K2 flows below the ROZ for the duration or at least a portion of the duration of the Schedule D ramp down, which would cause the reservoir to rise to guide curve, consequently prompting another spill event (possibly multiple additional spill events).



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-1 WY 2005 spill year schedule boating flows and down ramping of spill flows.

Throughout the period of record, Schedules AB and BC performed similarly to Schedule D. They were all implemented and completed successfully, in that they were able to follow the prescribed spill amounts and durations. However, like Schedule D, both Schedules AB and BC led to powerhouse over-cycling in almost every application, meaning the extended down ramp schedules described under Alternative 1 are unfeasible due to facility constraints.

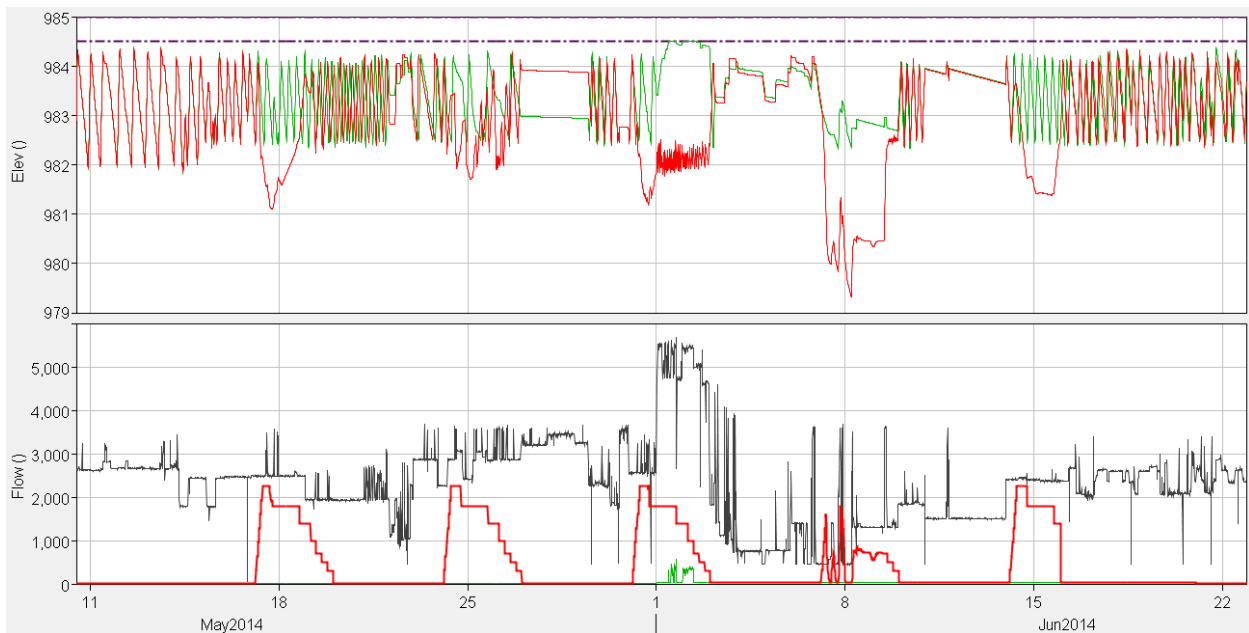
4.1.1.1 Assumptions

The following assumptions were incorporated into the Alternative 1 Condition 4 Spill Year Schedule Boating Flows and Down Ramping of Spill Flows Measure implementation to the model:

- To keep the model robust and repeatable for multiple WYs, a single discharge was selected for each step; in this case, the lowest discharge in the range presented in each step. For example, for Schedule D ramp down, the first step (Day 1) requires flows in the range of 3,500 cfs to 3,000 cfs. The model uses 3,000 cfs for this step. In reality, the operator would have flexibility to spill any amount between 3,000 cfs and 3,500 cfs
- The ramp down schedule is hard-wired into the rule script to better represent the decision an operator would make to initiate ramp down

4.1.1.2 Non-Spill Year Boating Flows and Down Ramping

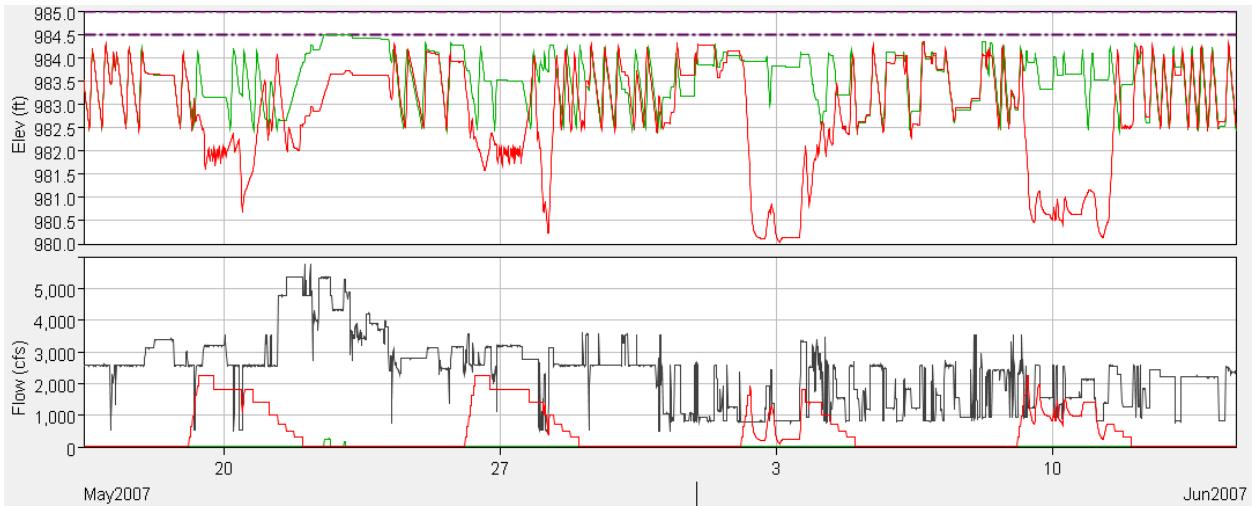
Within the period of record, non-spill years include WYs 2007, 2012, 2013, 2014, and 2015. The Non-Spill Year Boating Flows and Down Ramping schedule is attempted every weekend from May 15 to June 15 of non-spill years as shown in Table 3-6. Success of completing the Non-Spill Year Boating Flows and Down Ramping schedule varies and is primarily dependent on the volume of inflows coming into Kerckhoff Reservoir during the weekends. Figure 4-2 presents WY 2014, which is a non-spill year. In the upper plot, the green line represents existing conditions reservoir elevations. The red line represents Alternative 1 reservoir elevations. In the lower plot, the green line represents existing conditions spill to the PBR, the red line represents Alternative 1 spill, and the black line represents the inflow to Kerckhoff Reservoir. While WY 2014 is designated as a No Spill WY, there is sufficient inflow to support the full schedule for the first three weekends. Inflows to Kerckhoff Reservoir drop significantly by the fourth weekend, which results in lower pool elevation and poor and sporadic boating flows, and for the last weekend, boating flows are supported, but the ramp down schedule is cut short due to lack of available water.



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

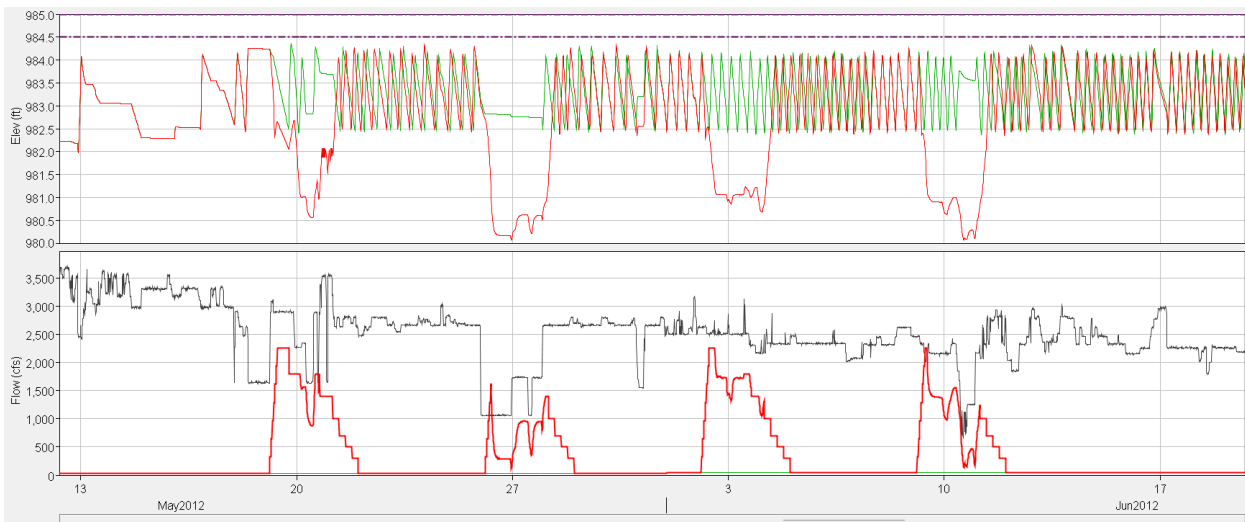
Figure 4-2 WY 2014 non-spill year boating flows and down ramping.

Observationally, WY 2014 had the most success in producing boating flows and a successful down ramping, and WY 2015 was the least successful. Boating flows and corresponding down ramping for the rest of the non-spill years are presented in Figure 4-3 through Figure 4-6 and summarized in Table 4-1.



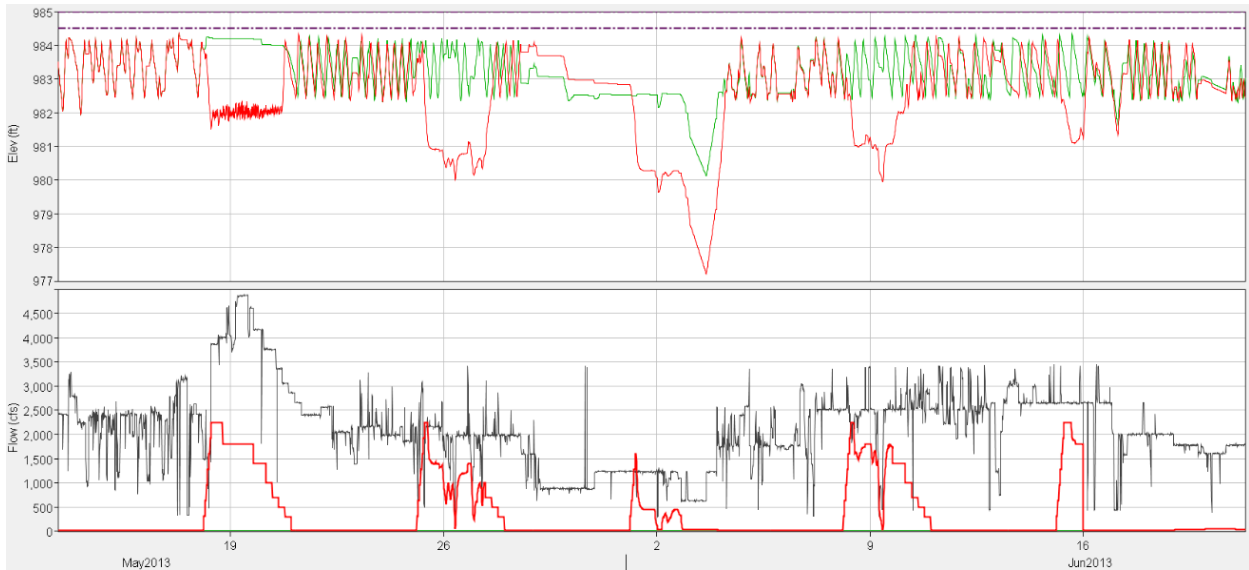
Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-3 WY 2007 non-spill year boating flows and down ramping.



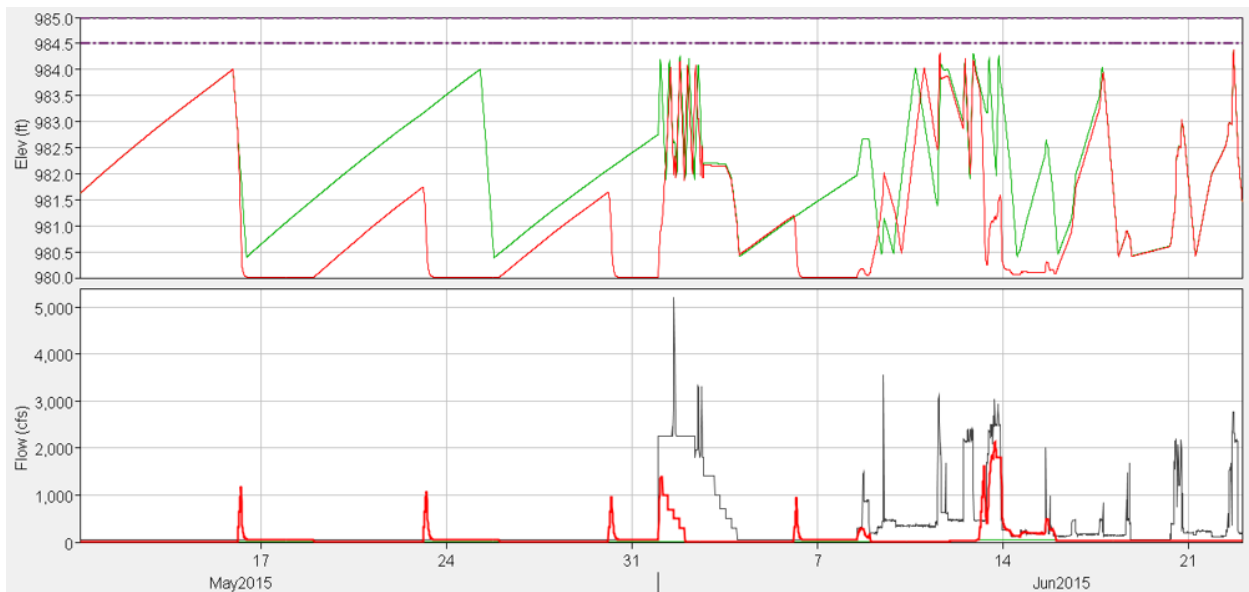
Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-4 WY 2012 non-spill year boating flows and down ramping.



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-5 WY 2013 non-spill year boating flows and down ramping.



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-6 WY 2015 non-spill year boating flows and down ramping.

Table 4-1 presents a summary of success or failure of the Non-Spill Years Boating Flows and Down Ramping schedules. In the table, "S" with the green shade represents a successful completion of the Boating Flow and Down Ramp schedule. "PS" with the orange shade represents a partial successful completion; this means it was able to achieve

boating flows for some duration but not for the full scheduled duration. “F” with the red shade represents failure to reach boating flows for any substantial duration. In years 2013, 2014, and 2015, there were five weekends that fell within the May 15 – June 15 period for boating flows. In years 2007 and 2012, there were only four weekends that met the criteria for boating flows.

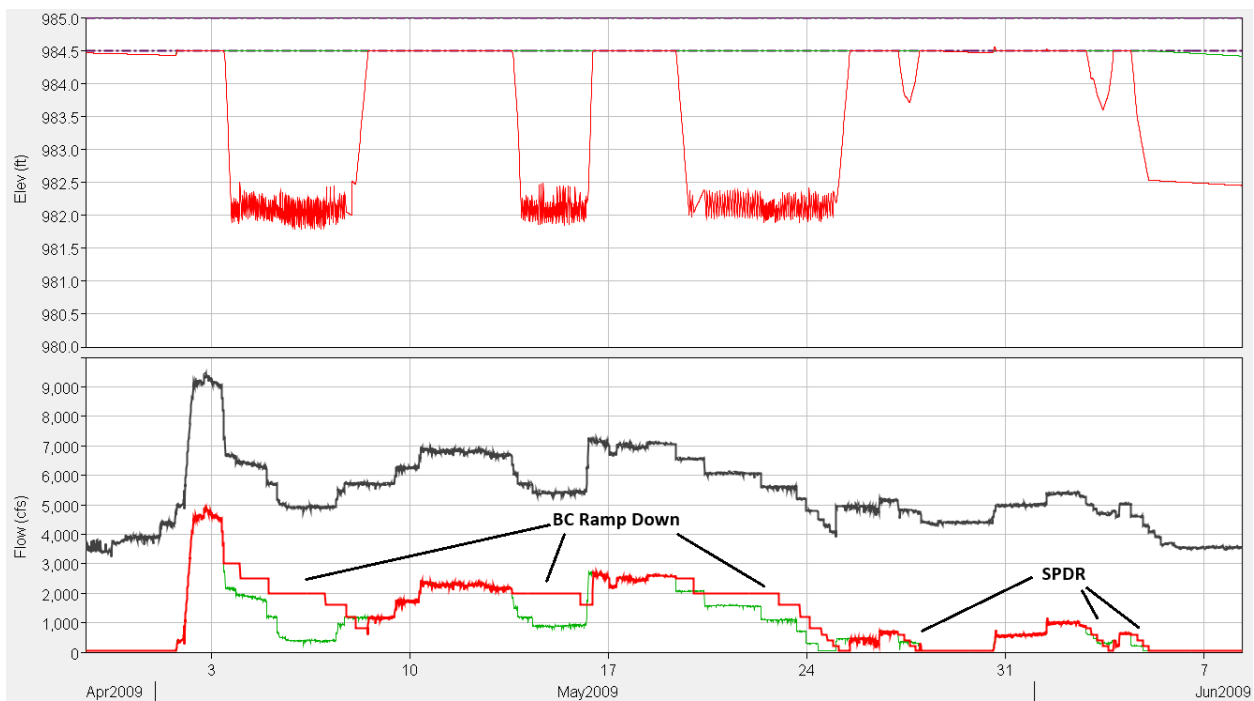
Table 4-1 Non-spill years boating flows success or failure.

WY	Weekend				
	1	2	3	4	5
2007	S	S	F	F	
2012	PS	F	PS	PS	
2013	S	PS	F	PS	PS
2014	S	S	S	F	PS
2015	F	F	F	F	F

S=Success, PS=Partial Success, F=Failure

4.1.1.3 Stranding Protection Down Ramping

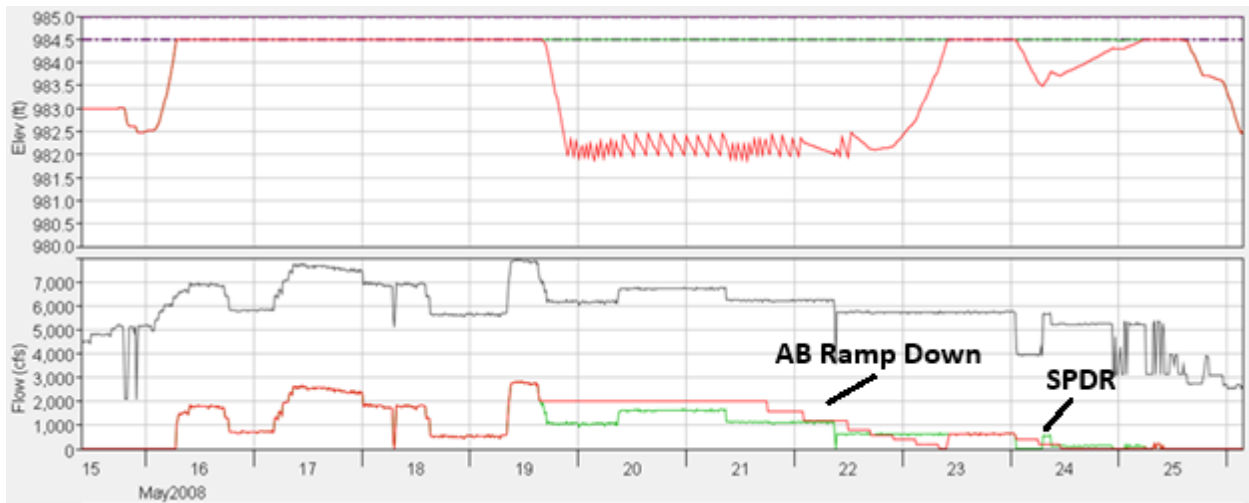
The Stranding Protection Down Ramping Measure covers initial and subsequent spills between May 1 and August 31. In other words, the ramp down schedules (AB, BC, D) are reserved for the large spill events in each spill season, while all others are handled by the Stranding Protection Down Ramping Measure. The Stranding Protection Down Ramping Measure was activated at least once in each of WYs 2008, 2009, 2010, 2011, and 2016. All other years are either non-spill years or did not exhibit initial or subsequent spills, which would have triggered the Stranding Protection Down Ramping Measure. Figure 4-7 shows the Stranding Protection Down Ramping Measure applied to WY 2009. Note during the large spill event, the Schedule BC ramp down is interrupted and restated two times during its recession. During the Schedule BC ramp down, spill is elevated over the demand, which results in the reservoir dropping toward K2 Powerhouse’s minimum operating reservoir elevation. To maintain capacity to meet the Schedule BC ramp down, the K2 Powerhouse must over-cycle, which is manifested in this plot with the oscillations in the pool elevation that correspond with the ramp down times. The smaller subsequent spill events are covered by Stranding Protection Down Ramping. Because the Stranding Protection Down Ramping ramp down better matches the inflow reductions over the same period, the pool elevation drops are minimal and avoid the K2 Powerhouse over-cycling.



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

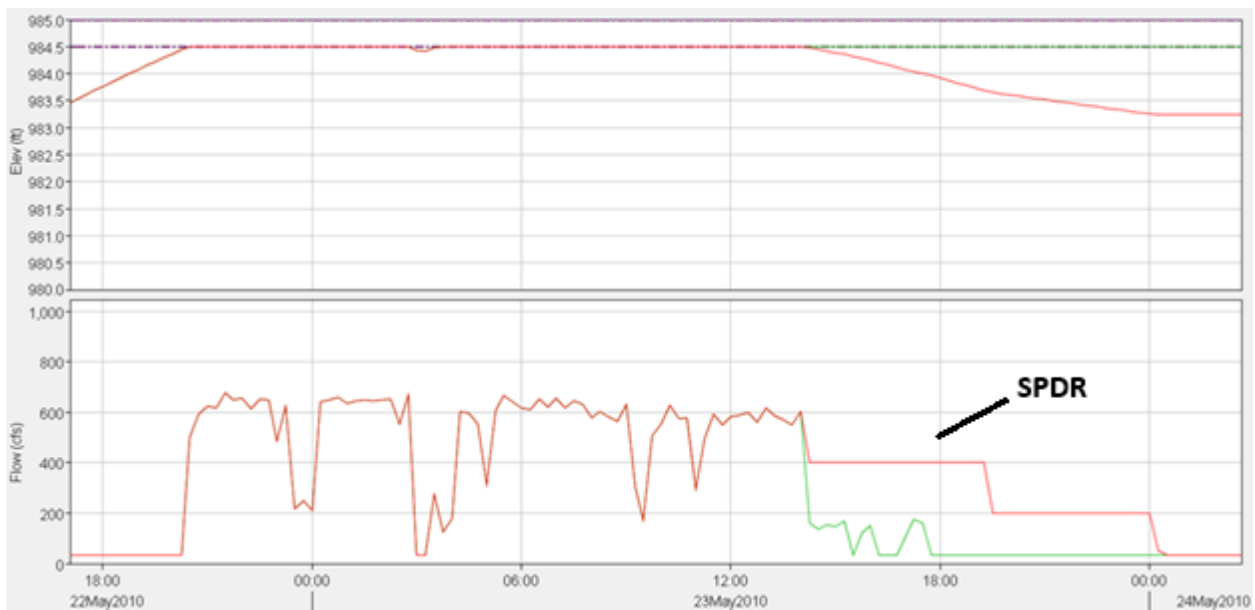
Figure 4-7 Stranding Protection Down Ramping Measure used in WY 2009.

In all the WYs where Stranding Protection Down Ramping was triggered, K2 Powerhouse over-cycling was avoided due to the shorter duration characteristic of Stranding Protection Down Ramping, compared to the Schedule AB, BC, and D ramp down schedules. An exception is a very brief period of K2 Powerhouse over-cycling during the Stranding Protection Down Ramping schedule in WY 2016. The other WYs in which Stranding Protection Down Ramping was called are presented in Figure 4-8 through Figure 4-10.



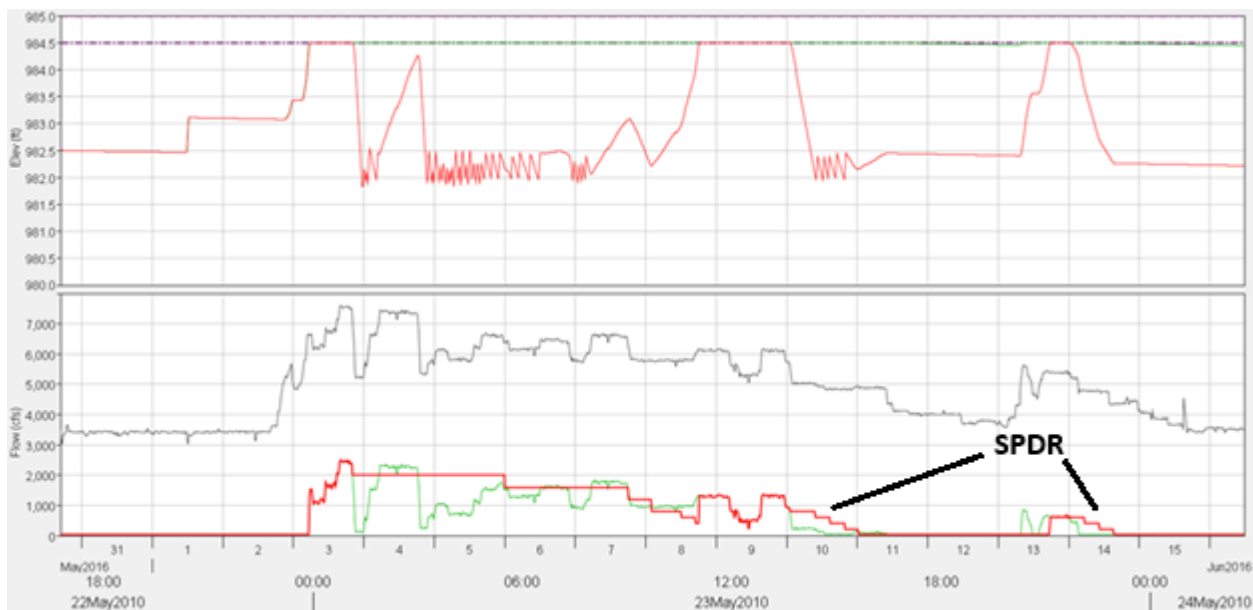
Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-8 WY 2008 Stranding Protection Down Ramping schedule.



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions.

Figure 4-9 WY 2010 zoomed-in view of small initial event with Stranding Protection Down Ramping.



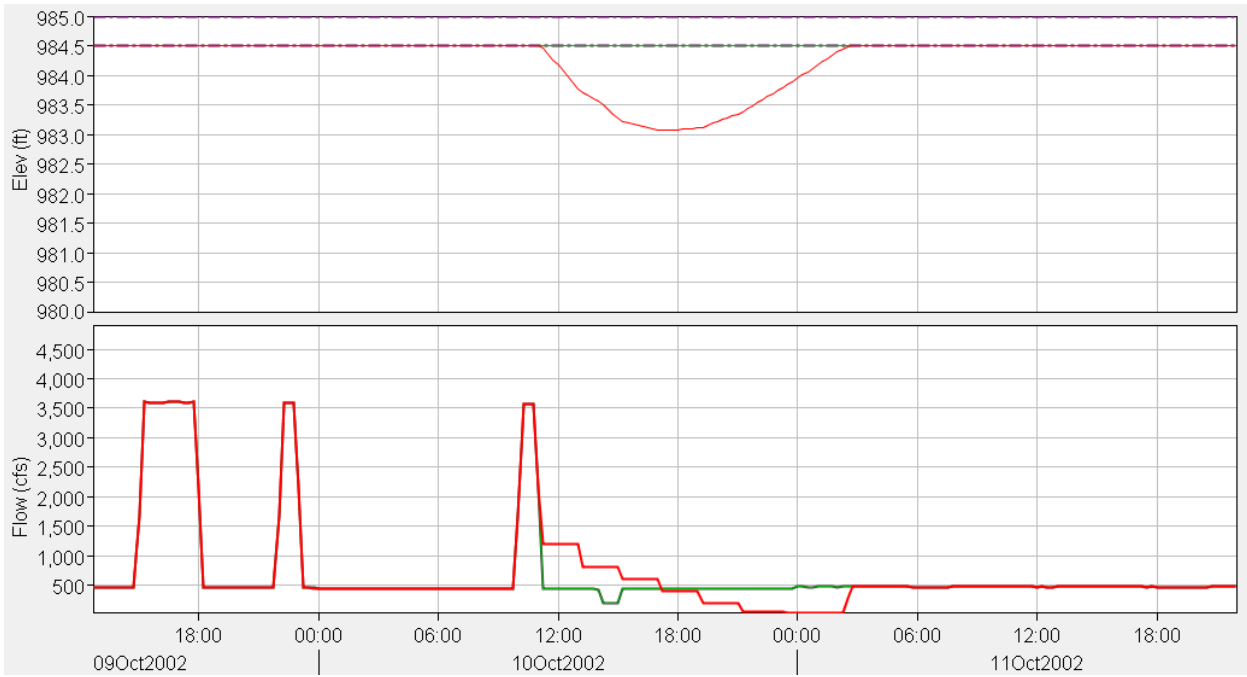
Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-10 WY 2016 Stranding Protection Down Ramping schedule.

4.1.1.4 September – October Down Ramp Measure

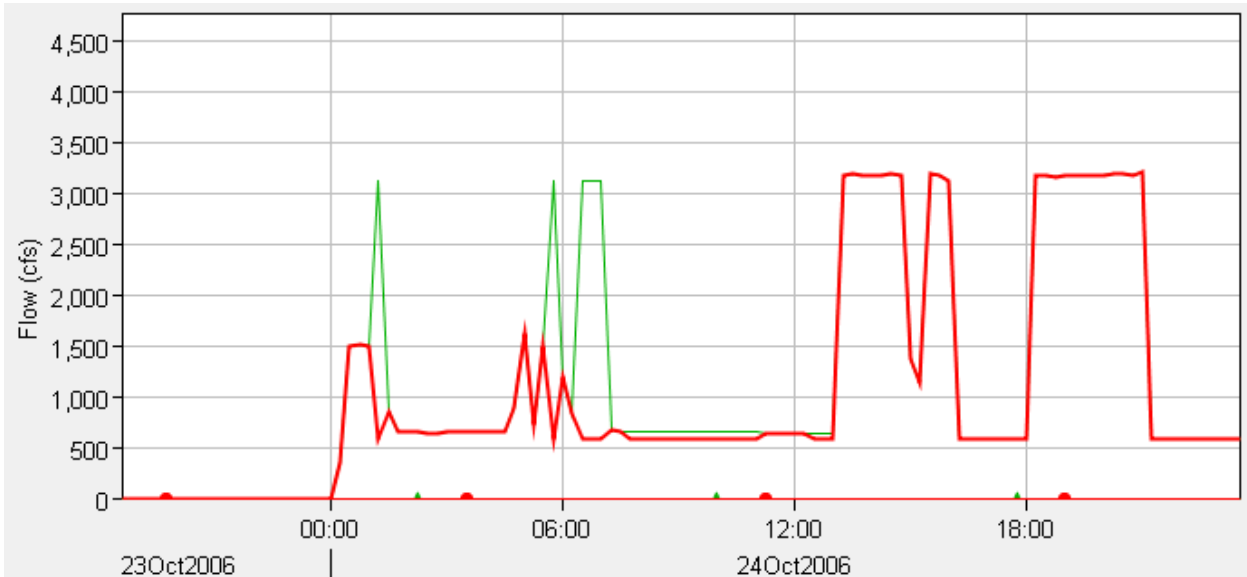
The September – October Down Ramp of spills was initiated for WYs 2003, 2007, and 2011, all occurring in the month of October. In all other WYs, either there were no spill events in September and October or the spill events lasted beyond October 31. Figure 4-11 shows an example of a successful September – October Down Ramp at the end of a spill cycle. As this ramp down has small ramping durations and starts ramping down at a lower 1,200 cfs, the reservoir pool is able to provide the volume needed to complete the ramp down. Notice the reservoir pool drops during the ramp down, as expected, to accommodate the additional spill over the inflowing load, but the pool does not drop low enough to enter the K2 Powerhouse’s minimum operating reservoir elevation to the extent it affects the ramp down schedule.

However, in a September – October Down Ramp in WY 2007, there was too much encroachment toward the K2 Powerhouse’s minimum operating reservoir elevation, which led to a brief period of powerhouse over-cycling. Figure 4-12 shows an example of the K2 Powerhouse flows being limited to prevent too much drawdown of the reservoir during the September – October Down Ramp. For WYs 2003 and 2011, the hydroelectric project was able to maintain full capacity at the K2 Powerhouse and still accommodate the September – October Down Ramp.



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions.

Figure 4-11 September – October Down Ramp for WY 2003.

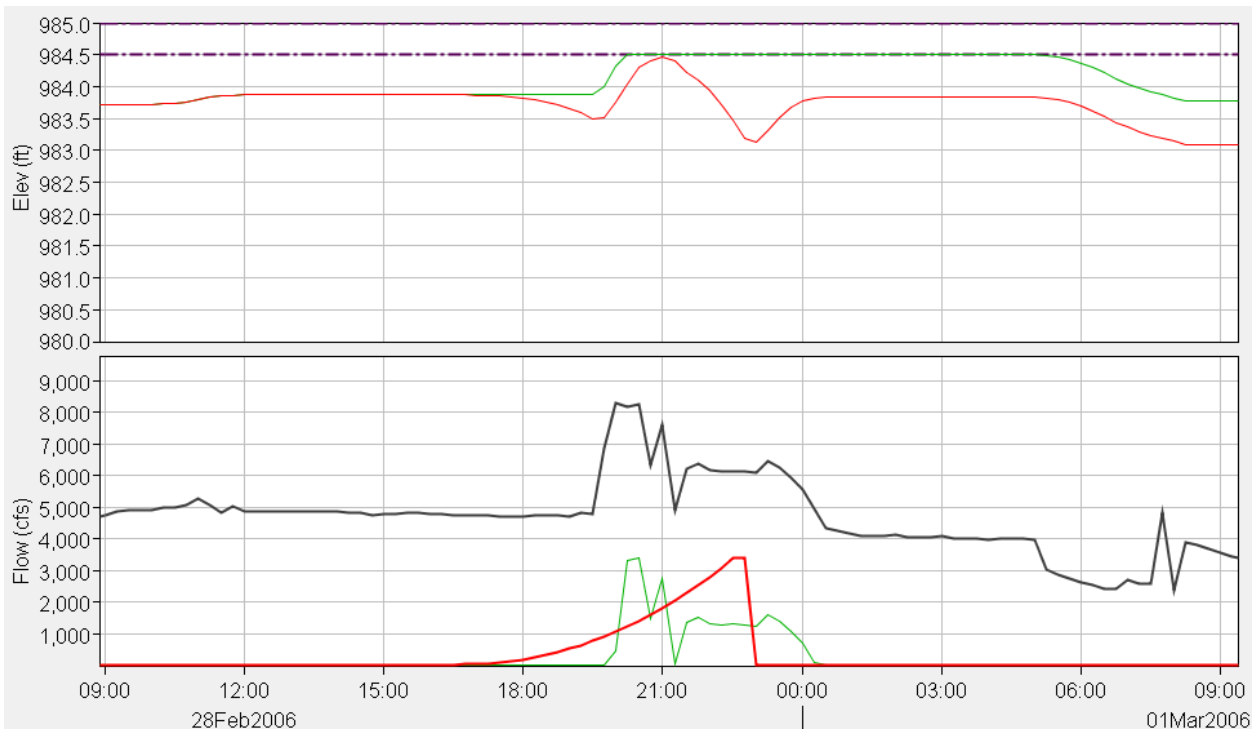


Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions.

Figure 4-12 WY 2007 impacts to K2 Powerhouse generation during September – October Down Ramp.

4.1.2 Alternative 1 Ramp Up Measure

Alternative 1's Modified BLM 2024 4(e) Condition 5 (Alternative 1 Ramp Up Measure) imposes a limit on the rate increase of stage as measured at Gage J-2, for spill events starting between MIF and 4,000 cfs, regardless of time of year. A spill event in the context of the Alternative 1 Ramp Up Measure was any initiation of an increase in inflows to Kerckhoff Reservoir from MIF that lasted more than several computation time steps (i.e., three or more time steps of ~45 minutes). The ramp up was imposed 42 times in the period of record over all WYs. The Gage J-2 rating curve presented in Figure 3-1 was used to schedule a series of hourly flow increases that equates to exactly one foot of rise at Gage J-2. That schedule was then imposed for each initiation of a spill event through the period of record. Figure 4-13 shows an example of a successful Alternative 1 Ramp Up Measure for an isolated spill event that begins on February 28, 2006, at 10 p.m. (20:00 hours in the figure).



Note: Green represents Existing Conditions. Red represents Alternative 1 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-13 Alternative 1 Ramp Up Measure for February 28, 2006 spill event.

The ramp up is required to begin in advance of inflow reaching Kerckhoff Reservoir, so it is forecast dependent. It is also dependent on the skill and experience of the operator to know how far in advance to initiate the Alternative 1 Ramp Up Measure. Here it is shown

that the Alternative 1 Ramp Up Measure begins around 4:30 p.m., about three hours in advance of the inflow spike. In implementing this schedule in the model, it was found that if the ramp up starts earlier than that, then too much flow is released from the reservoir before the inflow arrives, drawing down the reservoir too low, in which case the ramp up is interrupted, and spill has to reduce before completion. If the ramp up starts later than three hours prior to inflow arrival, then not enough of the reservoir is drawn down in advance of the inflow, and spill has to spike to keep the reservoir from rising above guide curve. It is evident that the initiation time of the ramp up is a key component to the success of the Alternative 1 Ramp Up Measure. However, it is likely to be a challenge for even an experienced operator to take an inflow forecast and know exactly when to initiate ramp up. This model can serve as a training mechanism to some degree, but it is likely that for any given spill event, initiation time would not be selected perfectly. In that regard, it is better to initiate the ramp up earlier than the ideal time rather than later. This would allow the operator to slow the ramp up rate (to less than one foot per hour at Gage J-2) to help tie into the arriving inflows successfully.

Of the Alternative 1 Ramp Up Measure operations, 41 of 42 were achieved successfully (97.6 percent success rate) for the entire period of record, with the model's advantage of being able to iterate to the ideal initiation time for each one.

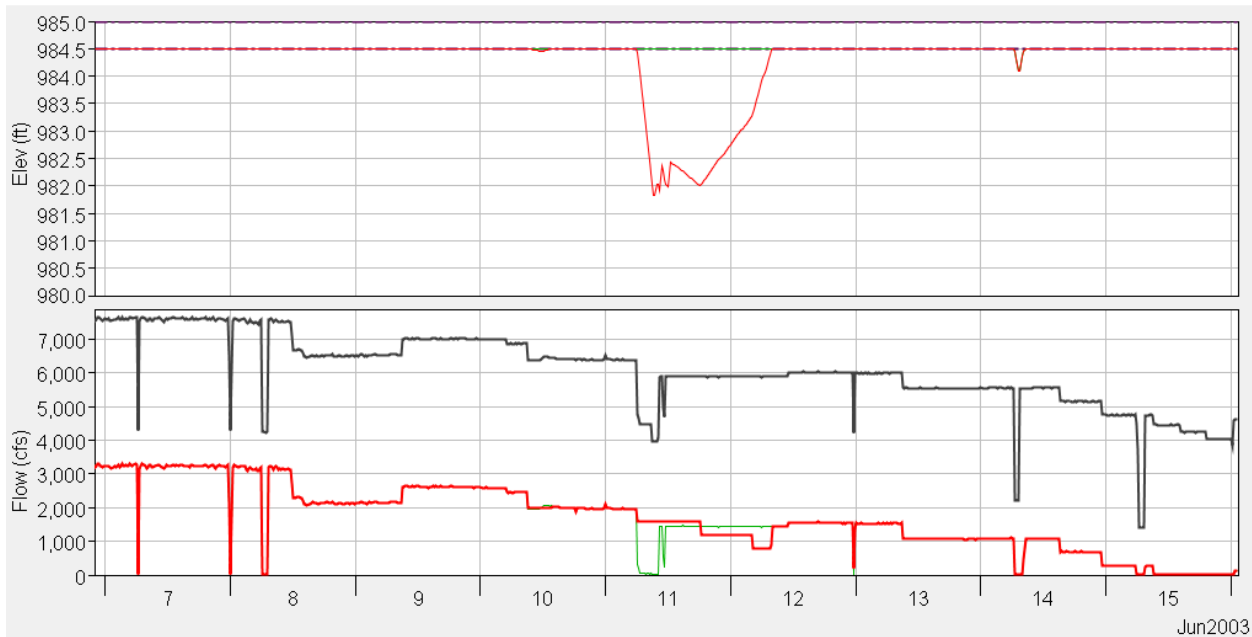
4.2 CEQA Alternative 2 Results

4.2.1 2025 Revised BLM 4(e) Condition 4

The 2025 Revised BLM 4(e) Condition 4 replaces the original Condition 4 by implementing the Modified EOS Flow Recession Measure and the original PG&E Subsequent Spill Ramp Down Measure as presented in Appendices 3 and 4 of DOI (2025).

4.2.1.1 Modified EOS Flow Recession Measure

The Modified EOS Flow Recession is applied to the largest spill event for each year's spill season (May 1 through August 31) and scheduled according to WY Type (AA or BA). All Modified EOS Flow Recession ramp downs begin at 9 a.m. Figure 4-14 shows an example of Modified EOS Flow Recession for WY 2003, which was designated a BA WY Type.



Note: Green represents Existing Conditions. Red represents Alternative 2 Conditions. Black represents inflows to Kerckhoff Reservoir.

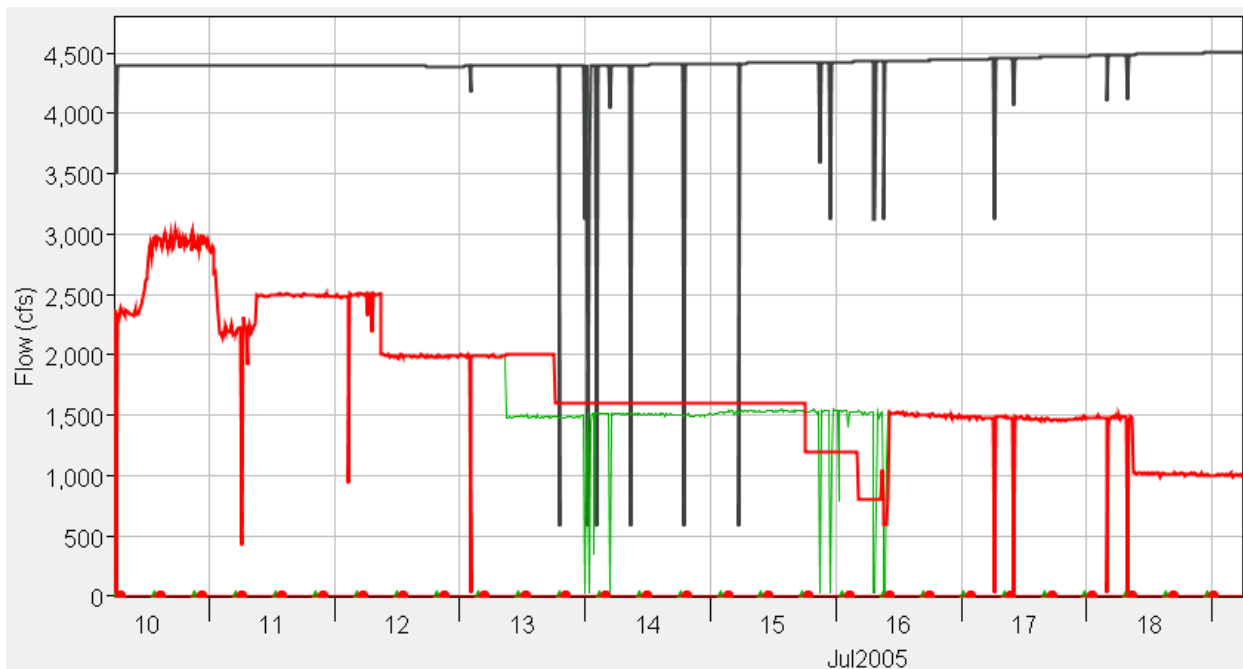
Figure 4-14 Modified EOS Flow Recession applied to WY 2003.

The BA Modified EOS Flow Recession ramp down begins on June 10 at 9 a.m. and holds around 2,000 cfs for 9 hours (the low end of the first schedule step of 2,500 to 2,000 cfs). The schedule then drops to 1,600 cfs (the low end of the second step range) and holds for 24 hours. However, here the inflows are too high to drop the spill, so it stays elevated in the first step. Around 9 a.m. on June 11, the inflow drops and the schedule is able to reduce to 1,600 cfs for another 12 hours, effectively producing boating flows (2,500-1,600 cfs) for the required duration of 33 hours.

Around midday on June 12, the ramp down flows recede at a faster rate than the inflows, and as a result, the schedule is interrupted as the hydroelectric project attempts to not exceed guide curve. This is a common occurrence for all the Modified EOS Flow Recession ramp downs, as the schedule ramps down at a faster rate than the recession rate of the inflows to Kerckhoff Reservoir. However, the step durations for the Modified EOS Flow Recession ramp down are minimums; the measure allows for longer durations at each step. An operator would be able to see the pool begin to elevate above guide curve and can increase the duration of individual steps to better match the recession rate of reservoir inflows. Consequently, while the Alternative 2 Modified EOS Flow Recession ramp downs do not necessarily look as clean as the Alternative 1 Condition 4 ramp downs, they

effectively work as intended, provided the operator extend the step durations as necessary to match the recession rates of the reservoir inflows.

The K2 Powerhouse cycling effect discussed in Alternative 1 Condition 4 is also present for Alternative 2 Modified EOS Flow Recession ramp downs. However, because the recession rate of the Modified EOS Flow Recession ramp down is faster, it can prevent long durations of excessive spill, which is where the K2 Powerhouse cycling effect takes place. Figure 4-15 shows an example of an AA Modified EOS Flow Recession schedule being applied in WY 2005. Here it is shown that the schedule is able to successfully apply the 57 hours of boating flows (as required for Schedule AA). However, during much of the boating flow period, the scheduled spill (red line) is slightly higher than the existing conditions spill (green line), which means the K2 Powerhouse (black line) must cycle down periodically to prevent exceedance of guide curve.



Note: Green represents Existing Conditions. Red represents Alternative 2 Conditions. Black represents inflows to Kerckhoff Reservoir.

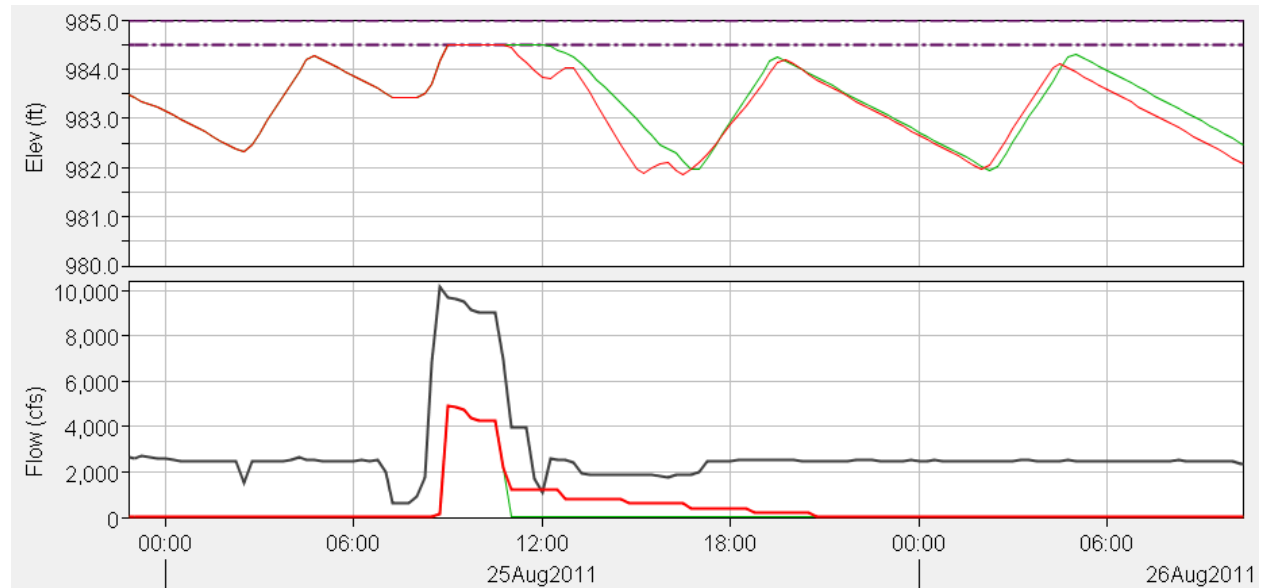
Figure 4-15 WY 2005 Alternative 2 Condition 4 (Revised) ramp down and K2 Powerhouse cycling.

4.2.1.2 Subsequent Spill Ramp Down Measure

The Subsequent Spill Ramp Down Measure in Alternative 2 is applied to any subsequent spills after the Modified EOS Flow Recession ramp down through October 31 of any given WY when daily average flows exceed 500 cfs, except during a powerhouse outage. The

Subsequent Spill Ramp Down schedule is the same regardless of WY. Subsequent Spill Ramp Downs were applied four times: twice in WY 2009, once in WY 2011, and once in WY 2016. No other WYs required Subsequent Spill Ramp Down.

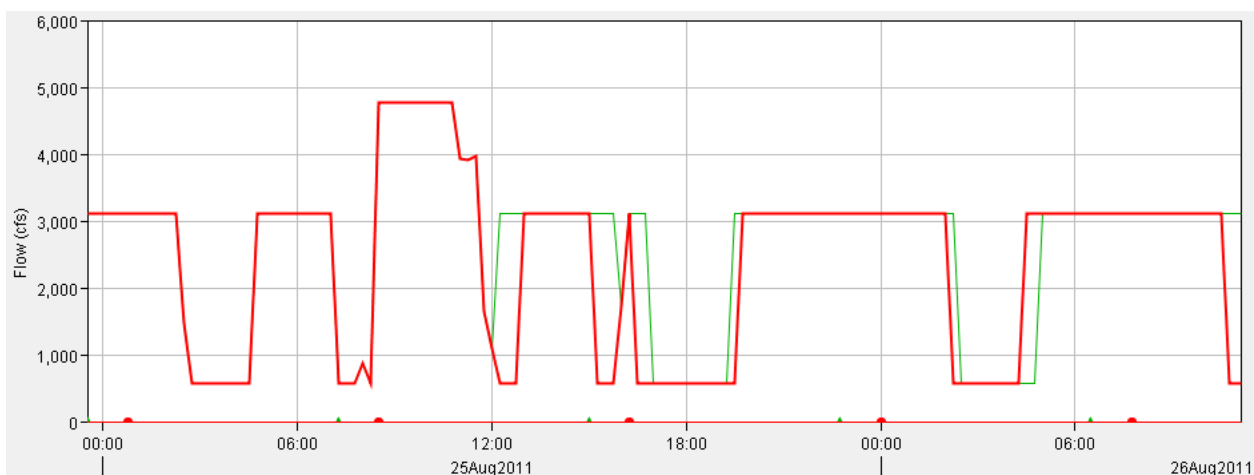
Figure 4-16 shows an example of a clean application of Subsequent Spill Ramp Down in August 2011. The Subsequent Spill Ramp Down ramp down (red line) elevates spill above existing conditions (green line), but inflows are sufficient to prevent the reservoir dropping to close to the lower end of the normal operating range, which would limit spill capacity.



Note: Green represents Existing Conditions. Red represents Alternative 2 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-16 Subsequent Spill Ramp Down application in WY 2011.

While there is an effect on K2 Powerhouse operation, it appears to be minor in that there is minimal additional cycling (Figure 4-17). However, there is a slight phase shift, where ramp up and ramp down times are offset between existing and Alternative 2 conditions. This phase shift could be problematic if it affects the ability to meet power demand.



Note: Green represents Existing Conditions. Red represents Alternative 2 Conditions.

Figure 4-17 WY 2011 Subsequent Spill Ramp Down effect on K2 Powerhouse.

In general, the Subsequent Spill Ramp Down was successfully applied all five times with minimal impact on the K2 Powerhouse. This is largely due to the short durations in the ramp down steps in the Subsequent Spill Ramp Down schedule and the fact that the Subsequent Spill Ramp Down begins at a much lower flow rate (1,600-1,200 cfs) than the Modified EOS Flow Recession or Alternative 1 ramp down schedules.

4.2.2 2025 Revised BLM 4(e) Condition 5

The 2025 Revised BLM 4(e) Condition 4 replaces the Modified BLM 4(e) Condition 5 by implementing the Modified Spill Season Flow Measure and the POM as presented in Appendices 1 and 2 of DOI (2025).

4.2.2.1 Modified Spill Season Flow Measure

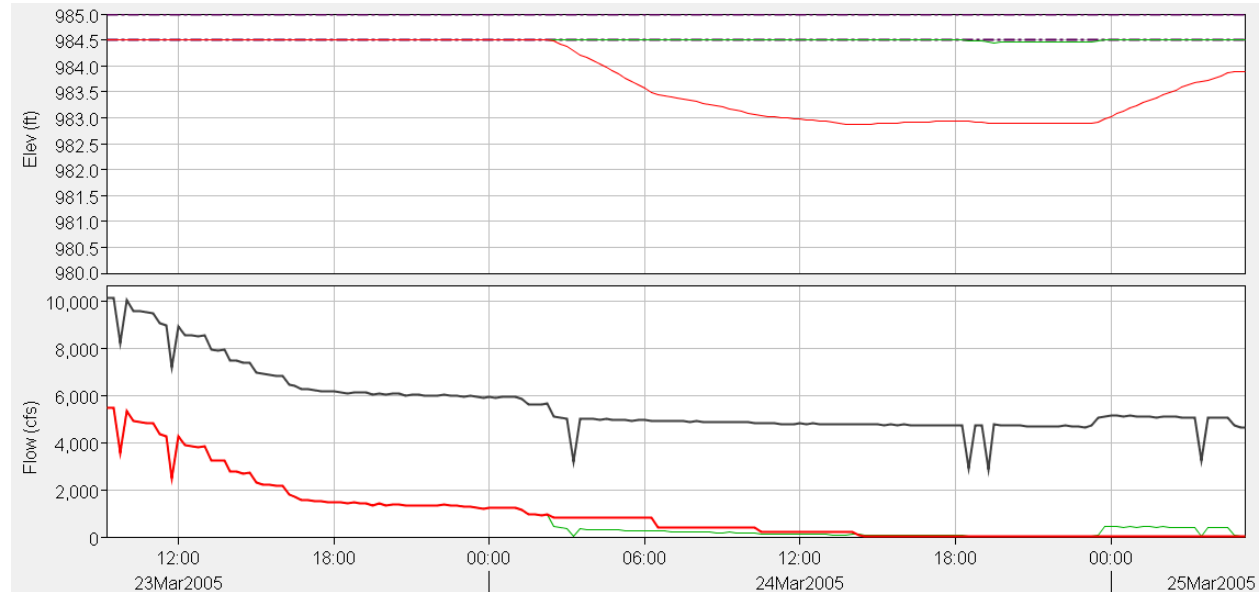
When sustained spills measured at Gage J-2 are 1,000 cfs⁶ or more (WY Type AA) or 500 cfs or more (WY Type BA) for at least 5 hours of continuous duration and neither the Modified EOS Flow Recession Measure nor the Subsequent Spill Ramp Down Measure is being implemented, subject to sufficient water availability,⁷ the model will initiate the Modified Spill Season Flow Measure schedule prior to average hourly flow declining below 800 cfs. The Modified Spill Season Flow Measure applies only from March 1 through

⁶ Flows are expressed as hourly average flows unless otherwise specified.

⁷ Sufficient water availability is dependent on combined accessible volume of water from inflow, storage within the normal operating range of Kerckhoff Reservoir, or current powerhouse diversions to complete the specified ramp down to minimum flow without decreasing below a 980-foot msl water surface elevation in Kerckhoff Reservoir.

August 31 of a given year. The Modified Spill Season Flow Measure was initiated 26 times for AA WYs and 4 times for BA WYs.

Figure 4-18 shows an example of a clean application of the Modified Spill Season Flow Measure that took place in March 2005, which is an AA WY. Because the Modified Spill Season Flow Measure schedule starts at 1,200 to 800 cfs and has short step durations of 4 hours, the storage in the reservoir can accommodate the additional spill enforced on the ramp down with or without diversions through the K2 Powerhouse.



Note: Green represents Existing Conditions. Red represents Alternative 2 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-18 Modified Spill Season Flow Measure application in March 2005.

Note that the small follow-up spill event required for existing conditions (green line) that takes place early on March 25 does not require Alternative 2 (red line) to spill because the reservoir elevation is still recovering toward guide curve.

All applications of Modified Spill Season Flow Measure for the entire period of record performed as required without interruption.

4.2.2.2 Modified Planned Outage Measure

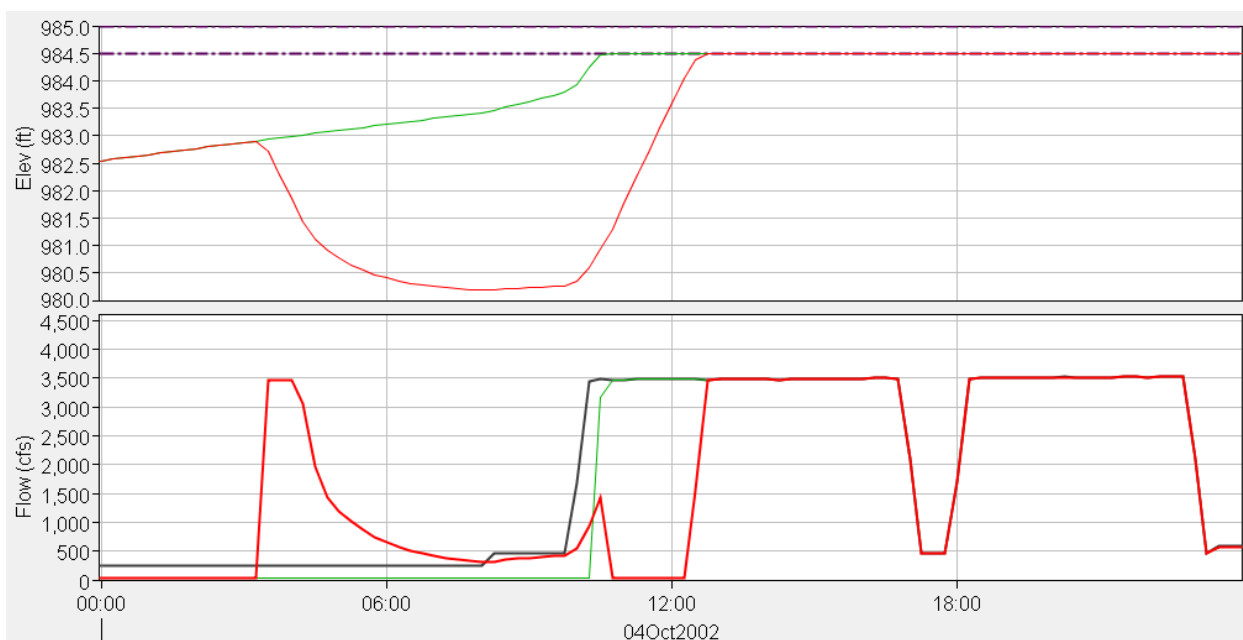
The POM has two components to it: initial release protocols associated with a planned outage, and a ramp down schedule for the end-of-spill events associated with a planned outage.

4.2.2.2.1 POM Initial Release Protocol

The POM Initial Release Protocol simply draws back an initial spill during the planned outage period to begin at 3:30 a.m. There is no ramp up schedule, rather the spill increase is mimicked at 3:30 a.m. given there is sufficient water availability. This measure only goes into effect during the planned outage period and only if flows below Kerckhoff Dam are expected to exceed a daily average flow⁸ of 1,000 cfs in AA WYs or 500 cfs in BA WYs as measured at Gage J-2. During planned outages, once the reservoir is at full capacity, any inflows would be spilled through the radial gates at Kerckhoff Dam. Thus, model simulations were run to see the effects of implementing the initial spill protocol and beginning spill operations at 3:30 a.m. when flows below Kerckhoff Dam were expected to exceed a daily average flow of 1,000 cfs in AA WYs or 500 cfs in BA WYs as measured at Gage J-2.

Of the WYs evaluated, WYs 2010, 2014, and 2015 had no spill above the initiation threshold during the planned outage time, so POM was not applied. WYs 2011 and 2012 had what could be considered gradual ramp ups to deterrence flows, so POM was not applied to those WYs. Figure 4-19 shows the POM ramp up applied at 3:30 a.m. on October 4, 2002 (WY 2003).

⁸ Daily average flow is calculated from midnight-midnight.



Note: Green represents Existing Conditions. Red represents Alternative 2 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-19 WY 2003 POM Initial Release Protocol.

As there is initially very little inflow, the reservoir immediately drops to the lower end of the reservoirs normal operating range (980.0 feet above msl). It only begins to recover once inflow increases to 3,500 cfs around 10 a.m. As there is typically no or very little inflow prior to the planned outage spill, pulling back the spill flow to 3:30 a.m. produces a very similar result for all other WYs where the POM Initial Release Protocol was applied. A secondary spill spike occurs around 12:15 p.m. to balance inflows. While the initial spill under the POM ramp up protocol is drawn back to 3:30 a.m. with the intention of the initial spill beginning at early morning hours so that spill arrives downstream near the K1 Powerhouse by approximately 8:30 a.m. prior to recreators entering the river. The secondary spike occurs around noon, when recreators are likely to be around the river. This reveals an unintended consequence of the POM Initial Release Protocol. If the initial spill did not begin at 3:30 a.m. due to the low inflows at the time, a similar sudden increase in flow downstream would still have occurred later in the day when higher inflows entered Kerckhoff Reservoir given the reservoir was at or near full capacity. Since the reservoir is at capacity and the K2 Powerhouse is offline, the 3,500 cfs inflow into the reservoir would have been passed downstream through the PBR via spill through the radial gates.

The POM Initial Release Protocol was applied 12 times during the period of record. All applications produce a similar effect as shown with the WY 2003 example, but with varying stage increase rates on the secondary flow spike, most of which occur during daytime hours. There are five study sites in the PBR, where rating curves have been developed. There is significant interest in minimizing rates of rise throughout the PBR for spill events like this. The total rise of the secondary spikes for each of the five study sites (Cardno 2021) and at the Gage J-2 site are shown in Table 4-2. Please refer to PG&E’s Stage Discharge Investigation (Cardno 2021) for travel times for flows to each study site.

Table 4-2 POM Initial Release Protocol secondary spike stage increase from beginning flow to largest observed flow.

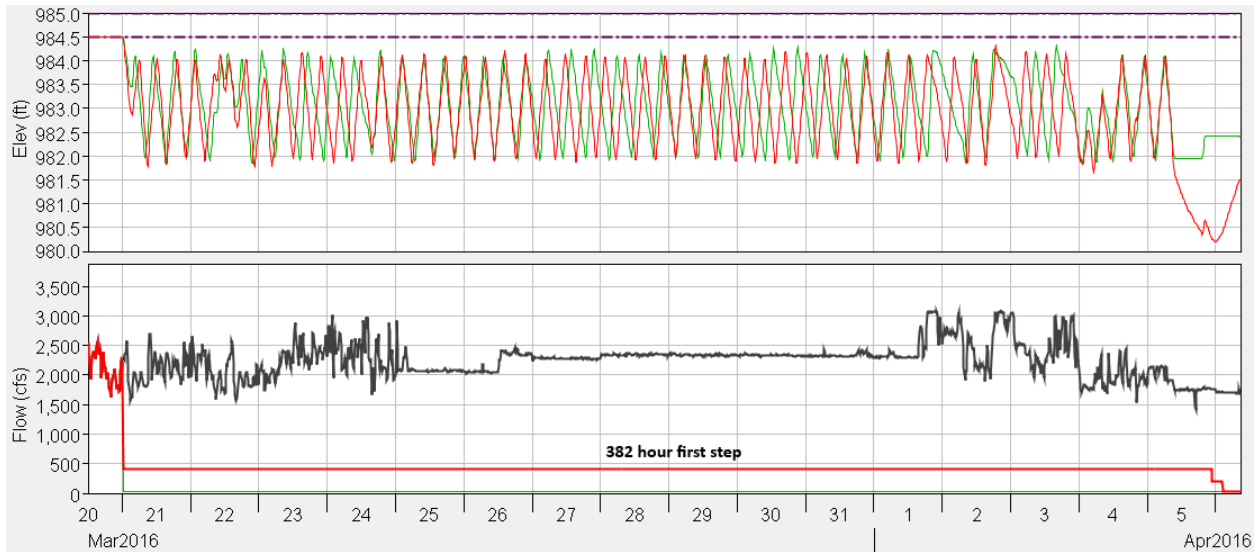
	Site 1	Site 2	Site 3	Site 4	Site 5	J2
	Rise	Rise	Rise	Rise	Rise	Rise
Date-Time	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
10/4/2002 3:30	7.2	8.9	5.2	9.0	11.7	5.5
10/23/2003 3:30	7.1	8.7	5.1	8.8	11.6	5.3
10/23/2005 3:30	3.1	4.0	2.4	4.5	4.5	2.5
10/4/2006 3:30	6.6	8.1	4.7	8.1	11.0	5.0
11/15/2007 3:30	6.8	8.3	4.8	8.3	11.2	5.1
11/19/2007 3:30	1.7	2.1	1.2	2.1	2.7	1.3
11/29/2007 3:30	7.0	8.7	5.1	8.7	11.5	5.3
11/9/2008 3:30	5.3	6.4	3.7	5.9	9.3	3.8
11/8/2012 3:30	4.9	5.9	3.3	5.3	8.7	3.5
12/12/2015 3:30	3.0	3.5	1.9	2.8	5.9	2.0
11/2/2016 3:30	4.7	5.6	3.1	4.9	8.4	3.3

4.2.2.2 Modified POM Ramp Down

The Modified POM Ramp Down is unique in its application in that during the first step of the ramp down schedule, the measure calls for running that step as long as sufficient water is available. Otherwise, the schedule mimics the Modified Spill Season Flow Measure. To implement the varying duration of the first step in the different WY applications, a trial-and-error approach was used to test out how long the first step could be run before the remainder of the schedule broke down and was not able to successfully complete.

WY 2016 was unusual in that the planned outage lasted from October to March and, at the conclusion of the outage, inflows to Kerckhoff Reservoir remained high enough that even with the K2 Powerhouse coming back online, there was still volume available to

service the Modified POM Ramp Down spill (Figure 4-20). This resulted in the first step of the Modified POM Ramp Down lasting 382 hours (~16 days).



Note: Green represents Existing Conditions. Red represents Alternative 2 Conditions. Black represents inflows to Kerckhoff Reservoir.

Figure 4-20 WY 2016 Modified POM Ramp Down.

The Modified POM Ramp Down was successful in all WYs where it was applied. Table 4-3 presents the first step durations for each WY. WYs 2010, 2014, and 2015 did not meet the flow threshold during the planned outage to initiate a Modified POM Ramp Down Measure.

Table 4-3 POM first step durations for all WYs.

WY	POM First Step Duration (hr)		WY	POM First Step Duration (hr)
2003	4		2011	25
2005	10		2012	4
2006	8		2013	50
2007	26		2014	NA
2008	17		2015	NA
2009	151		2016	382
2010	NA		2017	59

4.3 Reservoir Performance

Implementation of the two Alternatives affects the reservoir storage, as volume from the reservoir needs to be converted to spill to accommodate various ramp down and ramp up schedules.

Maxima, averages, and minima reservoir storage are plotted for each month of the period of record, presented in Figure 4-21, Figure 4-22, and Figure 4-23, respectively. This tabular output is presented in Appendix A of this report. Water year 2004 is included in the modeling simulation only for continuity in the modeling.

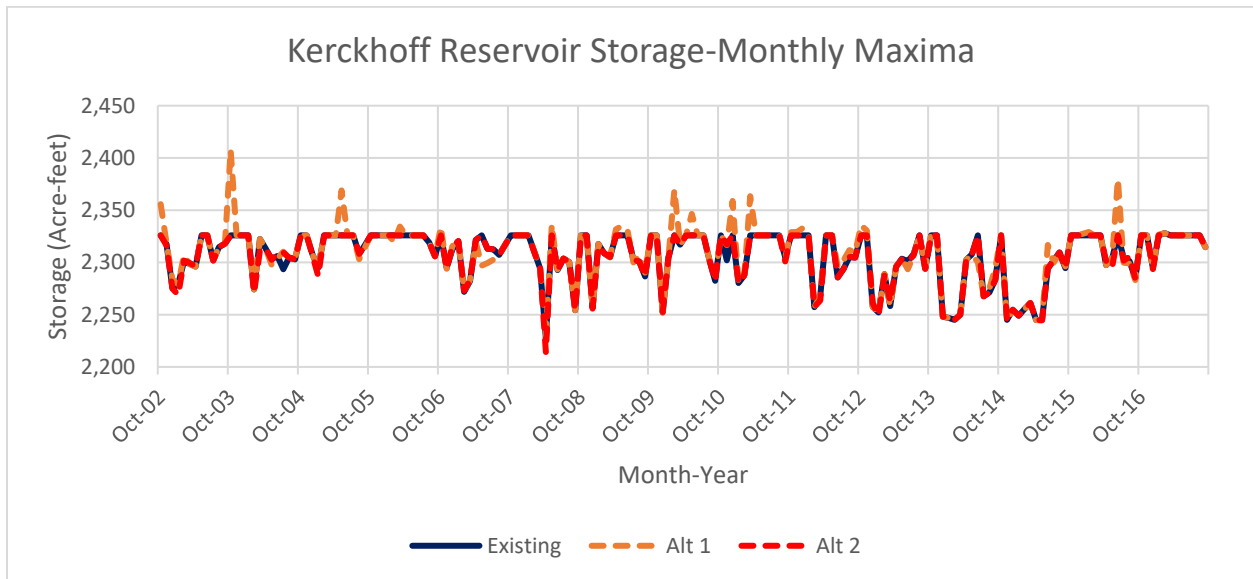


Figure 4-21 Kerckhoff Reservoir storage – monthly maxima.

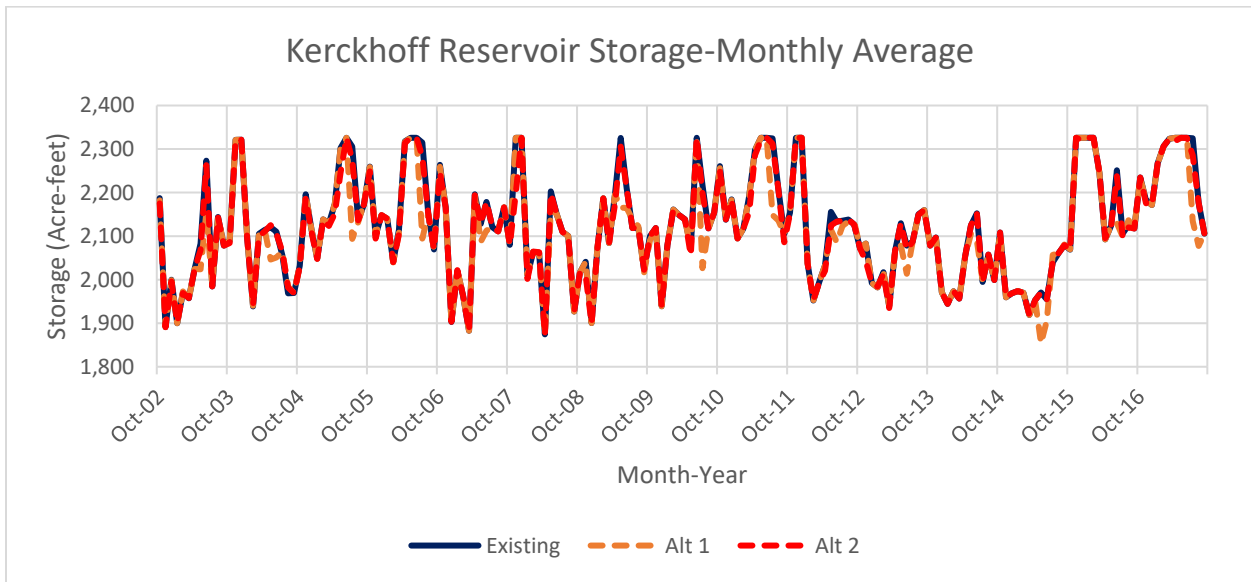


Figure 4-22 Kerckhoff Reservoir storage – monthly averages.

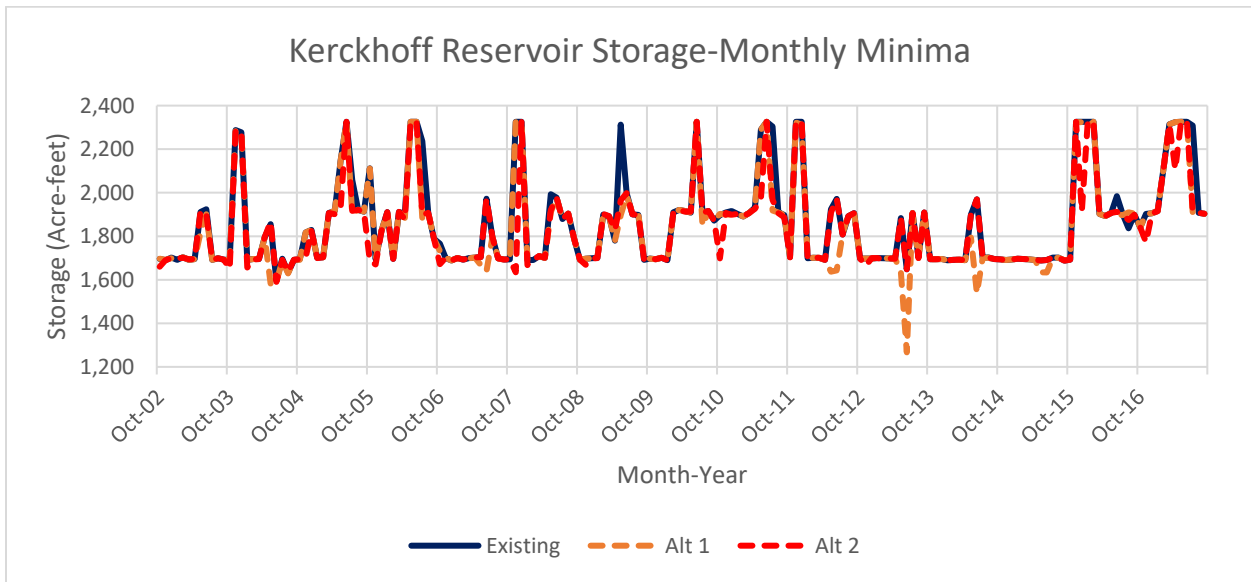


Figure 4-23 Kerckhoff Reservoir storage – monthly minima.

4.4 Stage Change Exceedance Analysis

There are two measures evaluated that are meant to mitigate excessive stage increases for initiation of spill events: the Alternative 1 Ramp Up Measure, discussed in Section **Error! Reference source not found.**, and the Alternative 2 POM Initial Release Protocol, discussed in Section 4.2.2.2.1.

The Alternative 1 Ramp Up Measure is explicitly limited in the model to an increase in spill of one foot of rise per hour at the Gage J-2 site. This measure was successfully applied 41 out of 42 times (97.6 percent success rate) in the period of record with no secondary spill spikes or negative effects on the K2 Powerhouse, with the important caveat of the dam operator having to have advanced notification of the magnitude and timing of incoming flows.

The Alternative 2 POM Initial Release Protocol simply maintains the same rate of discharge increase as the inflows, only with an earlier initiation time of 3:30 a.m. This measure failed to fulfill the intention of avoiding excessive stage increases in the PBR due to the resulting secondary spike in flow that occurs during daylight hours. This secondary spill spikes produced stage increases from a low of 1.2 feet at Study Site 3 to 11.7 feet at Study Site 5. The rating curves for PG&E's Stage Discharge Investigation (Cardno 2021) for Study Sites 1 through 5 were used to analyze stage changes from different flow levels up to 3,500 cfs in the PBR. Rating curves for higher flows were not analyzed for their associated stage changes under PG&E's stage-discharge investigation, which was utilized for the modeling effort. A skilled operator might be able to moderate this effect by limiting spill flows to a more gradual increase on the secondary spike, but the operator would be constrained by reservoir limits and their forecasting skill.

As discussed earlier, if the initial spill did not begin at 3:30 a.m. due to low inflows at the time, a similar sudden increase in flow downstream would still have occurred later in the day when higher inflows entered Kerckhoff Reservoir given the reservoir was at or near full capacity. Since the reservoir is at capacity and the K2 Powerhouse is offline, the 3,500 cfs inflow into the reservoir would have been passed downstream through the PBR via spill through the radial gates.

4.5 Reservoir Pool Limitations

Most of the Alternatives 1 and 2 ramp down measures create a drawdown effect on the reservoir, as the ramp down steps typically keep spill above inflows during the applied schedule. Some measures draw down the reservoir more than others. Typically, the higher initial flow measures with longer step durations draw down the reservoir to a point where it ultimately encroaches toward the K2 Powerhouse's minimum operating reservoir elevation, and to maintain the ramp down schedule, the pool is kept higher by cycling on and off the K2 Powerhouse (over-cycle, as discussed previously). The percentage of times a given measure encroaches toward the K2 Powerhouse's minimum operating reservoir

elevation and the percentage of times that leads to over-cycling is discussed in Section 5.0.

4.6 Flow Dips

Common throughout the period of record are periodic and short-duration flow dips on the inflows to Kerckhoff Reservoir as discussed in Section 2.2. Figure 4-24 shows a few examples of flow dips during June 2005, but these flow dips are present frequently and throughout the period of record. It is unclear what the causes of the flow dips are, but during the model simulation, spill at Kerckhoff Dam is halted and ramped back up to match the flow spikes to attempt to maintain guide curve. This may just be a model artifact, and in reality, an operator may be able to mitigate these spikes by maintaining spill during the brief dip in inflows, causing the reservoir to draw down slightly to make up the difference in flows. However, if the operator elected to match spill with inflows during any of these flow dips, it would cause a sudden decrease in flow followed by a sharp increase in flow in the PBR, resulting in extreme stage decreases and increases.

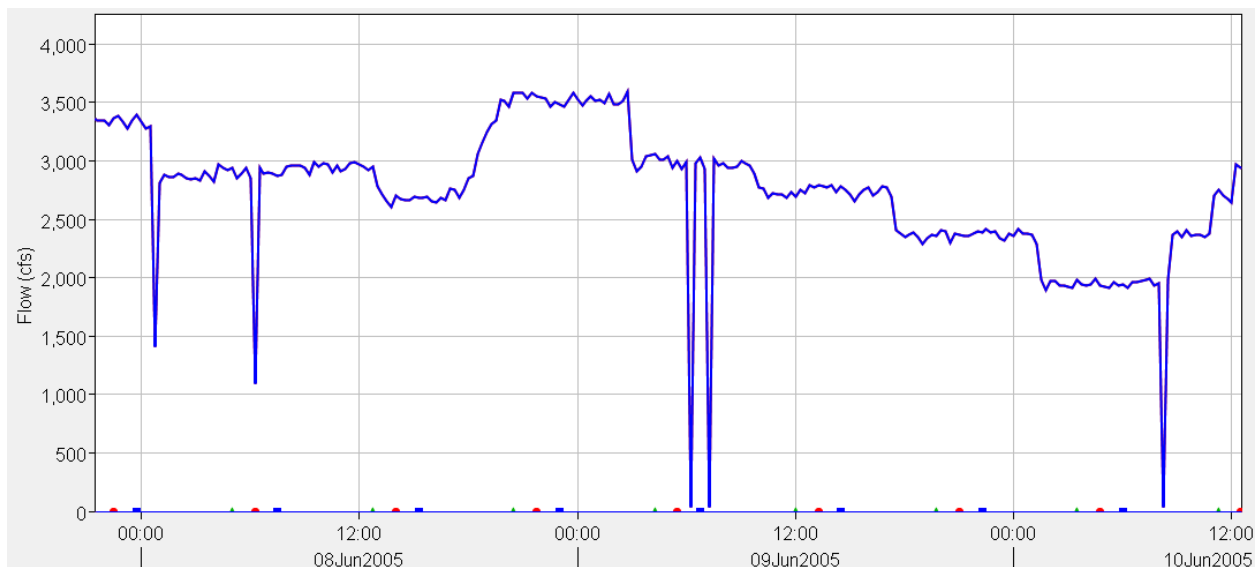


Figure 4-24 Flow dips.

As an example, the first of the two flow dips on June 9, shown in Figure 4-24, was evaluated for stage rate of rise at all five study sites, as well as the Gage J-2 site. The rates of rise are shown in Table 4-4.

Table 4-4 Flow dip stage rate of rise from lowest flow to highest observed flow.

Location	Stage Increase (feet)
Site 1	6.7
Site 2	8.3
Site 3	4.8
Site 4	8.2
Site 5	11.2
Gage J-2	5.1

There are hundreds of these flow dips of varying degrees, mostly occurring during the larger spill events.

5.0 SUMMARY AND CONCLUSIONS

When a substantial inflow to the reservoir is detected, the hydroelectric project reacts by increasing spill to try to maintain the reservoir pool at guide curve (984.5 feet msl). At the same time, there is an outflow demand for K2 Powerhouse flows that must be balanced. Alternatives 1 and 2 disrupt the balanced spill by imposing various measures. This imposition can create notable consequences that are described here:

- Encroachment toward the K2 Powerhouse's minimum operating reservoir elevation. When an Alternative's measure induces more spill than required to balance inflows, the reservoir services the additional required volume, which results in a decrease in reservoir stage. Severe spill flow imbalances with longer durations can cause the reservoir to encroach toward the K2 Powerhouse's minimum operating reservoir elevation, which can limit its ability to divert flows. If there are sufficient K2 Powerhouse flows at the time, the model would try to raise the pool by decreasing K2 Powerhouse flow. If the decrease in K2 flows requires skipping over the ROZ or dropping toward or below minimum reservoir operational levels, this can create an over-cycling effect as described in the next item.
- K2 Powerhouse over-cycling. When spill flows are limited, and the reservoir pool encroaches toward the K2 Powerhouse's minimum operating reservoir elevation (i.e., the K2 Powerhouse can no longer pass flows), if there is powerhouse flow at the time, the model reacts by cyclically ramping down K2 Powerhouse flows to keep the pool high enough to stay above the minimum operating elevation for the K2 Powerhouse. This can lead to powerhouse over-cycling—an unrealistic operation of the K2 Powerhouse. Based on the documented operational constraints, any operation that requires K2 to dwell in the ROZ is considered infeasible due to excessive cavitation and vibration impacts and the associated maintenance and outage consequences. That means operating strategies that require repeated short interval oscillations across the ROZ are not part of operating scenarios, as they can increase cycling wear and raise reliability/maintenance risk even if each individual crossing is brief. A likely strategy by the operator to avoid over-cycling would be to shut down the K2 Powerhouse for an extended period—long enough to bring the pool back to guide curve—before bringing it back online. However, starting and stopping the powerhouse are high stress events that are fundamentally different from steady state operation. They impose combined hydraulic, mechanical, thermal, and electrical stresses on the unit (e.g., rapid changes in wicket gate position and hydraulic loading, increased vibration and bearing loads, and braking/starting

wear). Frequent start/stop cycling is understood to accelerate cumulative damage mechanisms, including fatigue and cavitation-related runner damage, and it can increase the likelihood of forced outages and reduce component life. As a result, PG&E does not perform more than 10 start/stop cycles in a given year, and thus shutting down the K2 Powerhouse to complete the down ramp and avoid over-cycling is likely infeasible (personal email communication, J. Hartman and C. McCormick, March 5, 2026). Also exacerbating this situation is the restriction to operating the K2 Powerhouse in the ROZ (between 3,117 cfs and 1,744 cfs) and turbine unit start/stop limitations. If the powerhouse were running just above the ROZ, and an increase in spill (to meet an Alternative measure’s schedule) initiated a reduction in flow at the K2 Powerhouse, it would have to jump down to 1,744 cfs, rather than just reducing K2 Powerhouse flows modestly. That jump down then creates an under-discharge of reservoir outflows, leading to the reservoir rising, which would then prompt an increase in K2 Powerhouse flows to compensate. This oscillatory effect then continues through the implementation of the ramp down schedule and, as discussed previously, it is not considered feasible.

Table 5-1 presents a qualitative assessment of the success of CEQA Alternative 1 and 2 measures. The success rate provides a percentage of time the measure was successfully completed. The percentage of time the application of the measure caused K2 Powerhouse over-cycling is also presented. For example, on the first row, “Spill Year Schedule Boating Flows and Down Ramping of Spill Flows,” the schedule was completed successfully 100 percent of the time, but it also produced an encroachment toward K2’s minimum operating elevation that induced a K2 Powerhouse over-cycling effect 91.7 percent of the time.

Table 5-1 CEQA Alternatives 1 and 2 performance.

Measure	Count	Success Rate (%)	K2 Powerhouse Over-Cycling (%)
Alternative 1 Ramping Conditions			
Spill Year Schedule Boating Flows and Down Ramping of Spill Flows	12	100	91.7
Non-Spill Year Boating Flows and Down Ramping	28	28.6	4.6
Stranding Protection Down Ramping	8	100	12.5
September – October Down Ramp	4	100	0**
Alternative 1 Ramp Up Measure *	42	97.6	0
Alternative 2 Ramping Conditions			

Measure	Count	Success Rate (%)	K2 Powerhouse Over-Cycling (%)
Modified EOS Flow Recession	10	100	100
Subsequent Spill Ramp Down	5	100	0
Modified Spill Season Flow Measure	30	100	0
POM Initial Release Protocol	12	0	0
Modified POM Ramp Down	12	100	0

*Success would depend on the operator’s ability to receive advanced notification of the timing and magnitude of inflows and accurately predict the optimal initiation time of the ramp up.

**K2 Powerhouse Over-Cycling in WY2007 was not included here since it was very brief.

The following conclusions are presented for each of the Alternative measures:

5.1 CEQA Alternative 1

- 2024 BLM 4(e) Condition 4 – Spill Year Schedule Boating Flows and Down Ramping of Spill Flows. This measure was successful each of the 12 times it was applied during the period of record. However, due to the relatively high flows for ramp down initiation and the relatively long step durations, the K2 Powerhouse’s minimum operating reservoir elevation was encroached upon every instance, and all but one of those encroachments led to K2 Powerhouse over-cycling.
- 2024 BLM 4(e) Condition 4 – Non-Spill Year Boating Flows and Down Ramping. In general, there are typically not enough inflows during the summer months in non-spill years to sustain this schedule. Of the 28 times this was implemented in the period of record (over 6 non-spill years), only 28.6 percent of the time did it produce adequate boating flows. WY 2014 was rather successful, with four of five weekends producing successful boating flows. However, the other non-spill years at best only produced one or two successful weekends each.
- 2024 BLM 4(e) Condition 4 – Stranding Protection Down Ramping. With a more modest schedule initiation flow and shorter step durations, along with elevated inflows during the times this measure is applied, the Stranding Protection Down Ramping was not only 100 percent successful in its application, but it only encroached on the K2 Powerhouse’s minimum operating reservoir elevation 37.5 percent of the time and only induced K2 Powerhouse over-cycling 12.5 percent of the time (one instance in WY 2016).
- September – October Down Ramp. This measure has a similar modest schedule as the Stranding Protection Down Ramping; however, there is typically less inflow

during the months of September and October. So, while this measure was 100 percent successful in its applications, it did encroach on the K2 Powerhouse's minimum operating reservoir elevation 100 percent of the time. However, none of those induced K2 Powerhouse over-cycling, except during a very brief period during WY2007.

- Alternative 1 Ramp Up Measure. The Alternative 1 Ramp Up Measure works very well across the board. It was successful 97.6 percent of the time and caused no encroachment toward Kerckhoff Reservoir's minimum operating elevation or K2 Powerhouse over-cycling. However, the success of the application of this measure depends heavily on advanced notification of the magnitude and timing of forecasted inflows from upstream projects, as well as the skill of the operator to predict the time, in advance of an increase in inflows, at which initiation of the ramp up protocol should begin. It would be better for the operator to initiate the protocol earlier than later, as an earlier start would allow the operator to back off spill if the reservoir were draining too fast and still maintain a rate of stage increase at Gage J-2 of less than one foot per hour. A late start would require the operator to spill more than the protocol allows to prevent the reservoir from rising above guide curve.

5.2 CEQA Alternative 2

- Modified End-of-Spill Flow Recession. There is a 100 percent success rate with this measure; however, the higher initiation flows and longer durations of the schedule lead to significant drawdowns of the reservoir toward the K2 Powerhouse's minimum operating reservoir elevation such that K2 Powerhouse over-cycling happened 100 percent of the time this measure was applied.
- Subsequent Spill Ramp Down Measure. Similar to Alternative 1's Stranding Protection Down Ramping Measure, the modest schedule allows for 100 percent successful application but also minimal effect on reservoir drawdown toward the K2 Powerhouse's minimum operating reservoir elevation and no K2 Powerhouse over-cycling.
- Modified Spill Season Flow Measure. Similar to Alternative 1's Stranding Protection Down Ramping Measure, the modest schedule allows for 100 percent successful application with no significant effect on reservoir drawdown toward the K2 Powerhouse's minimum operating reservoir elevation and no K2 Powerhouse over-cycling.
- Planned Outage Measure Initial Release Protocol. The POM Initial Release Protocol anticipates an initial flow release to Kerckhoff Reservoir through forecasts and alerts, and it pre-spills to match that inflow at 3:30 a.m., when recreators are less likely to be in or around the river. While each application of

the POM Initial Release Protocol can mimic the initial planned outage spill at 3:30 a.m., the protocol is only able to hold that spill for a brief time, before the reservoir drops and available storage volume is depleted. This was the case for 100 percent of the POM Initial Release Protocol applications. While moving the initiation of the spill to 3:30 a.m. creates the sudden rise during nighttime hours, where few if any recreators would be expected to be near the river, moving the spill to happen before inflows arrive causes a drop in spill followed by a secondary spike once inflows do arrive. This secondary spike commonly happens in the middle of the day and typically results in large stage increases at the monitoring sites in the PBR of 1.2 feet to as high as 11.7 feet. As discussed previously, if the initial release protocol was not implemented due to insufficient water availability, if the reservoir received high inflows when it was at full capacity, a similar flow and stage change increase would have occurred due to the K2 Powerhouse being offline.

- Modified Planned Outage Measure Ramp Down. Similar to Alternative 1's Stranding Protection Down Ramping Measure, the modest schedule allows for 100 percent successful application. However, there is significant effect on reservoir drawdown, but no K2 Powerhouse over-cycling.

5.3 Sensitivity Analysis

No sensitivity analysis runs were completed for the modeling effort. Several inputs to the Operations Model have varying degrees of uncertainty. For the purposes of this report, inputs were set to best estimates, based on available data, Kerckhoff Hydroelectric Project understanding, and modeler experience. However, a sensitivity analysis could be conducted to further understand a realistic range of potential results.

This analysis would test the sensitivity of the model results to uncertain inputs, such as the following:

- Spillway rating curves
- Reservoir stage storage curves
- LTOR inflows
- Flood wave travel times in the PBR

In addition, model computation parameters could also be included in this sensitivity analysis, most notably the computation time step. Furthermore, many of the operational measures tested in this report suggest ranges for discharge and variability in step

durations. A sensitivity analysis could test flows and durations within the prescribed ranges to gauge how results react.

6.0 REFERENCES

- Cardno. 2021. Kerckhoff Hydroelectric Project Stage-Discharge Investigation. September 13, 2021
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- Pacific Gas and Electric Company (PG&E). 2025a. Kerckhoff Project ResSim Model – No Action 15-minute LTOR inflow. HEC-ResSim Model Files.
- Pacific Gas and Electric Company (PG&E). 2025b. PGE_Supplemental_FLA_15Min_Model. HEC-ResSim Model Files.
- Personal Email Communication between J. Hartman, Project Manager, Pacific Gas and Electric Company, San Francisco, CA, and C. McCormick, Environmental Scientist, State Water Resources Control Board, CA, regarding "Follow Up Questions and Project Updates," on March 5, 2026.
- United States Department of the Interior (DOI). 2024. Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions on the Federal Energy Regulatory Commission Ready for Environmental Analysis Notice for the Kerckhoff Hydroelectric Project, Federal Energy Regulatory Commission Project No. P-96-048, San Joaquin River, Fresno and Madera Counties, California. United States Department of the Interior, September 24, 2024.
- United States Department of the Interior (DOI). 2025. Revised Conditions and Recommendations for the Kerckhoff Hydroelectric Project, Federal Energy Regulatory Commission Project No. P-96-048, San Joaquin River, Fresno and Madera Counties, California. United States Department of the Interior, May 11, 2025.

APPENDIX A

STORAGE PRESENTED IN MONTHLY MINIMA, AVERAGES, AND MAXIMA

Month	Max				Avg				Min		
	Existing	Alt 1	Alt 2		Existing	Alt 1	Alt 2		Existing	Alt 1	Alt 2
Oct-02	2,325.90	2,355.70	2,325.90		2,187.20	2,182.00	2,175.30		1,695.70	1,697.00	1,659.80
Nov-02	2,317.50	2,318.50	2,316.30		1,891.10	1,891.00	1,890.60		1,690.40	1,691.40	1,690.20
Dec-02	2,275.20	2,283.40	2,274.90		1,999.90	1,998.80	1,996.00		1,701.80	1,698.70	1,699.50
Jan-03	2,279.40	2,279.20	2,268.90		1,900.00	1,900.10	1,901.50		1,692.00	1,691.80	1,697.90
Feb-03	2,300.80	2,306.90	2,301.70		1,971.00	1,973.10	1,969.50		1,703.60	1,703.30	1,701.50
Mar-03	2,298.50	2,298.20	2,299.40		1,957.20	1,957.00	1,957.60		1,692.00	1,691.80	1,694.60
Apr-03	2,296.10	2,295.90	2,296.00		2,024.80	2,024.60	2,024.70		1,695.10	1,694.80	1,694.90
May-03	2,325.90	2,326.60	2,325.90		2,082.70	2,023.60	2,067.90		1,911.60	1,817.10	1,917.20
Jun-03	2,325.90	2,325.90	2,325.90		2,273.10	2,153.60	2,262.90		1,923.80	1,900.80	1,901.40
Jul-03	2,301.90	2,301.90	2,301.90		1,984.50	1,985.90	1,984.50		1,691.60	1,691.60	1,691.60
Aug-03	2,314.80	2,314.90	2,314.80		2,143.80	2,143.80	2,143.80		1,699.00	1,699.00	1,699.00
Sep-03	2,317.90	2,317.90	2,317.90		2,078.20	2,078.20	2,078.20		1,692.10	1,692.10	1,692.10
Oct-03	2,325.90	2,407.40	2,325.90		2,089.20	2,089.60	2,084.20		1,690.40	1,690.40	1,650.80
Nov-03	2,325.90	2,325.90	2,325.90		2,321.00	2,321.00	2,321.00		2,287.70	2,287.70	2,287.70
Dec-03	2,325.90	2,325.90	2,325.90		2,321.30	2,321.30	2,321.30		2,277.70	2,277.70	2,277.70
Jan-04	2,325.90	2,325.90	2,325.90		2,093.70	2,093.70	2,091.80		1,690.80	1,690.80	1,656.30
Feb-04	2,274.10	2,274.10	2,270.60		1,938.50	1,938.50	1,941.40		1,695.00	1,695.00	1,693.20
Mar-04	2,322.40	2,322.40	2,311.70		2,105.20	2,105.20	2,100.10		1,695.40	1,695.40	1,695.60
Apr-04	2,313.20	2,313.20	2,313.50		2,114.10	2,114.10	2,110.80		1,795.40	1,795.40	1,795.70
May-04	2,303.00	2,297.70	2,302.50		2,120.40	2,046.10	2,125.20		1,855.70	1,580.80	1,866.30
Jun-04	2,306.10	2,303.80	2,309.30		2,110.20	2,050.80	2,105.80		1,595.60	1,591.00	1,590.30
Jul-04	2,293.40	2,310.30	2,309.50		2,056.10	2,064.60	2,064.70		1,697.10	1,687.90	1,691.80
Aug-04	2,304.70	2,303.90	2,304.70		1,968.60	1,984.10	1,981.80		1,632.80	1,629.10	1,636.60
Sep-04	2,302.90	2,303.70	2,302.90		1,969.40	1,969.40	1,969.50		1,692.00	1,692.80	1,692.10
Oct-04	2,325.90	2,325.90	2,325.90		2,031.70	2,032.60	2,029.10		1,693.60	1,691.60	1,693.60
Nov-04	2,325.90	2,325.90	2,325.90		2,196.10	2,196.10	2,186.90		1,817.60	1,817.60	1,702.50
Dec-04	2,307.80	2,307.80	2,306.80		2,116.10	2,116.10	2,109.80		1,829.20	1,829.20	1,825.20
Jan-05	2,294.80	2,294.80	2,287.00		2,048.30	2,048.30	2,047.50		1,700.90	1,700.90	1,699.40

	Max				Avg				Min		
Feb-05	2,325.90	2,325.90	2,325.90		2,138.30	2,138.30	2,137.00		1,703.10	1,703.10	1,703.30
Mar-05	2,325.90	2,325.90	2,325.90		2,129.40	2,129.40	2,123.50		1,906.70	1,906.70	1,906.70
Apr-05	2,325.90	2,325.90	2,325.90		2,174.10	2,174.10	2,151.70		1,916.20	1,916.20	1,901.00
May-05	2,325.90	2,368.90	2,325.90		2,302.40	2,302.50	2,245.80		2,145.20	2,145.20	1,925.10
Jun-05	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,325.80		2,325.80	2,325.80	2,325.80
Jul-05	2,325.90	2,325.90	2,325.90		2,305.60	2,093.70	2,275.40		2,058.30	1,899.90	1,916.20
Aug-05	2,308.20	2,303.10	2,308.20		2,136.30	2,132.30	2,136.30		1,921.30	1,922.30	1,921.30
Sep-05	2,316.50	2,314.50	2,316.50		2,172.50	2,174.10	2,172.50		1,913.20	1,913.90	1,913.20
Oct-05	2,325.90	2,325.90	2,325.90		2,259.80	2,258.70	2,248.80		2,112.40	2,111.60	1,687.00
Nov-05	2,325.90	2,325.90	2,325.90		2,101.30	2,101.30	2,094.40		1,694.40	1,694.40	1,670.30
Dec-05	2,325.90	2,325.90	2,325.90		2,147.90	2,147.90	2,148.40		1,825.50	1,825.50	1,824.70
Jan-06	2,325.90	2,325.90	2,325.90		2,139.80	2,139.80	2,139.80		1,910.50	1,910.50	1,910.50
Feb-06	2,325.90	2,320.00	2,325.90		2,040.40	2,039.60	2,040.40		1,696.20	1,696.20	1,696.20
Mar-06	2,325.90	2,334.40	2,325.90		2,114.50	2,106.80	2,104.70		1,911.10	1,912.50	1,912.20
Apr-06	2,325.90	2,325.90	2,325.90		2,317.90	2,316.20	2,313.70		1,903.20	1,884.50	1,877.30
May-06	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,325.80		2,325.80	2,325.80	2,325.80
Jun-06	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,325.80		2,325.80	2,325.80	2,325.80
Jul-06	2,325.90	2,325.90	2,325.90		2,314.70	2,094.50	2,282.70		2,236.20	1,882.80	1,897.80
Aug-06	2,319.00	2,319.00	2,319.00		2,151.60	2,151.60	2,151.60		1,907.70	1,907.70	1,907.70
Sep-06	2,305.90	2,305.90	2,305.90		2,069.20	2,069.20	2,069.20		1,788.00	1,788.00	1,788.00
Oct-06	2,325.90	2,334.10	2,325.90		2,263.90	2,259.50	2,246.10		1,765.80	1,732.30	1,671.80
Nov-06	2,294.90	2,293.90	2,293.80		2,166.10	2,165.90	2,165.90		1,700.10	1,701.50	1,701.50
Dec-06	2,312.60	2,315.60	2,315.60		1,902.80	1,902.70	1,903.10		1,688.80	1,688.70	1,688.70
Jan-07	2,320.30	2,320.60	2,320.60		2,020.10	2,021.90	2,021.90		1,700.70	1,700.10	1,700.00
Feb-07	2,271.90	2,272.90	2,272.90		1,962.30	1,963.10	1,963.10		1,692.70	1,693.00	1,693.00
Mar-07	2,282.20	2,283.30	2,283.10		1,882.60	1,882.70	1,882.60		1,700.10	1,698.40	1,698.40
Apr-07	2,321.30	2,319.20	2,321.60		2,196.00	2,194.40	2,194.50		1,702.20	1,702.70	1,702.50
May-07	2,325.90	2,296.90	2,325.90		2,128.30	2,086.80	2,128.50		1,703.90	1,668.10	1,704.30
Jun-07	2,313.00	2,299.40	2,313.00		2,178.40	2,112.70	2,178.40		1,972.50	1,639.80	1,972.50

	Max				Avg				Min		
Jul-07	2,312.60	2,302.60	2,312.60		2,120.30	2,120.10	2,120.30		1,797.10	1,796.10	1,797.10
Aug-07	2,307.20	2,307.30	2,307.20		2,110.90	2,111.00	2,110.90		1,698.40	1,698.50	1,698.40
Sep-07	2,316.80	2,316.90	2,316.80		2,166.00	2,166.30	2,166.00		1,693.10	1,693.20	1,693.10
Oct-07	2,325.90	2,325.90	2,325.90		2,079.90	2,080.00	2,079.90		1,693.90	1,694.10	1,693.90
Nov-07	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,197.50		2,325.80	2,325.80	1,634.40
Dec-07	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,325.80		2,325.80	2,325.80	2,325.80
Jan-08	2,325.90	2,325.90	2,325.90		2,009.80	2,009.80	2,001.60		1,690.10	1,690.10	1,667.50
Feb-08	2,310.60	2,310.60	2,310.00		2,063.90	2,063.90	2,064.60		1,690.80	1,690.80	1,692.00
Mar-08	2,294.20	2,294.20	2,294.80		2,061.70	2,061.70	2,063.00		1,708.50	1,708.50	1,709.10
Apr-08	2,227.60	2,227.60	2,214.10		1,874.40	1,874.40	1,873.30		1,700.80	1,700.80	1,700.90
May-08	2,325.90	2,336.00	2,325.90		2,202.90	2,159.00	2,197.40		1,993.30	1,910.90	1,920.50
Jun-08	2,292.70	2,292.70	2,292.70		2,151.70	2,151.70	2,151.70		1,977.40	1,977.40	1,977.40
Jul-08	2,303.70	2,303.70	2,303.70		2,109.60	2,109.60	2,109.60		1,878.90	1,878.90	1,878.90
Aug-08	2,300.40	2,300.40	2,300.40		2,100.30	2,100.30	2,100.30		1,904.00	1,904.00	1,904.00
Sep-08	2,254.20	2,254.20	2,254.20		1,926.70	1,926.70	1,926.70		1,788.10	1,788.10	1,788.10
Oct-08	2,325.90	2,325.90	2,325.90		2,016.50	2,016.50	2,016.50		1,692.50	1,692.50	1,692.50
Nov-08	2,325.90	2,325.90	2,325.90		2,041.10	2,041.10	2,009.40		1,696.90	1,696.90	1,669.00
Dec-08	2,256.70	2,256.70	2,255.80		1,900.20	1,900.20	1,898.80		1,699.00	1,699.00	1,697.80
Jan-09	2,317.70	2,317.70	2,315.50		2,071.00	2,071.00	2,071.40		1,700.40	1,700.40	1,699.60
Feb-09	2,308.60	2,308.60	2,308.90		2,186.80	2,186.80	2,186.60		1,899.30	1,899.30	1,902.50
Mar-09	2,305.00	2,305.00	2,305.20		2,083.90	2,083.90	2,084.20		1,891.80	1,891.80	1,892.10
Apr-09	2,325.90	2,331.80	2,325.90		2,195.40	2,195.40	2,172.90		1,780.00	1,780.00	1,828.70
May-09	2,325.90	2,334.80	2,325.90		2,325.30	2,165.30	2,305.60		2,313.00	1,896.50	1,965.00
Jun-09	2,325.90	2,330.20	2,325.90		2,210.30	2,164.70	2,210.30		1,998.20	1,986.00	1,998.20
Jul-09	2,302.70	2,300.10	2,302.70		2,118.50	2,138.60	2,118.50		1,900.20	1,907.10	1,900.20
Aug-09	2,300.80	2,306.60	2,300.80		2,119.40	2,122.50	2,119.40		1,898.30	1,903.50	1,898.30
Sep-09	2,286.50	2,290.20	2,286.50		2,022.70	2,016.80	2,022.70		1,691.90	1,700.30	1,691.90
Oct-09	2,325.90	2,325.90	2,325.90		2,099.80	2,090.30	2,099.80		1,697.30	1,696.90	1,697.30
Nov-09	2,325.90	2,325.90	2,325.90		2,118.50	2,118.50	2,118.50		1,694.70	1,694.70	1,694.70

	Max				Avg				Min		
Dec-09	2,252.10	2,252.10	2,252.10		1,938.80	1,938.80	1,938.80		1,701.20	1,701.20	1,701.20
Jan-10	2,304.80	2,304.80	2,304.80		2,079.60	2,079.60	2,079.60		1,690.40	1,690.40	1,690.40
Feb-10	2,325.90	2,369.20	2,325.90		2,161.10	2,160.70	2,161.10		1,909.60	1,909.60	1,909.60
Mar-10	2,317.10	2,317.10	2,317.10		2,148.30	2,148.30	2,148.30		1,920.60	1,920.60	1,920.60
Apr-10	2,325.90	2,325.90	2,325.90		2,138.50	2,138.50	2,138.20		1,915.70	1,915.70	1,913.20
May-10	2,325.90	2,346.40	2,325.90		2,074.60	2,069.40	2,055.70		1,908.60	1,908.60	1,913.40
Jun-10	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,325.80		2,325.80	2,325.80	2,325.80
Jul-10	2,325.90	2,325.90	2,325.90		2,217.10	2,026.20	2,199.00		1,908.50	1,849.00	1,908.50
Aug-10	2,302.40	2,302.60	2,302.40		2,117.90	2,116.40	2,117.90		1,915.60	1,913.10	1,915.60
Sep-10	2,282.50	2,287.30	2,282.50		2,154.00	2,155.20	2,154.00		1,871.40	1,872.80	1,871.40
Oct-10	2,325.90	2,325.90	2,325.90		2,260.80	2,256.60	2,250.30		1,896.80	1,902.30	1,698.50
Nov-10	2,302.00	2,316.60	2,317.20		2,137.50	2,138.70	2,138.50		1,909.30	1,900.70	1,907.10
Dec-10	2,325.90	2,358.80	2,325.90		2,184.40	2,182.90	2,182.80		1,915.70	1,898.40	1,899.00
Jan-11	2,280.30	2,280.30	2,280.30		2,094.70	2,094.70	2,094.70		1,902.90	1,902.90	1,902.90
Feb-11	2,287.70	2,287.70	2,287.70		2,116.90	2,116.90	2,116.90		1,890.60	1,890.60	1,890.60
Mar-11	2,325.90	2,363.50	2,325.90		2,191.90	2,191.80	2,155.40		1,906.80	1,906.80	1,906.80
Apr-11	2,325.90	2,325.90	2,325.90		2,297.50	2,297.50	2,285.70		1,932.30	1,932.30	1,926.00
May-11	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,320.20		2,289.30	2,289.30	1,971.90
Jun-11	2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,325.80		2,325.80	2,325.80	2,325.80
Jul-11	2,325.90	2,325.90	2,325.90		2,324.20	2,148.50	2,312.40		2,303.70	1,918.10	1,967.00
Aug-11	2,325.90	2,325.90	2,325.90		2,209.50	2,136.30	2,208.00		1,910.80	1,909.40	1,906.40
Sep-11	2,304.80	2,304.80	2,301.00		2,105.10	2,105.10	2,085.70		1,897.10	1,897.10	1,887.40
Oct-11	2,325.90	2,329.00	2,325.90		2,153.90	2,153.90	2,151.50		1,704.30	1,704.30	1,701.70
Nov-11	2,325.90	2,329.20	2,325.90		2,325.80	2,325.90	2,325.80		2,325.80	2,322.50	2,325.80
Dec-11	2,325.90	2,332.80	2,325.90		2,325.90	2,325.80	2,325.90		2,325.80	2,312.80	2,325.80
Jan-12	2,325.90	2,325.90	2,325.90		2,037.70	2,037.70	2,036.90		1,698.70	1,698.70	1,699.10
Feb-12	2,257.10	2,257.10	2,257.50		1,952.00	1,952.00	1,953.40		1,701.40	1,701.40	1,701.80
Mar-12	2,268.30	2,268.30	2,263.60		1,994.60	1,994.60	1,993.80		1,700.70	1,700.70	1,701.50
Apr-12	2,325.90	2,325.90	2,325.90		2,033.10	2,033.10	2,020.40		1,691.60	1,691.60	1,691.60

	Max				Avg				Min		
May-12	2,325.90	2,325.90	2,325.90		2,155.70	2,114.40	2,124.50		1,923.70	1,637.10	1,909.40
Jun-12	2,285.60	2,295.90	2,285.60		2,133.10	2,086.10	2,133.10		1,971.60	1,642.90	1,971.60
Jul-12	2,293.90	2,302.20	2,293.90		2,135.30	2,124.20	2,135.30		1,807.50	1,810.80	1,807.50
Aug-12	2,305.20	2,311.80	2,305.20		2,138.20	2,133.10	2,138.20		1,892.50	1,898.40	1,892.50
Sep-12	2,304.70	2,309.40	2,304.70		2,126.50	2,132.80	2,126.50		1,905.90	1,906.30	1,905.90
Oct-12	2,325.90	2,335.50	2,325.90		2,071.50	2,072.50	2,071.50		1,697.30	1,696.00	1,697.30
Nov-12	2,325.90	2,330.50	2,325.90		2,082.80	2,082.80	2,042.20		1,697.30	1,697.30	1,665.20
Dec-12	2,257.40	2,257.40	2,260.70		1,992.60	1,992.60	1,992.50		1,697.30	1,697.30	1,699.50
Jan-13	2,252.10	2,252.10	2,249.30		1,982.10	1,982.10	1,984.20		1,699.50	1,699.50	1,699.60
Feb-13	2,288.90	2,288.90	2,287.80		2,017.10	2,017.10	2,013.20		1,699.20	1,699.20	1,693.60
Mar-13	2,258.20	2,258.20	2,262.60		1,938.90	1,938.90	1,934.70		1,698.20	1,698.20	1,698.10
Apr-13	2,296.00	2,296.00	2,295.80		2,066.60	2,066.60	2,066.70		1,697.30	1,697.30	1,697.10
May-13	2,303.50	2,303.50	2,303.30		2,129.60	2,078.20	2,129.40		1,883.70	1,635.30	1,883.60
Jun-13	2,301.20	2,293.40	2,301.00		2,078.20	2,013.60	2,069.10		1,648.30	1,266.70	1,648.10
Jul-13	2,307.90	2,306.80	2,306.60		2,086.60	2,086.00	2,086.60		1,907.20	1,906.70	1,906.50
Aug-13	2,325.90	2,325.90	2,325.90		2,150.10	2,149.30	2,149.20		1,704.90	1,700.10	1,699.90
Sep-13	2,293.90	2,293.90	2,293.90		2,159.70	2,159.70	2,159.70		1,909.50	1,909.50	1,909.50
Oct-13	2,325.90	2,327.80	2,325.90		2,078.10	2,078.10	2,078.10		1,694.50	1,694.50	1,694.50
Nov-13	2,325.90	2,325.90	2,325.90		2,096.80	2,096.80	2,096.80		1,694.70	1,694.70	1,694.70
Dec-13	2,248.20	2,248.20	2,248.20		1,970.90	1,970.90	1,970.90		1,695.00	1,695.00	1,695.00
Jan-14	2,246.90	2,246.90	2,246.90		1,944.30	1,944.30	1,944.30		1,689.60	1,689.60	1,689.60
Feb-14	2,245.10	2,245.10	2,245.10		1,973.60	1,973.60	1,973.60		1,691.80	1,691.80	1,691.80
Mar-14	2,250.00	2,250.00	2,250.00		1,956.60	1,956.60	1,956.60		1,692.10	1,692.10	1,692.10
Apr-14	2,302.50	2,302.50	2,302.50		2,054.30	2,054.30	2,054.30		1,690.10	1,690.10	1,690.10
May-14	2,307.90	2,307.20	2,307.90		2,124.80	2,105.30	2,124.80		1,899.70	1,793.90	1,899.70
Jun-14	2,325.90	2,300.40	2,325.90		2,152.50	2,089.60	2,152.50		1,969.30	1,538.90	1,969.30
Jul-14	2,267.60	2,268.20	2,267.60		1,994.80	1,996.70	1,994.80		1,701.40	1,700.00	1,701.40
Aug-14	2,271.30	2,275.20	2,271.30		2,057.50	2,057.40	2,057.50		1,702.80	1,702.20	1,702.80
Sep-14	2,283.50	2,294.90	2,283.50		1,999.00	1,999.30	1,999.00		1,695.10	1,691.30	1,695.10

	Max				Avg				Min		
Oct-14	2,325.90	2,325.90	2,325.90		2,108.30	2,107.30	2,108.30		1,694.20	1,694.20	1,694.20
Nov-14	2,245.00	2,245.00	2,245.00		1,959.60	1,959.60	1,959.60		1,691.10	1,691.10	1,691.10
Dec-14	2,254.70	2,254.70	2,254.70		1,968.60	1,968.60	1,968.60		1,692.80	1,692.80	1,692.80
Jan-15	2,249.00	2,249.00	2,249.00		1,973.70	1,973.70	1,973.70		1,696.50	1,696.50	1,696.50
Feb-15	2,255.40	2,255.40	2,255.40		1,969.60	1,969.60	1,969.60		1,695.00	1,695.00	1,695.00
Mar-15	2,261.20	2,261.20	2,261.20		1,918.90	1,918.90	1,918.90		1,694.10	1,694.10	1,694.10
Apr-15	2,244.90	2,244.90	2,244.90		1,952.70	1,952.70	1,952.70		1,691.00	1,691.00	1,691.00
May-15	2,244.80	2,244.60	2,244.80		1,970.50	1,853.60	1,970.50		1,688.70	1,634.00	1,688.70
Jun-15	2,294.20	2,316.70	2,294.20		1,954.60	1,905.90	1,954.60		1,690.80	1,633.80	1,690.80
Jul-15	2,302.00	2,299.90	2,302.00		2,039.70	2,056.90	2,039.70		1,702.20	1,699.40	1,702.20
Aug-15	2,309.60	2,308.80	2,309.60		2,060.40	2,060.50	2,060.40		1,702.10	1,701.30	1,702.10
Sep-15	2,294.60	2,296.20	2,294.60		2,079.30	2,080.60	2,079.30		1,688.30	1,690.00	1,688.30
Oct-15	2,325.90	2,325.90	2,325.90		2,069.00	2,069.80	2,069.00		1,692.20	1,692.50	1,692.20
Nov-15	2,325.90	2,326.30	2,325.90		2,325.90	2,325.80	2,325.90		2,325.80	2,324.20	2,325.80
Dec-15	2,325.90	2,327.50	2,325.90		2,325.80	2,325.80	2,319.80		2,325.80	2,323.80	1,914.80
Jan-16	2,325.90	2,329.20	2,325.90		2,325.90	2,325.80	2,325.90		2,325.80	2,301.10	2,325.80
Feb-16	2,325.90	2,325.90	2,325.90		2,325.90	2,325.90	2,325.90		2,325.80	2,325.80	2,325.80
Mar-16	2,325.90	2,325.90	2,325.90		2,245.20	2,245.20	2,246.20		1,902.60	1,902.60	1,901.90
Apr-16	2,297.40	2,297.40	2,301.00		2,092.30	2,092.30	2,095.40		1,892.80	1,892.80	1,892.10
May-16	2,303.80	2,303.80	2,295.50		2,124.10	2,124.10	2,123.30		1,906.60	1,906.60	1,907.30
Jun-16	2,325.90	2,379.70	2,325.90		2,251.30	2,129.80	2,237.70		1,984.10	1,903.10	1,911.80
Jul-16	2,304.50	2,299.70	2,301.70		2,105.60	2,099.10	2,099.20		1,902.10	1,896.60	1,898.70
Aug-16	2,301.20	2,298.90	2,305.50		2,125.40	2,136.50	2,119.90		1,836.60	1,910.30	1,874.40
Sep-16	2,284.50	2,283.00	2,284.40		2,117.40	2,118.60	2,117.30		1,899.20	1,904.10	1,899.10
Oct-16	2,325.90	2,325.90	2,325.90		2,234.70	2,233.60	2,234.60		1,840.90	1,839.40	1,840.90
Nov-16	2,325.90	2,325.90	2,325.90		2,182.00	2,182.00	2,175.60		1,902.90	1,902.90	1,772.30
Dec-16	2,294.60	2,294.60	2,293.60		2,171.50	2,171.50	2,171.10		1,905.20	1,905.20	1,904.50
Jan-17	2,325.90	2,326.50	2,325.90		2,267.30	2,266.70	2,267.10		1,916.40	1,916.40	1,915.40
Feb-17	2,328.10	2,328.10	2,328.10		2,306.30	2,306.00	2,306.30		2,114.60	2,114.60	2,114.60

	Max					Avg					Min		
Mar-17	2,325.90	2,325.90	2,325.90			2,323.60	2,323.60	2,323.60			2,314.00	2,314.00	2,314.00
Apr-17	2,325.90	2,325.90	2,325.90			2,325.80	2,325.80	2,318.50			2,324.70	2,324.70	2,108.00
May-17	2,325.90	2,325.90	2,325.90			2,325.80	2,325.80	2,325.80			2,325.80	2,325.80	2,325.80
Jun-17	2,325.90	2,325.90	2,325.90			2,325.80	2,325.80	2,325.80			2,325.80	2,325.80	2,325.80
Jul-17	2,325.90	2,325.90	2,325.90			2,324.80	2,134.20	2,285.70			2,308.50	1,907.70	1,913.40
Aug-17	2,325.90	2,325.90	2,325.90			2,176.60	2,077.30	2,176.60			1,908.00	1,908.00	1,908.00
Sep-17	2,314.60	2,314.60	2,314.60			2,105.80	2,105.80	2,105.80			1,903.50	1,903.50	1,903.50